This manual links to Kinetix 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

# Kinetix 5100 EtherNet/IP Indexing Servo Drives

Catalog Numbers 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, 2198-E4004-ERS, 2198-E4007-ERS, 2198-E4015-ERS, 2198-E4020-ERS, 2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, 2198-E4150-ERS

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual

Original Instructions

# Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

**IMPORTANT** Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

## Set Up EtherNet/IP Communication

Chapter 5



## Use the Keypad Interface

Chapter 6



## Configure the Drive with KNX5100C Software

Chapter 7



## Configure the Drive in Studio 5000 Logix Designer Application

Chapter 8



## Tuning

Chapter 9



## Modes of Operation

Chapter 10

## Chapter 16

### Troubleshoot the Kinetix 5100 Drive System



## Appendix A

### Interconnect Diagrams



## Appendix B

### Upgrade Kinetix 5100 Drive Firmware



## Appendix C

### Use Add-On Instructions



## Appendix D

### Full Closed Loop Control



## Appendix E

### Use the Scope Function in KNX5100C Software



## Appendix F

### History of Changes

This manual provides detailed installation instructions for mounting, wiring, and troubleshooting your Kinetix® 5100 drive; and system integration for your drive/motor combination with a Logix controller.

This manual is intended for engineers and technicians that are directly involved in the installation and wiring of the Kinetix 5100 drive and programmers who are directly involved in operation, field maintenance, and integration of the Kinetix 5100 drive.

If you do not have a basic understanding of the Kinetix 5100 drive, contact your local Rockwell Automation sales representative for information on available training courses.

## Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes. Translated versions are not always available for each revision.

| Topic | Page |
|---|---|
| Added support for linear actuators, linear motors, and induction motors. | Throughout |
| Updated guidance for downloading fault code and parameter spreadsheets. | Throughout |
| Updated the Typical Control Configurations section. | 18 |
| Updated Table 34 - Feedback Signals by Device Type. | 67 |
| Updated cable information to include linear actuators, linear motors, and induction motors. | 87…90 |
| Added a procedure for Motor Analyzer - Rotary Motors and Linear Motors. | 136 |
| Added a procedure for Dynamic Motor Analyzer - Induction Motors. | 137 |
| Added a procedure for Static Motor Analyzer - Induction Motors. | 138 |
| Added a procedure for Inertia Estimation Motor Analyzer - Induction Motors. | 139 |
| Updated the Configure Electronic Gear (E-Gear) Ratio section. | 162 |
| Updated Chapter 9, Tuning. | 194 |
| Added Select Operation Mode and Direction Control section. | 228 |
| Updated the Position Control section. | 230 |
| Updated the Speed Mode section. | 240 |
| Updated the Torque Mode section. | 246 |
| Added a Filter section to combine the filter types into one section. | 250 |
| Updated the Dual and Multi-modes section. | 263 |
| Updated the Analog Outputs and Monitoring section. | 276 |
| Updated the Detailed Operation in PR Mode section. | 280 |
| Updated the Homing section. | 292 |
| Added information to the Arithmetic Operation Commands section. | 332 |
| Updated the PR Execution Process section. | 351 |
| Added Kinetix 5100 Servo Drive and Linear Actuator Wiring Examples. | 460 |
| Updated Appendix C Use Add-On Instructions. | 479 |

## Conventions

These conventions are used throughout this manual:

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide steps or hierarchical information.
- Parameters are shown in this format: ID185 (P2.000).

## Access Fault Codes and Parameter List

This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

## Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

| Resource | Description |
|---|---|
| Kinetix 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001 | Provides the fault codes for Kinetix 5100 servo drives. |
| Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002 | Provides the parameters for Kinetix 5100 servo drives. |
| Kinetix Rotary Motion Specifications, publication KNX-TD001 | Provides product specifications for Kinetix VPL, VPC, VPF, VPH, VPS, Kinetix MPL, MPM, MPF, MPS; Kinetix TL and TLY, Kinetix RDB, and Kinetix HPK rotary motors. |
| Kinetix Linear Motion Specifications, publication KNX-TD002 | Provides product specifications for Kinetix MPAS and MPMA linear stages, Kinetix VPAR, MPAR, and MPAI electric cylinders, and Kinetix LDC and Kinetix LDL linear motors. |
| Kinetix 5700, 5500, 5300, 5100 Servo Drives Specifications, publication KNX-TD003 | Provides product specifications for Kinetix Integrated Motion over the EtherNet/IP network and EtherNet/IP networking servo drive families. |
| Kinetix Rotary and Linear Motion Cable Specifications Technical Data, publication KNX-TD004 | Product specifications for Kinetix 2090 motor and interface cables. |
| Kinetix 3, 300, 350, 2000, 6000, 6200, 6500, 7000 Servo Drives Specifications, publication KNX-TD005 | Provides product specifications for Kinetix Integrated Motion over the EtherNet/IP network (Kinetix 6500 and Kinetix 350), Integrated Motion over Sercos interface (Kinetix 6200, Kinetix 6000, Kinetix 2000, and Kinetix 7000), and component (Kinetix 3) servo drive families. |
| Kinetix 5100 Drive Systems Design Guide, publication KNX-RM011 | System design guide to select the required (drive specific) drive module, power accessory, feedback connector kit, and motor cable catalog numbers for your Kinetix 5100 drive system. |
| Kinetix 5100 EtherNet/IP Indexing Servo Drive Automatic Device Configuration Application Technique, publication 2198-AT004 | Provides information on how to use Automatic Device Configuration to configure your Kinetix drive. |
| Ultra3000 to Kinetix 5100 Servo Drive Migration Guide, publication 2198-RM003 | Provides information on how to migrate from the Ultra™3000 drive to the Kinetix 5100 servo drive. |
| Kinetix 300 to Kinetix 5100 Servo Drive Migration Guide, publication 2198-RM004 | Provides information on how to migrate from the Kinetix 300 drive to the Kinetix 5100 servo drive. |
| Kinetix 5100 AC Line Filter Installation Instructions, publication 2198-IN017 | Provides information on how to install and wire the Kinetix 5100 AC line filters. |
| Kinetix 5100 Auxiliary Feedback Connector Kit Installation Instructions, publication 2198-IN018 | Provides information on how to attach the Kinetix 5100 auxiliary feedback connector kit to your shielded, twisted-pair customer-supplied cable. |
| Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019 | Provides information on how to attach the Kinetix 5100 feedback connector kit to Kinetix 2090 flying lead motor feedback cables. |
| Kinetix 5100 I/O Terminal Expansion Block Installation Instructions, publication 2198-IN020 | Provides information on how to install and wire the Kinetix 5100 I/O terminal expansion block. |
| Kinetix 5700 Shunt Passive Modules Installation Instructions, publication 2198-IN011 | Provides information on how to install and wire 2198-R004 and 2198-R031 passive shunts for use with Kinetix 5100 servo drives. |
| Kinetix 300 Shunt Resistor Installation Instructions, publication 2097-IN002 | Provides information on how to install and wire 2097-R6 and 2097-R7 shunt resistors for use with Kinetix 5100 servo drives. |
| Feedback Battery Box Installation Instructions, publication 2198-IN022 | Provides information on how to install or replace a battery box, install a battery, and prepare a feedback cable for a battery box installation. |
| Shaft Seal Kits for Kinetix TLP Motors Installation Instructions, publication 2090-IN044 | Provides information about how to remove and replace shaft seals on Kinetix TLP motors. |
| 2090-Series Kinetix TLP Power and Feedback Cables, publication 2090-IN046 | Provides information on how to build cables for Kinetix TLP servo motors. |
| Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048 | Provides information on how to attach Kinetix 2090 connector kits to bulk cable and build your own Kinetix TLP motor power and feedback cables. |

| Resource | Description |
|---|---|
| Kinetix TLP Multi-purpose Servo Motors Installation Instructions, publication TLP-IN001 | Provides information on how to install the Kinetix TLP multi-purpose servo motor. |
| System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001 | Provides information, examples, and techniques designed to minimize system failures caused by electrical noise. |
| Servo Drive Installation Best Practices Application Technique, publication MOTION-AT004 | Best practice examples to help reduce the number of potential noise or electromagnetic interference (EMI) sources in your system and to make sure that the noise sensitive components are not affected by the remaining noise. |
| Kinetix Motion Control Selection Guide, publication KNX-SG001 | Overview of Kinetix servo drives, motors, actuators, and motion accessories that are designed to help make initial decisions for the motion control products best suited for your system requirements. |
| MicroLogix 1100 Programmable Controllers User Manual, publication 1763-UM001 | Provides information on how to install, wire, and troubleshoot the MicroLogix™ programmable controllers. |
| MicroLogix 1200 Programmable Controllers User Manual, publication 1762-UM001 | |
| MicroLogix 1400 Programmable Controllers User Manual, publication 1766-UM001 | |
| Micro810 Programmable Controllers User Manual, publication 2080-UM001 | Provides information on how to install, wire, and troubleshoot the Micro800™ programmable controllers. |
| Micro820 Programmable Controllers User Manual, publication 2080-UM005 | |
| Micro830, Micro850, Micro870, Programmable Controllers User Manual, publication 2080-UM002 | |
| GuardLogix 5570 Controllers User Manual, publication 1756-UM022 | Provides information on how to install, configure, program, and use ControlLogix® controllers and GuardLogix® controllers in Studio 5000 Logix Designer® projects. |
| GuardLogix 5580 Controllers User Manual, publication 1756-UM543 | |
| Compact GuardLogix 5370 Controllers User Manual, publication 1769-UM022 | Provides information on how to install, configure, program, and use CompactLogix™ and Compact GuardLogix controllers. |
| Compact GuardLogix 5380 Controllers User Manual, publication 5069-UM001 | |
| GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099 | Provides information on how to achieve and maintain Safety Integrity Level (SIL) and Performance Level (PL) safety application requirements for GuardLogix and Compact GuardLogix controllers. |
| GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference Manual, publication 1756-RM012 | |
| ControlFLASH Firmware Upgrade Kit User Manual, publication 1756-UM105 | Provides information on how to upgrade your drive firmware by using ControlFLASH™ software. |
| Rockwell Automation Product Selection website http://www.rockwellautomation.com/global/support/selection.page | Online product selection and system configuration tools, including AutoCAD (DXF) drawings. |
| Motion Analyzer System Sizing and Selection Tool website https://motionanalyzer.rockwellautomation.com/ | Comprehensive motion application sizing tool used for analysis, optimization, selection, and validation of your Kinetix Motion Control system. |
| EtherNet/IP Network Devices User Manual, ENET-UM006 | Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network. |
| Ethernet Reference Manual, ENET-RM002 | Describes basic Ethernet concepts, infrastructure components, and infrastructure features. |
| Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control, publication SGI-1.1 | Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components. |
| Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1 | Provides general guidelines for installing a Rockwell Automation industrial system. |
| Product Certifications website, rok.auto/certifications. | Provides declarations of conformity, certificates, and other certification details. |

# Notes:

Chapter 1

# Start

Use this chapter to become familiar with the Kinetix® 5100 drive system and obtain an overview of installation configurations.



## About the Kinetix 5100 Drive System

The Kinetix 5100 EtherNet/IP™ indexing servo drives are designed to provide a single drive solution for applications with output power requirements between 0.4…15.0 kW (2.6…78 A rms).

**Table 1 - Kinetix 5100 Drive System Overview**

| Kinetix 5100 System Component | Cat. No. | Description |
|---|---|---|
| Kinetix 5100 Servo Drive | 2198-E*xxxx*-ERS | Kinetix 5100 EtherNet/IP indexing drives with Safe Torque Off (STO) are available with 120V single-phase, 200…230V single-phase, 230V three-phase, and 480V three-phase (nom) input voltages. |
| Terminal block for I/O connector | 2198-TBIO | 50-pin terminal block. Plugs into I/O connector for control interface connections. |
| Motor Feedback Connector Kit | 2198-K51CK-D15M | Motor feedback connector kit with 15-pin connector plug for compatible servo motors. Kit features battery backup for Kinetix TLP, TL, and TLY multi-turn encoders. |
| Auxiliary Feedback Connector Kit | 2198-AUXKIT | Auxiliary feedback connector kit for master feedback and load feedback connections to the AUX connector. |
| Feedback Battery Box | 2198-KTBT | The feedback battery box is used in applications where Kinetix TLP motor position data must be maintained in the event of a power loss. The battery box is included with Kinetix 2090 cables for Kinetix TLP motors and is also available as this replacement kit. |
| Logix PAC® Controller Platforms | Bulletin 5069 and 1769 | EtherNet/IP networking with CompactLogix™ 5370 and CompactLogix 5380 controllers with embedded dual-port. CompactLogix 5480 controllers for the benefits of Logix control with Windows®-based computing. |
| | 1756-EN2T, 1756-EN2TR, and 1756-EN3TR module | EtherNet/IP network communication modules for use with ControlLogix® 5570 and ControlLogix 5580 controllers. |
| Micro Controller Platforms | MicroLogix™ 1400 controllers provide communication ports, an isolated combination RS-232/485 communication port, an Ethernet port, and a non-isolated RS-232 communication port. | |
| | Micro800™ controllers with embedded inputs/outputs can accommodate from two to five plug-in modules and up to four expansion I/O modules. | |
| Configuration Software | Studio 5000® Environment | Studio 5000 Logix Designer® application (version 30 or later) is used to program, commission, and maintain Logix 5000™ controllers. |
| | Connected Components Workbench software | Connected Components Workbench™ design and configuration software (CCW), version 10.0 or later, provides support for programming, configuration of Micro800 controller, and integration with the HMI editor. |
| | KNX5100C software | KNX5100C software, version 1.001 or later, provides configuration and tuning of Kinetix 5100 drives via the mini-USB cable connection. |
| | RSLogix 500® software | RSLogix 500 software is used to program MicroLogix 1100 and 1400 controllers. |
| Rotary Servo Motors | Kinetix TLP | Compatible rotary motors include Kinetix TLP (200V and 400V-class) servo motors. |
| | Kinetix MP | Compatible rotary motors include Kinetix MPL, MPM, MPF, and MPS (200V and 400V-class) servo motors. |
| | Kinetix TL and TLY | Compatible rotary motors include Kinetix TL and TLY (200V-class) servo motors. |

**Table 1 - Kinetix 5100 Drive System Overview (Continued)**

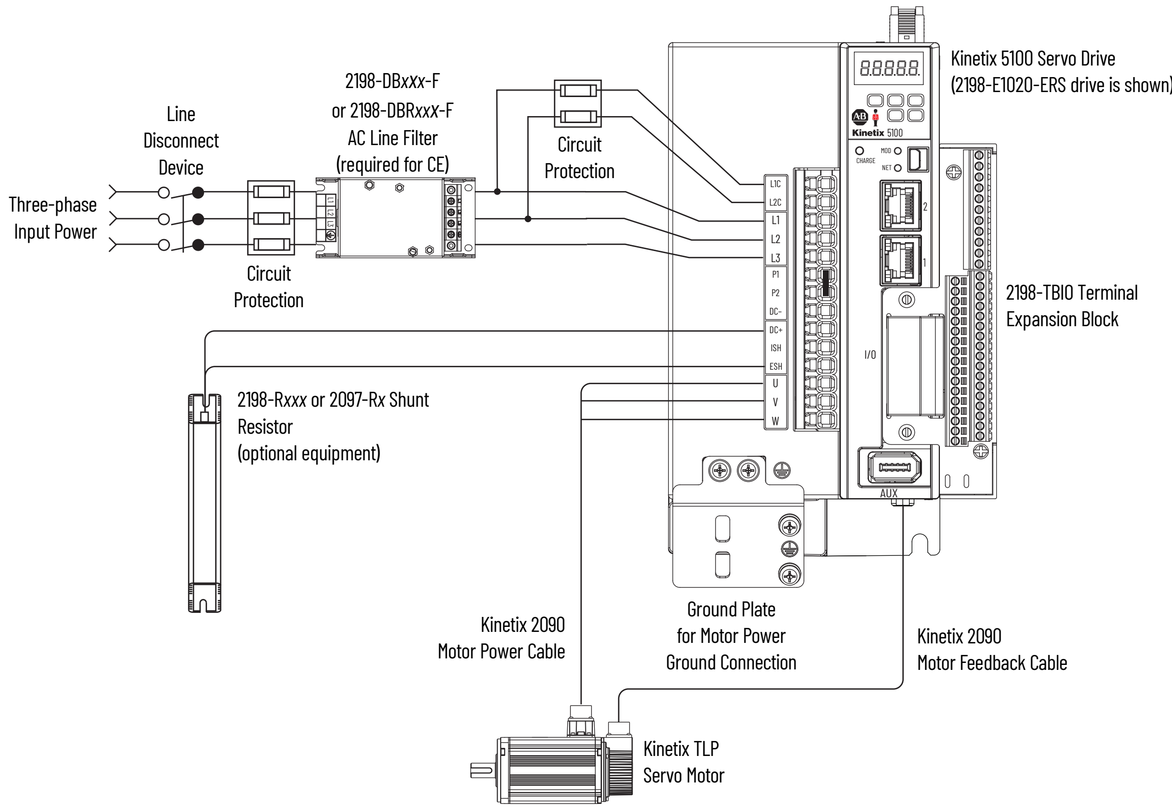
| Kinetix 5100 System Component | Cat. No. | Description |
|---|---|---|
| Linear Actuators | Kinetix MP and LDAT | Compatible linear actuators include 200V and 400V-class Kinetix MPAS and MPMA linear stages, Kinetix MPAR and MPAI linear actuators, and LDAT-Series linear thrusters. |
| Linear Motors | Kinetix LDC and LDL | Compatible motors include Kinetix LDC iron-core and Kinetix LDL ironless linear motors. |
| Induction Motors | N/A | Induction motors with closed-loop control are supported. |
| Cables | 2090-CTFB-MxDx-*xxxxx* | Kinetix 2090 motor feedback cables for Kinetix TLP motors. |
| | 2090-CTPx-MxDx-*xxxxx* | Kinetix 2090 motor power/brake cables for Kinetix TLP motors. |
| | 2090-CFBM6Dx-CxAA*xx* | Motor feedback cables for Kinetix TLY servo motors. |
| | 2090-CP*x*M6DF-16AA*xx* | Motor power/brake cables for Kinetix TLY servo motors. |
| | 2090-DANFCT-S*xx* | Motor feedback cables for Kinetix TL servo motors. |
| | 2090-DANPT-16S*xx* | Motor power cables for Kinetix TL servo motors. |
| | 2090-DANBT-18S*xx* | Motor brake cables for Kinetix TL servo motors. |
| | 2090-CFBM7DF-CEA*xxx* | Motor feedback cables for Kinetix MP servo motors with Hiperface encoders. |
| | 2090-CP*x*M7DF-*xx*A*xxx* | Motor power/brake cables for Kinetix MP servo motors. |
| | 2090-XXNFMF-S*xx*<br>2090-CFBM7DF-CDAF*xx* | Standard and continuous-flex feedback cables that include additional conductors for use with incremental encoders. |
| | 1585J-M8CBJM-*x*<br>1585J-M8UBJM-*x* | Ethernet cables are available in standard lengths. Shielded cable is required to meet EMC specifications. |
| | 2198-USBC | Interface cable with mini-USB connector for KNX5100C software configuration. |
| | 2198-USBF | Filter for mini-USB port to reduce the vulnerability to electrical noise. |
| AC Line Filters | 2198-DB*xxx*-F<br>2198-DBR*xxx*-F | Bulletin 2198 three-phase AC line filters are required to meet CE and are available for use in all Kinetix 5100 drive systems. |
| 24V DC Power Supply | 1606-XL*xxx* | Bulletin 1606 24V DC power supply for digital input/output, Safe Torque Off (STO) circuitry, and motor brake control. |
| External Shunt Resistors | 2097-R6, and 2097-R7<br>2198-R004, 2198-R031 | Bulletin 2097 and 2198 external passive shunt resistors are available for when the internal shunt capability of the drive is exceeded. |

# Typical Hardware Configuration

Typical Kinetix 5100 drive systems include single-phase and three-phase standalone configurations.

In this example, three-phase input power is applied to the Kinetix 5100 drive.

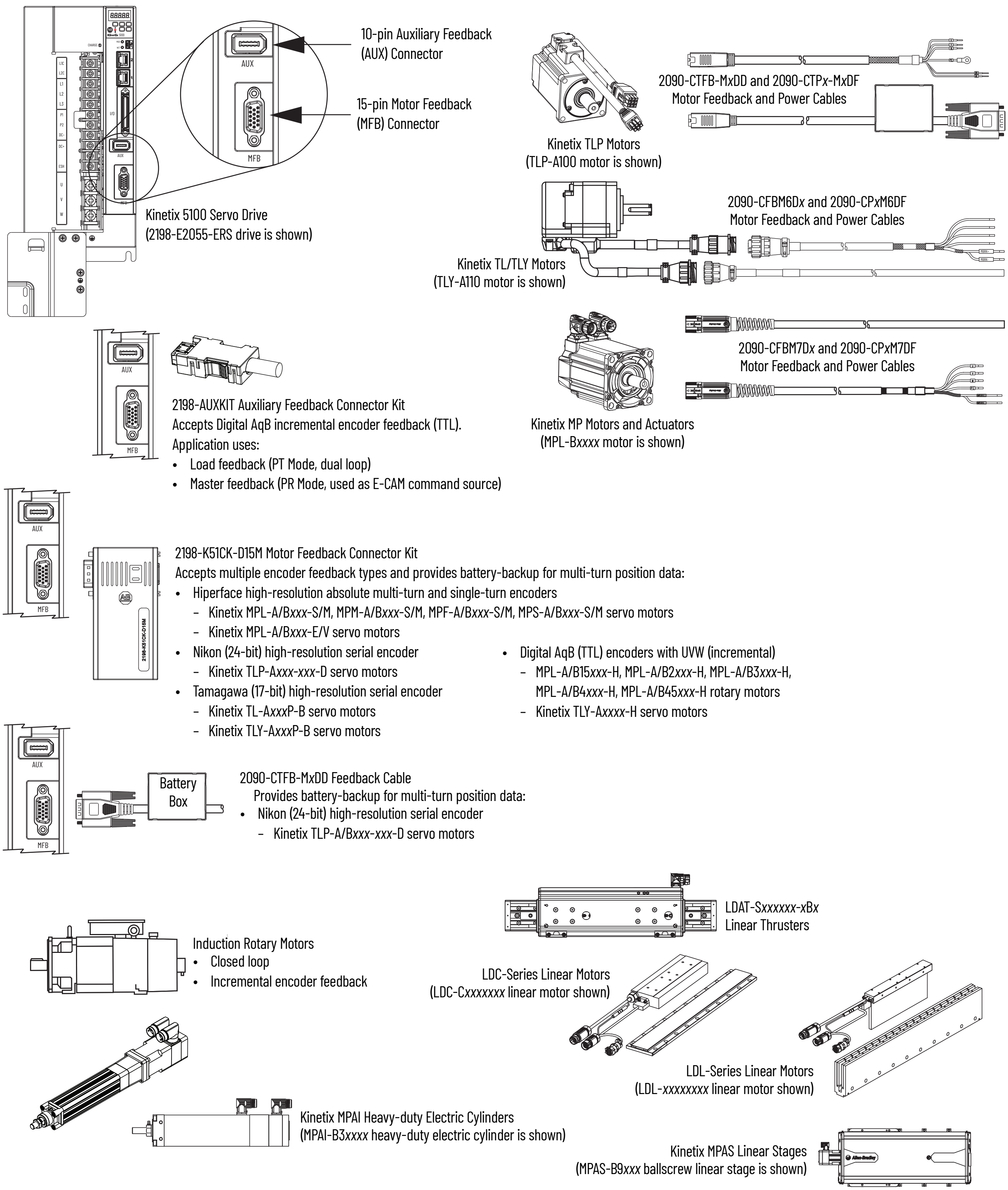
**Figure 1 - Kinetix 5100 Standalone Drive with Three-phase Input Power**



## Motor and Auxiliary Feedback Configurations

Motor feedback connections are made at the 15-pin motor feedback (MFB) connector. Auxiliary feedback connections are made by using the auxiliary feedback (AUX) connector. These examples illustrate how you can use the Bulletin 2198 connector kits for making these connections. To see motor power and brake connections, refer to Chapter 4 on page 88.

**Figure 2 - Feedback Configuration Example**



## Typical Communication Configurations

The Kinetix 5100 drives support linear, ring, and star Ethernet topologies by using ControlLogix, CompactLogix, MicroLogix, and Micro800 controllers.

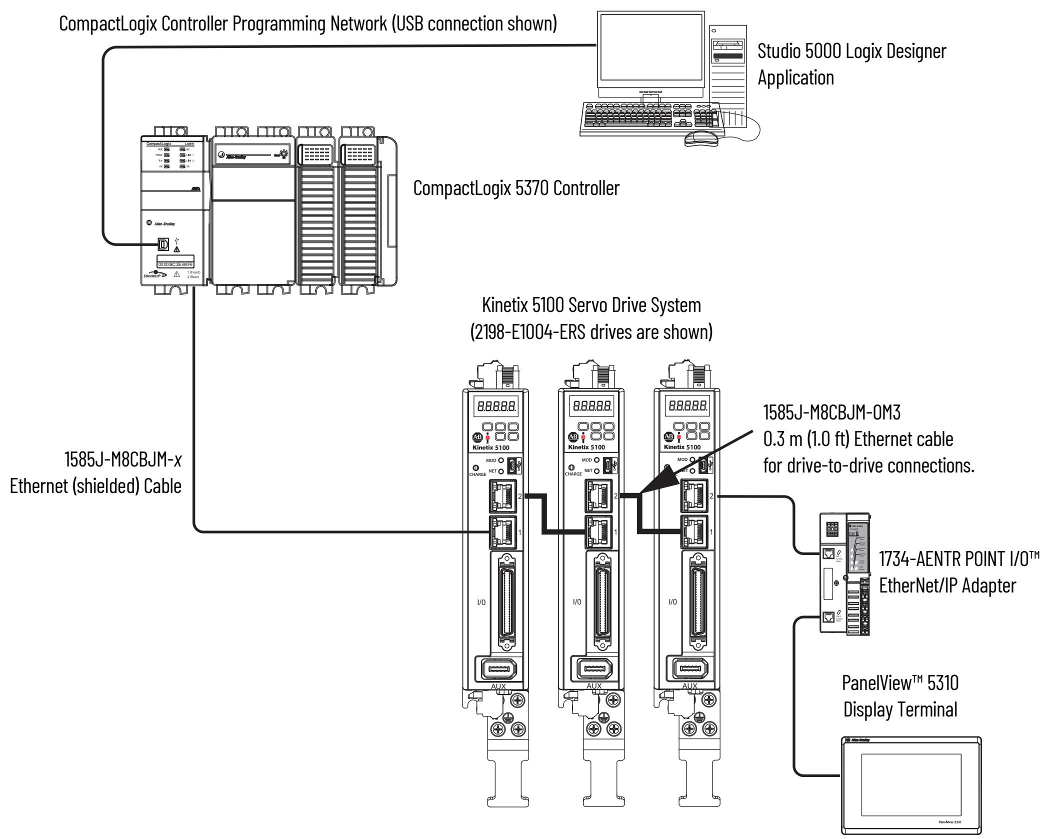
These examples feature the CompactLogix 5370 programmable automation controllers (catalog number 1769-L*xx*ER, for example) with support for Kinetix 5100 drives via Class 1 EtherNet/IP connection by using an Add-On Profile (AOP) and Add-On Instructions or Explicit Messaging (using Class 3 EtherNet/IP messaging) over the EtherNet/IP network. Other Allen-Bradley® controllers are also compatible with the Kinetix 5100 servo drives.

Refer to CompactLogix Controllers Specifications Technical Data, publication 1769-TD005, for more information on CompactLogix 5370 L1, L2, and L3 controllers.

### Linear Topology

In this example, all devices are connected in linear topology. The Kinetix 5100 drives include dual-port connectivity, however, if any device becomes disconnected, all devices downstream of that device lose communication. Devices without dual-ports must include the 1783-ETAP module or be connected at the end of the line.

**Figure 3 - Kinetix 5100 Linear Communication Installation**

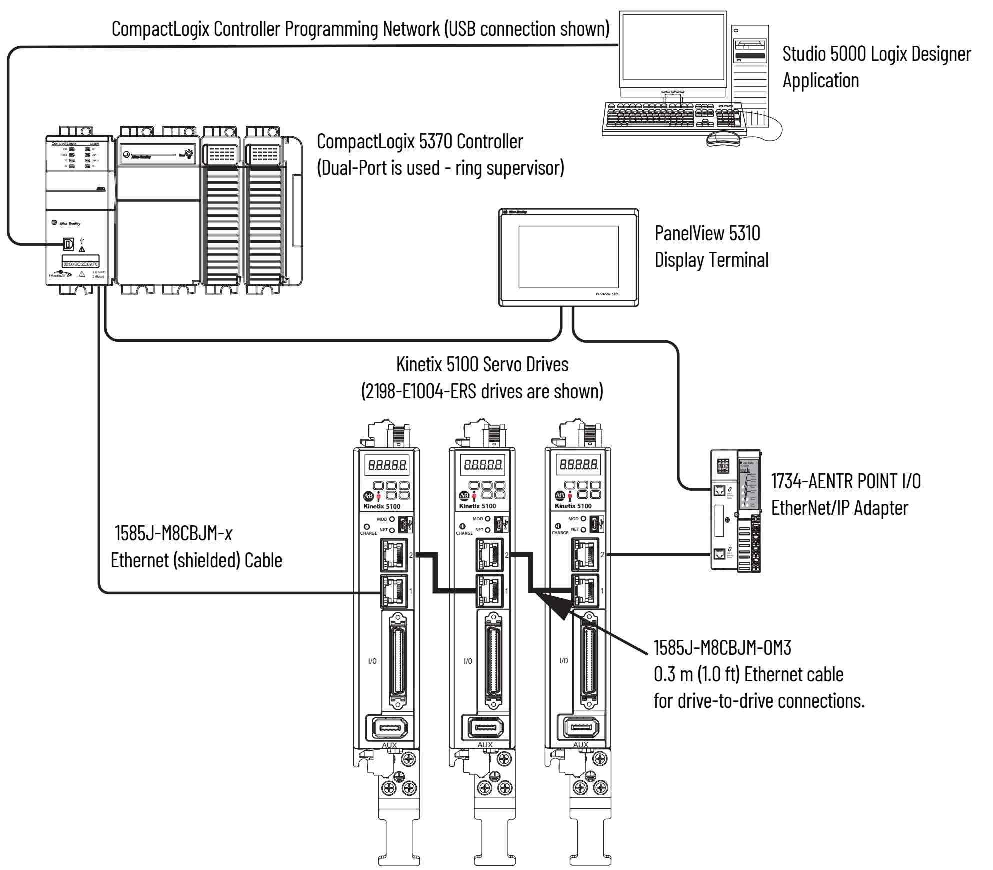


## Ring Topology

In this example, the devices are connected by using ring topology. If only one device in the ring is disconnected, the rest of the devices continue to communicate. For the ring topology to work correctly, a Device Level Ring (DLR) supervisor is required (for example, the Bulletin 1783 ETAP device). DLR is an ODVA standard. For more information, refer to the EtherNet/IP Embedded Switch Technology Application Guide, publication ENET-AP005.

Devices without dual-ports, for example the display terminal, require a 1783-ETAP module to complete the network ring.

**Figure 4 - Kinetix 5100 Ring Communication Installation**

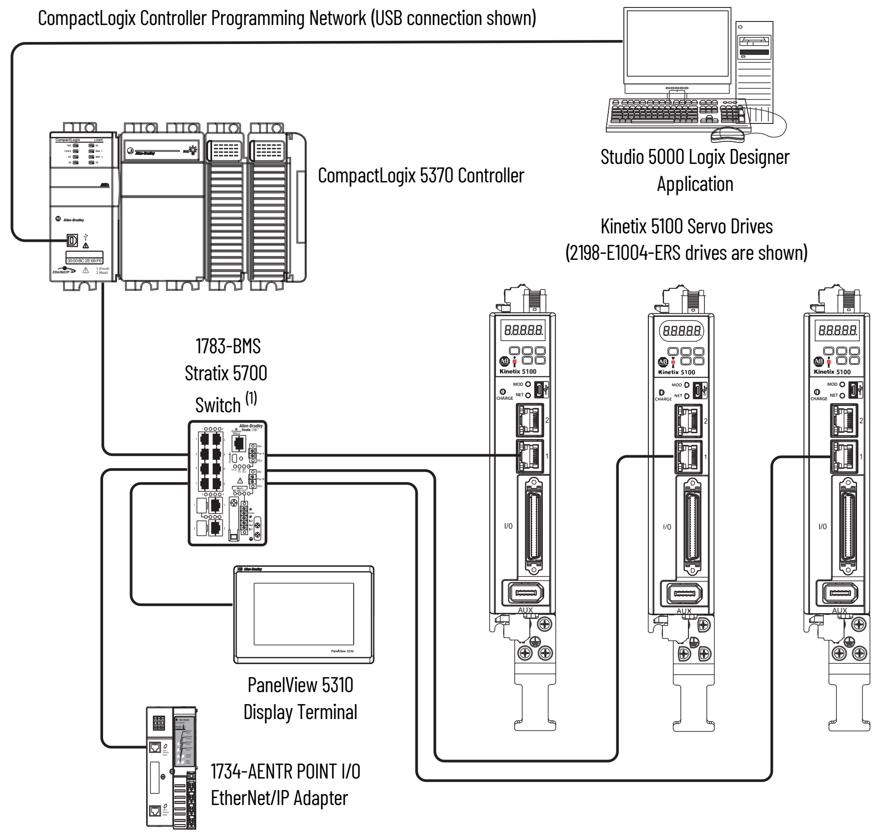


## Star Topology

In this example, the devices are connected by using star topology. Each device is connected directly through a Stratix® 5700 switch.

Kinetix 5100 drives have dual-ports, so linear topology is maintained from the switch port to the drive, but each drive uses a unique port on the Ethernet switch. The loss of one device does not impact the operation of other devices.

**Figure 5 - Kinetix 5100 Star Communication Installation**




(1) While a switch with PTP is shown in this example, the Kinetix 5100 drive does not require a switch with the PTP function.

## Typical Control Configurations

You can configure Kinetix 5100 servo drives by using various methods for network control.

All Kinetix 5100 drive configurations require the use of KNX5100c software. This software is required to configure the following:

- Motor direction (rotation) and unit scaling
- Motor and feedback selection (including loop types)
- Digital I/O
- Tuning
- E-CAM profiles
- PR configurations

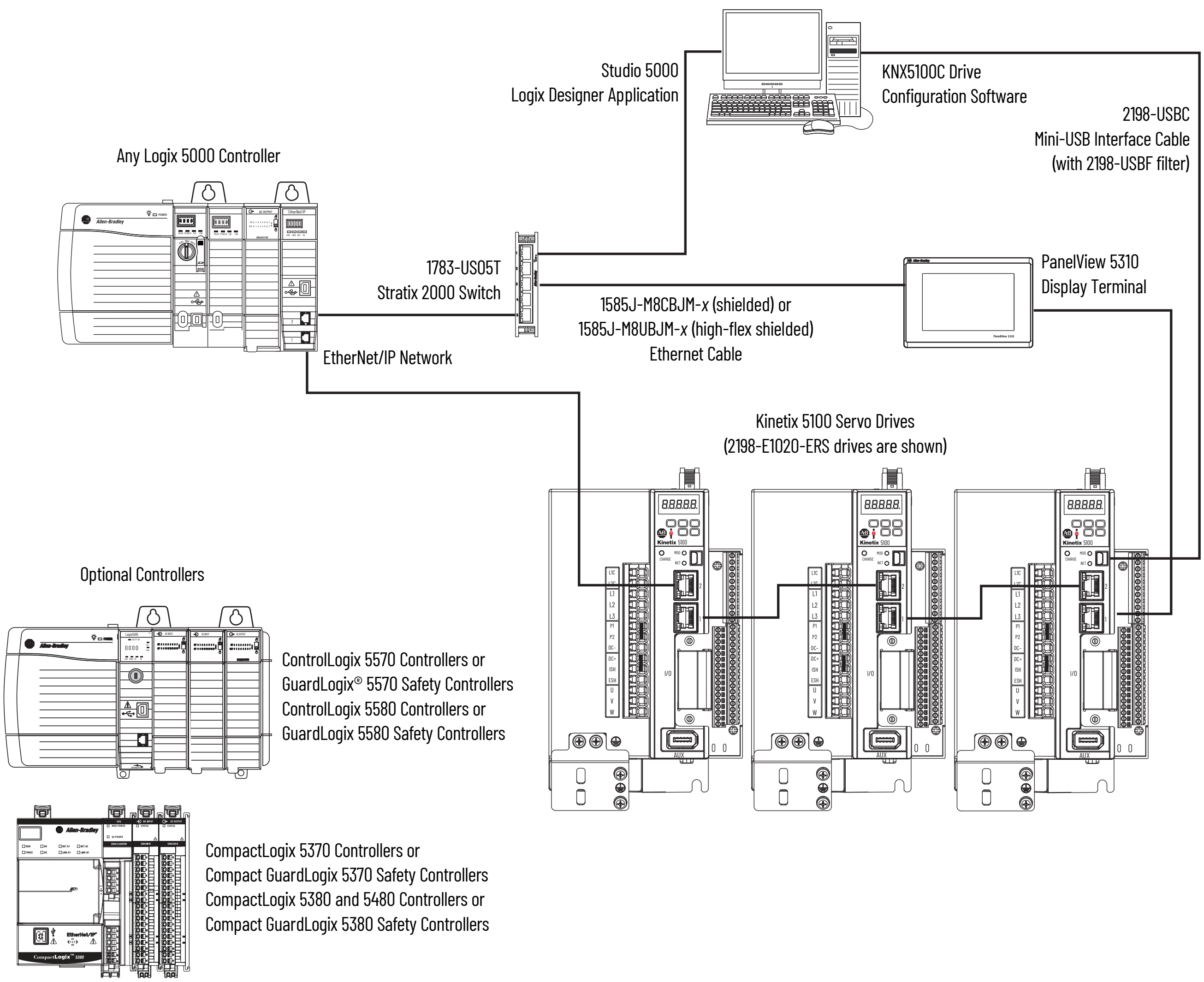
## Logix Enabled Using a Class 1 EtherNet/IP Connection

You can use the Kinetix 5100 drive with a Logix 5000™ controller and Studio 5000 software to deliver a simplified programming experience by using a Class 1 Ethernet/IP connection (AOP) and supported Add-On-Instructions to program and control the drive. In this architecture, the drive is configured by using the KNX5100C software with a USB connection. It is important to note that this implementation seems like Integrated Motion on Ethernet/IP (CIP) motion. This connection is NOT CIP motion but does provide simple control for your small motion application. More information on the AOP is found in Chapter 8 and the Add-On Instruction library is found in Appendix C.

**IMPORTANT** The Kinetix 5100 drive does not support PTP or Integrated Motion on EtherNet/IP (CIP) motion. The Kinetix 5100 drive is a Class 1 EtherNet/IP device and uses a Requested Packet Interval (RPI) to exchange data between the PAC and drive.

**IMPORTANT** Class 1 and Class 3 EtherNet/IP Connections do not support induction motors and linear motors.

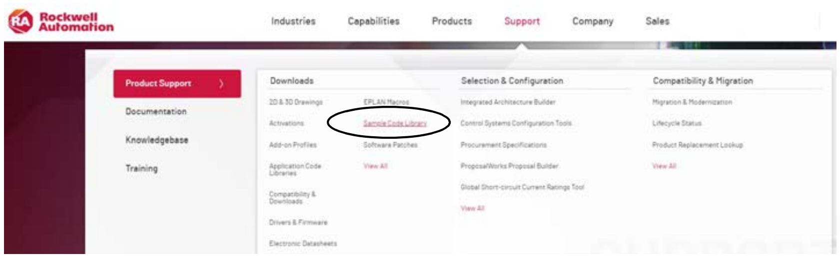
**Figure 6 - Kinetix 5100 Drive System with PAC Controller and EtherNet/IP Network Control**



## Micro800 Using a Class 3 EtherNet/IP Connection

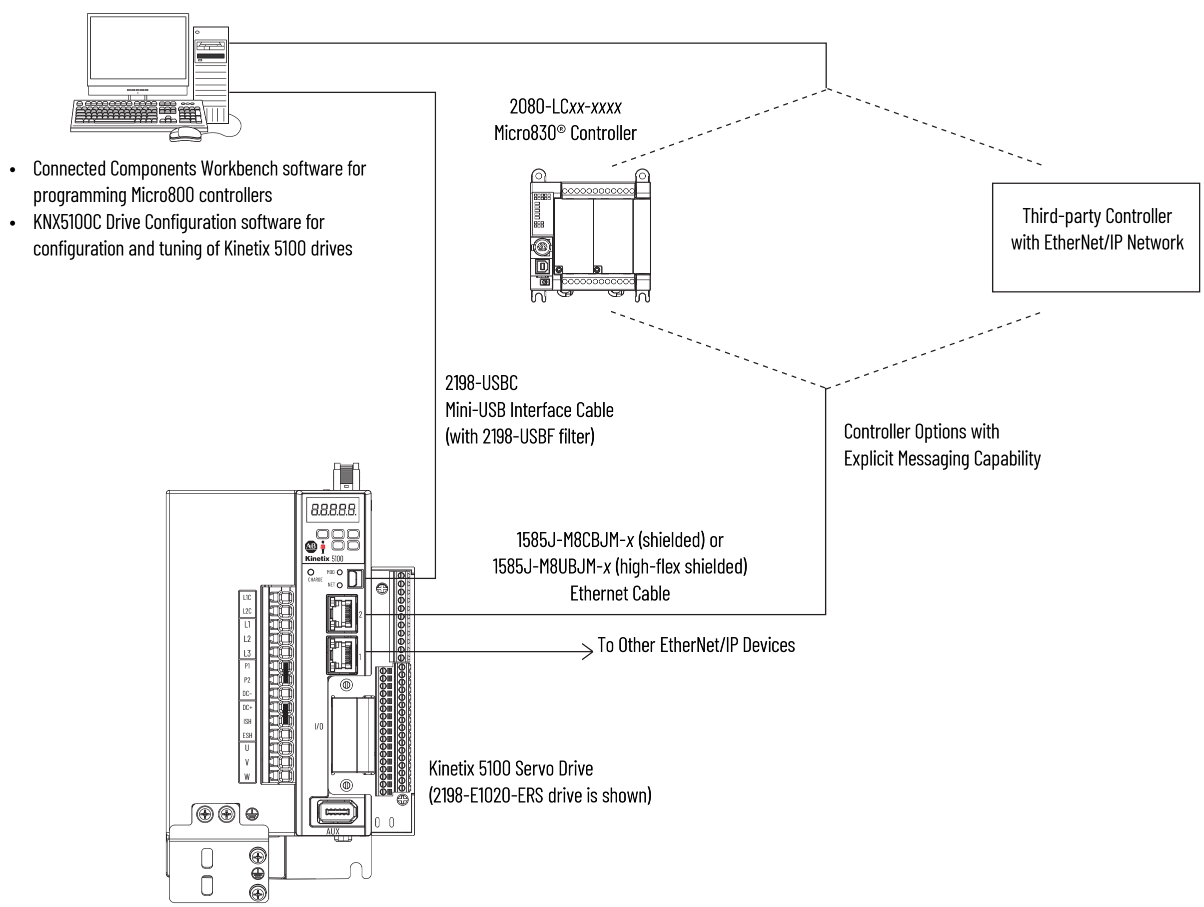
You can use the Kinetix 5100 drive with a Micro800 controller and Connected Components Workbench software to provide a simplified programming experience using Class 3 explicit messaging between the drive and controller. Connected Components Workbench software is used to program the controller and uses a User Defined Function Block (UDFB) to pass data (both command and status) between the controller and drive. In this architecture the drive is configured by using the KNX5100C software with a USB connection. Examples that use explicit messaging are available from the sample code website.

From https://www.rockwellautomation.com/, go to the Support tab and click on Sample Code Library. Use a keyword search: Kinetix 5100.




| **IMPORTANT** | Class 1 and Class 3 EtherNet/IP Connections do not support induction motors and linear motors. |
|---|---|

**Figure 7 - Kinetix 5100 Drive System with PLC Controller and Class 3 EtherNet/IP Explicit Messaging Control**



## Pulse Train Output Control with Motion User Defined Function Block

The Kinetix 5100 drive can be used with a Micro800 controller + Connected Components Workbench (CCW) software to provide a simplified programming experience using Pulse Train Output (PTO) wiring between the drive and controller. Connected Components Workbench software is used to program the controller and uses the built in CCW Motion Library and User Defined Function Block (UDFB) to control the drive. In this architecture the drive is configured by using the KNX5100C software with a USB connection. There is an optional PTO feedback (AQB) channel that can be used to provide feedback from this drive. There is also one digital input used to enable the drive (Servo On) and one digital output used for the Ready signal. Examples using explicit messaging are available from the [sample code website](https://www.rockwellautomation.com/).

From [https://www.rockwellautomation.com/](https://www.rockwellautomation.com/), go to the Support tab and click on Sample Code Library. Use a keyword search: Kinetix 5100.

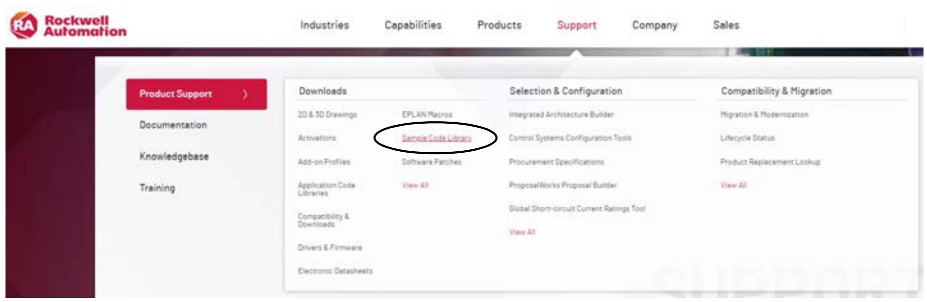
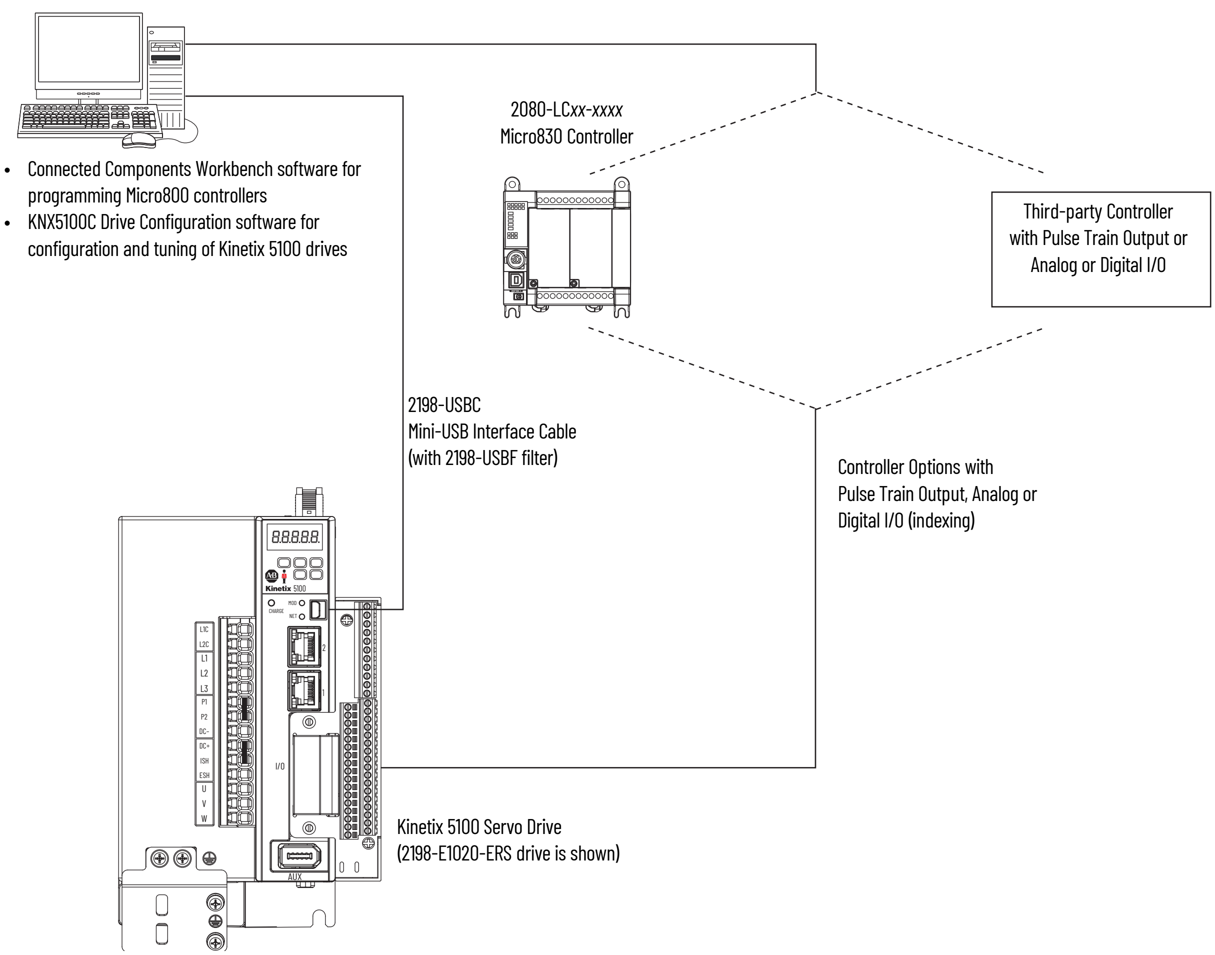



Figure 8 - Kinetix 5100 Drive System with PLC Controller and PTO, Analog or Digital I/O Control



## Catalog Number Explanation

Kinetix 5100 drive catalog numbers and descriptions are listed in these tables.

### Table 2 - Kinetix 5100 EtherNet/IP Indexing Servo Drives

| Cat. No. | Input Voltage | Continuous Output Power(1) kW | Continuous Output Current A (rms) | Peak Output Current A (rms) |
|---|---|---|---|---|
| 2198-E1004-ERS | 95…132V rms single-phase<br>170…253V rms single-phase<br>170…253V rms three-phase | 0.20<br>0.40<br>0.40 | 2.6 | 6.5 |
| 2198-E1007-ERS | | 0.375<br>0.75<br>0.75 | 5.1 | 15.4 |
| 2198-E1015-ERS | | 0.75<br>1.50<br>1.50 | 7.9 | 23.7 |
| 2198-E1020-ERS | | 1.00<br>2.00<br>2.00 | 13.4 | 40.6 |
| 2198-E2030-ERS | 170…253V rms three-phase | 3.00 | 17.9 | 55.9 |
| 2198-E2055-ERS | | 5.50 | 41.3 | 91.4 |
| 2198-E2075-ERS | | 7.50 | 49.0 | 127.5 |
| 2198-E2150-ERS | | 15.00 | 78.0 | 162.0 |
| 2198-E4004-ERS | 342…528V rms three-phase | 0.40 | 1.60 | 5.4 |
| 2198-E4007-ERS | | 0.75 | 3.19 | 8.0 |
| 2198-E4015-ERS | | 1.50 | 6.05 | 15.11 |
| 2198-E4020-ERS | | 2.00 | 7.42 | 20.78 |
| 2198-E4030-ERS | | 3.00 | 13.95 | 26.08 |
| 2198-E4055-ERS | | 5.50 | 24.80 | 37.65 |
| 2198-E4075-ERS | | 7.50 | 31.0 | 53.32 |
| 2198-E4150-ERS | | 15.00 | 41.26 | 70.14 |

(1) Continuous Output Power is rated at the Kinetix TLP motor shaft output power.

### Table 3 - Kinetix 5100 Servo Drive Accessories

| Cat. No. | Drive Components |
|---|---|
| 2198-TBIO | Terminal block for I/O connections |
| 2097-R6, 2097-R7,<br>2198-R004, and 2198-R031 | External passive-shunt resistors for use when additional shunt capability is needed. |
| 2198-DB*xxx*-F<br>2198-DBR*xxx*-F | AC line filters (required to meet CE) |
| 2198-K51CK-D15M | Motor feedback connector kit |
| 2198-AUXKIT | Auxiliary feedback connector kit |
| 2198-KTBT | Feedback battery-box replacement kit |
| 2198-USBC | Interface cable with mini-USB connector for KNX5100C software configuration. |
| 2198-USBF | Filter for mini-USB port to reduce the vulnerability to electrical noise. |

## Agency Compliance

If this product is installed within the European Union and has the CE marking, the following regulations apply.

**ATTENTION:** The drive and line filter must be grounded. Failure to do this renders the filter ineffective and can cause damage to the filter. For ground examples, see Ground the Drive System on page 79.

For more information on electrical noise reduction, see the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

To comply with IEC 61800-3 (category C3) and IEC 61800-5-2, these requirements apply:

- Install an AC line filter (catalog number 2198-D*xxx*-F) as close to the drive as possible.
- Bond drive modules and line-filter grounding screws by using a braided ground strap as shown in Figure 52 on page 79.
- Use Kinetix 2090 motor-power cables or use connector kits and connect the cable shields to the subpanel with clamp provided.
- Use Kinetix 2090 motor-feedback cables or use connector kits and properly connect the feedback cable shield.
- Drive-to-motor cables must not exceed 50 m (164 ft), depending on AC input power and feedback type. See Maximum Cable Length on page 89 for specifications.
- Install the Kinetix 5100 system inside an enclosure. Run input power wiring in conduit (grounded to the enclosure) outside of the enclosure. Separate signal and power cables.
- Separate signal and power cables. Segregate input power wiring and motor power cables from control wiring and motor feedback cables. Use shielded cable for power wiring and provide a grounded 360° clamp termination.

See Appendix A on page 447 for interconnect diagrams, including input power wiring and drive/motor interconnect diagrams.

# Notes:

# Plan and Install the Kinetix 5100 Drive System

This chapter describes system installation guidelines used in preparation for mounting your Kinetix® 5100 drive components.



**ATTENTION:** Plan the installation of your system so that you can cut, drill, tap, and weld with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

## System Design Guidelines

Use the information in this section when you design your enclosure and plan to mount your system components on the panel.

For online product selection and system configuration tools, including AutoCAD (DXF) drawings of the product, see http://www.rockwellautomation.com/global/support/selection.page.

### System Mounting Requirements

- To comply with UL and CE requirements, the Kinetix 5100 drive system must be mounted in a grounded conductive enclosure offering protection as defined in standard IEC 60529 to IP20 such that they are not accessible to an operator or unskilled person.
- To maintain the functional safety rating of the Kinetix 5100 drive system, this enclosure must be appropriate for the environmental conditions of the industrial location and provide a protection class of IP54 or higher.
- The panel you install inside the enclosure for mounting your system components must be on a flat, rigid, vertical surface that won't be subjected to shock, vibration, moisture, oil mist, dust, or corrosive vapors in accordance with pollution degree 2 (EN 61800-5-1) because the product is rated to protection class IP20 (EN 60529).
- Size the drive enclosure so as not to exceed the maximum-ambient temperature rating. Consider heat dissipation specifications for all drive components.

- Use high-frequency (HF) techniques for bonding to connect the enclosure, machine frame, and motor housing, and to provide a low-impedance return path for high-frequency (HF) energy and reduce electrical noise.

  Bond the Kinetix 5100 drive modules and line filter grounding screws by using a braided ground strap as shown in Figure 52 on page 79.

See the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, to better understand the concept of electrical noise reduction.

## AC Line Filter Selection

An AC line filter is required to meet CE requirements. Install an AC line filter for input power as close to the 2198-E*xxxx*-ERS servo drive as possible.

| IMPORTANT | Kinetix 5100 servo drives support only grounded wye power configurations. For facility power configuration examples, see Determine the Input Power Configuration on page 74. |
|---|---|

**Table 4 - AC Line Filter Selection**

| Kinetix 5100 Drive Cat. No. | Input Voltage (nom) | AC Line Filter Cat. No. Single-phase Operation | | AC Line Filter Cat. No. Three-phase Operation |
|---|---|---|---|---|
| 2198-E1004-ERS | 120V single-phase<br>200…230V single-phase<br>230V three-phase | 2198-DB111-F | 2198-DB310-F | 2198-DB310-F |
| 2198-E1007-ERS | | 2198-DB127-F | | |
| 2198-E1015-ERS | | | 2198-DB324-F | 2198-DB324-F |
| 2198-E1020-ERS | | | | |
| 2198-E2030-ERS | 230V three-phase | – | | |
| 2198-E2055-ERS | | – | | 2198-DB335-F |
| 2198-E2075-ERS | | – | | 2198-DB356-F |
| 2198-E2150-ERS | | – | | 2198-DBR90-F |
| 2198-E4004-ERS | 480V three-phase | – | | 2198-DB418-F |
| 2198-E4007-ERS | | – | | |
| 2198-E4015-ERS | | – | | |
| 2198-E4020-ERS | | – | | |
| 2198-E4030-ERS | | – | | |
| 2198-E4055-ERS | | – | | 2198-DB433-F |
| 2198-E4075-ERS | | – | | |
| 2198-E4150-ERS | | – | | 2198-DBR40-F |

| IMPORTANT | Select 2198-DB310-F and 2198-DB324-F line filters for replacements in existing installations and new systems of 2198-E10XX-ERS drives. |
|---|---|

## Circuit Breaker/Fuse Selection

The Kinetix 5100 drives use internal solid-state motor short-circuit protection and, when connected to a suitable branch circuit protection, are rated for use on a circuit that can deliver up to 5000 A (fuses or circuit breakers).

**IMPORTANT** Do not use circuit protection devices on the output of an AC drive as an isolating disconnect switch or motor overload device. These devices are designed to operate on sine-wave voltage and the drive's PWM waveform does not allow it to operate properly. As a result, damage to the device occurs.

Make sure the selected components are properly coordinated and meet acceptable codes including any requirements for branch circuit protection. Evaluation of the short-circuit available current is critical and must be kept below the short-circuit current rating of the circuit breaker.

See the Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003, for input current and inrush current specifications for your Kinetix 5100 drive.

*Circuit Breaker/Fuse Specifications*

Kinetix 5100 servo drives use internal solid-state motor short-circuit protection and, when protected by suitable branch circuit protection, are rated for use on a circuit capable of delivering up to 5000 A when protected by fuses or circuit breakers. These fuses and Allen-Bradley® circuit breakers are recommended for use with 2198-E*xxxx*-ERS drives.

**Table 5 - Control Power Circuit-protection Specifications**

| Cat. No. | Fuse (Bussman) Cat. No | Miniature CB Cat. No. |
|---|---|---|
| 2198-E1004-ERS | KTK-R-2 (2 A) | 1489-M2D010 |
| 2198-E1007-ERS | | |
| 2198-E1015-ERS | | |
| 2198-E1020-ERS | | 1489-M2D020 |
| 2198-E2030-ERS | | 1489-M2D010 |
| 2198-E2055-ERS | KTK-R-3 (3 A) | 1489-M2D016 |
| 2198-E2075-ERS | | |
| 2198-E2150-ERS | KTK-R-5 (5 A) | 1489-M2D030 |

### Table 6 - Input Power UL/CSA Circuit-protection Specifications

| Kinetix 5100 Drive Cat. No. | Drive Voltage | Fuses (Bussmann) Cat. No. | Miniature CB (1) Cat. No. | Molded Case CB Cat. No. |
|---|---|---|---|---|
| 2198-E1004-ERS | 120V/230V, single-phase | KTK-R-15 (15 A) | 1489-M2D100 | – |
| | 230V, three-phase | KTK-R-10 (10 A) | 1489-M3D100 | – |
| 2198-E1007-ERS | 120V/230V, single-phase | KTK-R-20 (20 A) | 1489-M2D200 | – |
| | 230V, three-phase | KTK-R-15 (15 A) | 1489-M3D130 | – |
| 2198-E1015-ERS | 120V/230V, single-phase | KTK-R-30 (30 A) | 1489-M2D300 | – |
| | 230V, three-phase | KTK-R-25 (25 A) | 1489-M3D200 | – |
| 2198-E1020-ERS | 120V/230V, single-phase | LPJ-40SP (40 A) | 1489-M2D400 | – |
| | 230V, three-phase | LPJ-35SP (35 A) | 1489-M3D300 | – |
| 2198-E2030-ERS | 230V, three-phase | LPJ-50SP (50 A) | 1489-M3D350 | – |
| 2198-E2055-ERS | | LPJ-70SP (70 A) | 1489-M3D600 | – |
| 2198-E2075-ERS | | LPJ-80SP (80 A) | – | 140G-G2C3-C70 |
| 2198-E2150-ERS | | LPJ-125SP (125 A) | – | 140G-G2C3-D12 |
| 2198-E4004-ERS | 380…480V AC, three-phase | KTK-R-10 (10A) | 1489-M3D100 | – |
| 2198-E4007-ERS | | KTK-R-15 (15A) | 1489-M3D100 | – |
| 2198-E4015-ERS | | KTK-R-20 (20A) | 1489-M3D150 | – |
| 2198-E4020-ERS | | KTK-R-25 (25A) | 1489-M3D200 | – |
| 2198-E4030-ERS | | KTK-R-30 (30A) | 1489-M3D300 | – |
| 2198-E4055-ERS | | LPJ-35SP (35A) | 1489-M3D350 | – |
| 2198-E4075-ERS | | LPJ-45SP (45A) | – | 140G-G6C3-C45 |
| 2198-E4150-ERS | | LPJ-90SP (90A) | – | 140G-G6C3-C60 |

(1) There are no recommended motor-protection circuit breakers for the Kinetix 5100 servo drives.

### Table 7 - Input Power IEC (non-UL/CSA) Circuit-protection Specifications

| Kinetix 5100 Drive Cat. No. | Drive Voltage | DIN gG Fuses Amps, Max | Miniature CB (1) Cat. No. | Molded Case CB Cat. No. |
|---|---|---|---|---|
| 2198-E1004-ERS | 120V/230V, single-phase | 15 | 1489-M2D100 | – |
| | 230V, three-phase | 10 | 1489-M3D100 | – |
| 2198-E1007-ERS | 120V/230V, single-phase | 20 | 1489-M2D200 | – |
| | 230V, three-phase | 15 | 1489-M3D130 | – |
| 2198-E1015-ERS | 120V/230V, single-phase | 30 | 1489-M2D300 | – |
| | 230V, three-phase | 25 | 1489-M3D200 | – |
| 2198-E1020-ERS | 120V/230V, single-phase | 40 | 1489-M2D400 | – |
| | 230V, three-phase | 35 | 1489-M3D300 | – |
| 2198-E2030-ERS | 230V, three-phase | 50 | 1489-M3D350 | – |
| 2198-E2055-ERS | | 70 | 1489-M3D600 | – |
| 2198-E2075-ERS | | 80 | – | 140G-G2C3-C70 |
| 2198-E2150-ERS | | 125 | – | 140G-G2C3-D12 |
| 2198-E4004-ERS | 380…480V AC, three-phase | 10 | 1489-M3D100 | – |
| 2198-E4007-ERS | | 15 | 1489-M3D100 | – |
| 2198-E4015-ERS | | 20 | 1489-M3D150 | – |
| 2198-E4020-ERS | | 25 | 1489-M3D200 | – |
| 2198-E4030-ERS | | 30 | 1489-M3D300 | – |
| 2198-E4055-ERS | | 35 | 1489-M3D350 | – |
| 2198-E4075-ERS | | 45 | – | 140G-G6C3-C45 |
| 2198-E4150-ERS | | 90 | – | 140G-G6C3-C60 |

(1) There are no recommended motor protection circuit breakers for the Kinetix 5100 servo drives.

## Transformer Selection

The Kinetix 5100 drive does not require an isolation transformer for three-phase input power. However, a transformer can be required to match the voltage requirements of the drive to the available service.

To size a transformer for the main AC power inputs, see Circuit Breaker/Fuse Selection on page 27 and Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003.

| | |
|---|---|
| **IMPORTANT** | Transformers (auto transformer is not supported) must have WYE secondary with grounded neutral. Phase to neutral voltage must not exceed the input voltage rating of the drive. |

| | |
|---|---|
| **IMPORTANT** | Use a factor of 1.5 for single and three-phase power (this factor is used to compensate for transformer, drive, and motor losses, and to account for utilization in the intermittent operating area of the torque speed curve).<br>For example, size a transformer to the voltage requirements of catalog number 2198-E2030-ERS = 3 kW continuous x 1.5 = 4.5 KVA transformer. |

| | |
|---|---|
| **IMPORTANT** | A line reactor must be used if the source transformer is greater than 150 KVA, max and 3% impedance, min. |

## Passive Shunt Considerations

See Table 8 for the 2198-E*xxxx*-ERS servo drives that include internal shunt resistors. Bulletin 2198-R*xxx* and 2097-R*x* external passive shunts are available to provide additional shunt capacity for applications where the internal shunt capacity is exceeded or in applications requiring shunt capacity for drives without an internal shunt.

**Table 8 - External Passive-shunt Options**

<table>
<tr><th rowspan="2">Kinetix 5100 Servo Drive Cat. No.</th><th>Internal Shunt Resistor</th><th>Shunt Power Capacity of Resistor</th><th>External Shunt Resistance, min</th><th colspan="4">Bulletin 2198 External Shunt Module [1] Cat. No.</th></tr>
<tr><th>Ω</th><th>W</th><th>Ω</th><th>2198-R031</th><th>2198-R004</th><th>2097-R6</th><th>2097-R7</th></tr>
<tr><td>2198-E1004-ERS</td><td rowspan="3">100</td><td>5</td><td rowspan="2">60</td><td>–</td><td>–</td><td>X</td><td>X</td></tr>
<tr><td>2198-E1007-ERS</td><td rowspan="2">14</td><td>–</td><td>–</td><td>X</td><td>X</td></tr>
<tr><td>2198-E1015-ERS</td><td>30</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E1020-ERS</td><td rowspan="2">20</td><td rowspan="2">20</td><td rowspan="2">15</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E2030-ERS</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E2055-ERS</td><td>–</td><td>–</td><td rowspan="2">10</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E2075-ERS</td><td>–</td><td>–</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E2150-ERS</td><td>–</td><td>–</td><td>5</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E4004-ERS</td><td rowspan="3">80</td><td>10</td><td>80</td><td>–</td><td>–</td><td>–</td><td>X</td></tr>
<tr><td>2198-E4007-ERS</td><td>10</td><td>60</td><td>–</td><td>–</td><td>X</td><td>X</td></tr>
<tr><td>2198-E4015-ERS</td><td>10</td><td rowspan="2">40</td><td>–</td><td>–</td><td>X</td><td>X</td></tr>
<tr><td>2198-E4020-ERS</td><td>–</td><td>–</td><td>–</td><td>–</td><td>X</td><td>X</td></tr>
<tr><td>2198-E4030-ERS</td><td>–</td><td>–</td><td>30</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E4055-ERS</td><td>–</td><td>–</td><td>20</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E4075-ERS</td><td>–</td><td>–</td><td>15</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2198-E4150-ERS</td><td>–</td><td>–</td><td>12</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
</table>

(1) Shunt resistor selection is based on the needs of your actual hardware configuration.

**ATTENTION:** See Table 8 for the minimum external shunt resistance. Connecting an external shunt resistor of with resistance rating lower than specified results in (drive-side) shunt circuitry damage.

Catalog number 2198-R031 is composed of resistor coils that are housed inside an enclosure. Catalog numbers 2198-R004, 2097-R6, and 2097-R7 are shunt resistors without an enclosure.

**Figure 9 - External Passive Shunts**

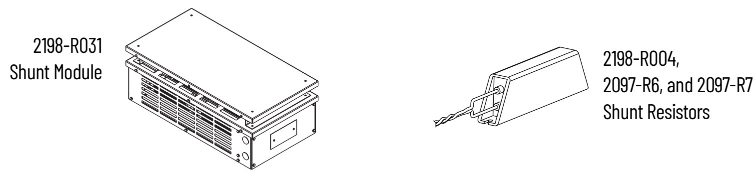



**Table 9 - External Shunt Module Specifications**

| Shunt Module Cat. No. | Resistance Ω | Continuous Power W | Weight, approx kg (lb) |
|---|---|---|---|
| 2097-R6 | 75 | 150 | 0.3 (0.7) |
| 2097-R7 | 150 | 80 | 0.2 (0.4) |
| 2198-R004 | 33 | 400 | 1.8 (4.0) |
| 2198-R031 | 33 | 3100 | 16.8 (37) |

How the Bulletin 2198-R*xxx* and 2097-R*x* shunts connect to the Kinetix 5100 drive is explained in External Passive-shunt Resistor Connections on page 102 and illustrated with interconnect diagrams in Passive Shunt Wiring Examples on page 453.

**IMPORTANT** We recommend that new installations or field replacements for 2097-R6 and 2097-R7 shunt modules use 2198-R002 or 2198-R001 shunt resistors

## Enclosure Selection

This example is provided to assist you in size selection for an enclosure for your Kinetix 5100 drive system. You need heat dissipation data from all components that are planned for your enclosure to calculate the enclosure size. See Table 10 on page 31 for the Kinetix 5100 drive heat dissipation specifications.

With no active method of heat dissipation (such as fans or air conditioning), either of the following approximate equations can be used.

| Metric | Standard English |
|---|---|
| $A = \dfrac{0.38Q}{1.8T - 1.1}$ | $A = \dfrac{4.08Q}{T - 1.1}$ |
| Where T is temperature difference between inside air and outside ambient (°C), Q is heat that is generated in enclosure (Watts), and A is enclosure surface area ($m^2$). The exterior surface of all six sides of an enclosure is calculated as | Where T is temperature difference between inside air and outside ambient (°F), Q is heat that is generated in enclosure (Watts), and A is enclosure surface area ($ft^2$). The exterior surface of all six sides of an enclosure is calculated as |
| A = 2dw + 2dh + 2wh | A = (2dw + 2dh + 2wh) /144 |
| Where d (depth), w (width), and h (height) are in meters. | Where d (depth), w (width), and h (height) are in inches. |

If the maximum ambient rating of the Kinetix 5100 drive system is 50 °C (122 °F) and if the maximum environmental temperature is 20 °C (68 °F), then T=30. In this example, the total heat dissipation is 416 W (sum of all components in enclosure). So, in the equation below, T=30 and Q=416.

$$A = \frac{0.38\,(416)}{1.8\,(30) - 1.1} = 2.99\ m^2$$

In this example, the enclosure must have an exterior surface of at least 2.99 $m^2$. If any portion of the enclosure is not able to transfer heat, do not include that value in the calculation.

Because the minimum cabinet depth to house the Kinetix 5100 system (selected for this example) is 300 mm (11.8 in.), the cabinet needs to be approximately 1500 x 700 x 300 mm (59.0 x 27.6 x 11.8 in.) HxWxD.

$$1.5 \times (0.300 \times 0.70) + 1.5 \times (0.300 \times 2.0) + 1.5 \times (0.70 \times 2.0) = 3.31\ m^2$$

Because this cabinet size is considerably larger than what is necessary to house the system components, it can be more efficient to provide a means of cooling in a smaller cabinet. Contact your cabinet manufacturer for options available to cool your cabinet.

**Table 10 - Power Dissipation Specifications**

| Kinetix 5100 (200V-class) Drives Cat. No. | Loss (230V), max W |
|---|---|
| 2198-E1004-ERS | 38.06 |
| 2198-E1007-ERS | 66.33 |
| 2198-E1015-ERS | 87.23 |
| 2198-E1020-ERS | 139.83 |
| 2198-E2030-ERS | 179.53 |
| 2198-E2055-ERS | 328.52 |
| 2198-E2075-ERS | 372.33 |
| 2198-E2150-ERS | 648.55 |

| Kinetix 5100 (400V-class) Drives Cat. No. | Loss (380V), max W | Loss (480V), max W |
|---|---|---|
| 2198-E4004-ERS | 51 | 56 |
| 2198-E4007-ERS | 71 | 86 |
| 2198-E4015-ERS | 99 | 117 |
| 2198-E4020-ERS | 109 | 123 |
| 2198-E4030-ERS | 214 | 220 |
| 2198-E4055-ERS | 342 | 363 |
| 2198-E4075-ERS | 467 | 494 |
| 2198-E4150-ERS | 501 | 541 |

Table 10 provides total power dissipation for Kinetix 5100 drives, three-phase operation, with 100% rated current and speed.

## Minimum Clearance Requirements

This section provides information to assist you in sizing your cabinet and positioning your Kinetix 5100 drive system:

- Additional clearance is required for cables and wires connected to the drive modules.
- Additional clearance is required if other devices are installed above and/or below the drive module and have clearance requirements of their own.
- Additional clearance left and right of the drive module is required when mounted adjacent to noise sensitive equipment or clean wireways.
- Recommended minimum cabinet depth:
  - 300 mm (11.81 in.) for 2198-E1004, 2198-E1007, 2198-E1015, 2198-E1020, 2198-E2030, 2198-E2055, and 2198-E2075 servo drives
  - 300 mm (11.81 in.) for 2198-E4004, 2198-E4007, 2198-E4015, 2198-E4020, 2198-E4030, 2198-E4055, and 2198-E4075 servo drives
  - 350 mm (13.78 in.) for 2198-E2150 and 2198-E4150 servo drives

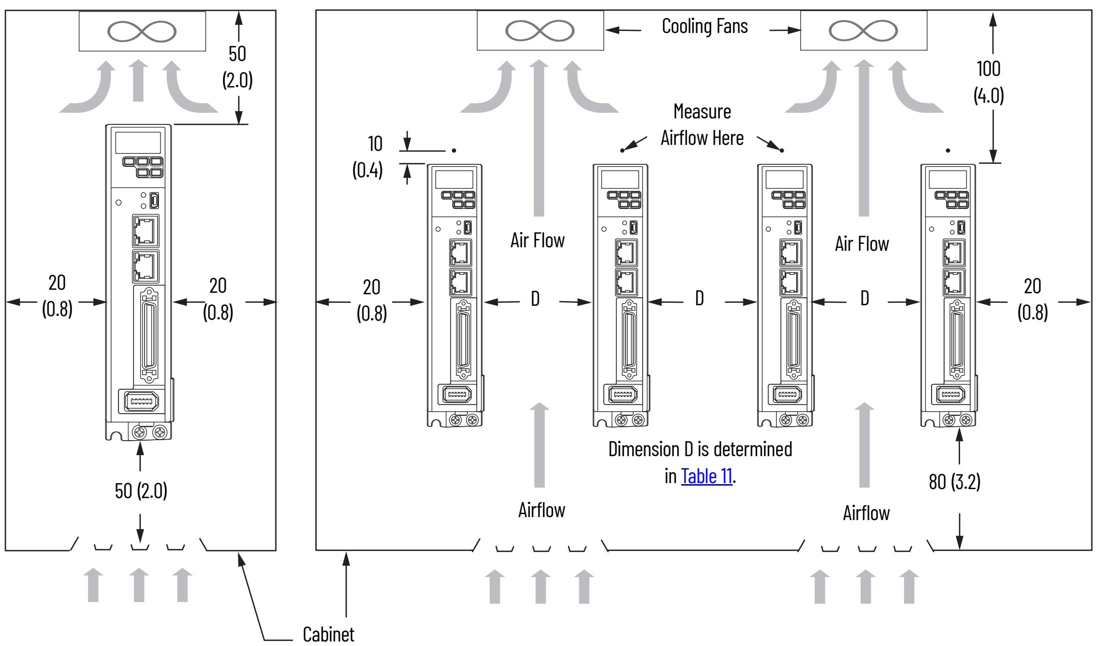
To maintain adequate ventilation:

- Install cooling fans above servo drives inside the cabinet to remove excess heat.
- Keep servo drives away from heat sources.
- Make sure that the ambient temperature at 5.0 cm (1.96 in.) beneath the drives does not exceed the operating temperature range.

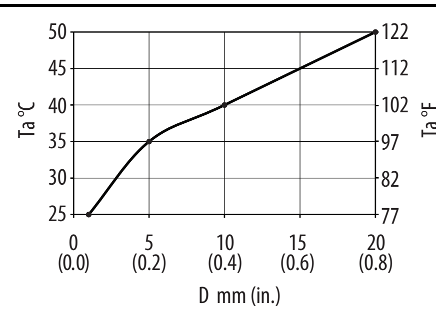
**ATTENTION:** To avoid damage to drives due to overheating, cooling fans must be installed when 2198-E1004-ERS drives are mounted in the cabinet. Make sure that there is a minimum of 0.5 m/s (1.6 ft/s) air flow at 10 mm (0.4 in.) above the top-center of the drive.

**Figure 10 - Minimum Clearance Requirements**

Dimensions are in mm (in.)




## Table 11 - Dimension D

| Kinetix 5100 Drive Cat. No. | | Temperature, Ambient Versus Dimension D |
|---|---|---|
| 2198-E1004-ERS<br>2198-E1007-ERS<br>2198-E1015-ERS<br>2198-E1020-ERS<br>2198-E2030-ERS<br>2198-E2055-ERS<br>2198-E2075-ERS<br>2198-E2150-ERS | 2198-E4004-ERS<br>2198-E4007-ERS<br>2198-E4015-ERS<br>2198-E4020-ERS<br>2198-E4030-ERS<br>2198-E4055-ERS<br>2198-E4075-ERS<br>2198-E4150-ERS |   |

**IMPORTANT** Mount the drive in an upright position as shown. Do not mount the drive on its side.

See Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003 for Kinetix 5100 drive dimensions.

## Electrical Noise Reduction

This section outlines best practices that minimize the possibility of noise-related failures as they apply specifically to Kinetix 5100 system installations. For more information on the concept of high-frequency (HF) bonding, the ground plane principle, and electrical noise reduction, see the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

### HF Bond the Drives

Bonding is the practice where you connect the metal chassis, assemblies, frames, shields, and enclosures to reduce the effects of electromagnetic interference (EMI).

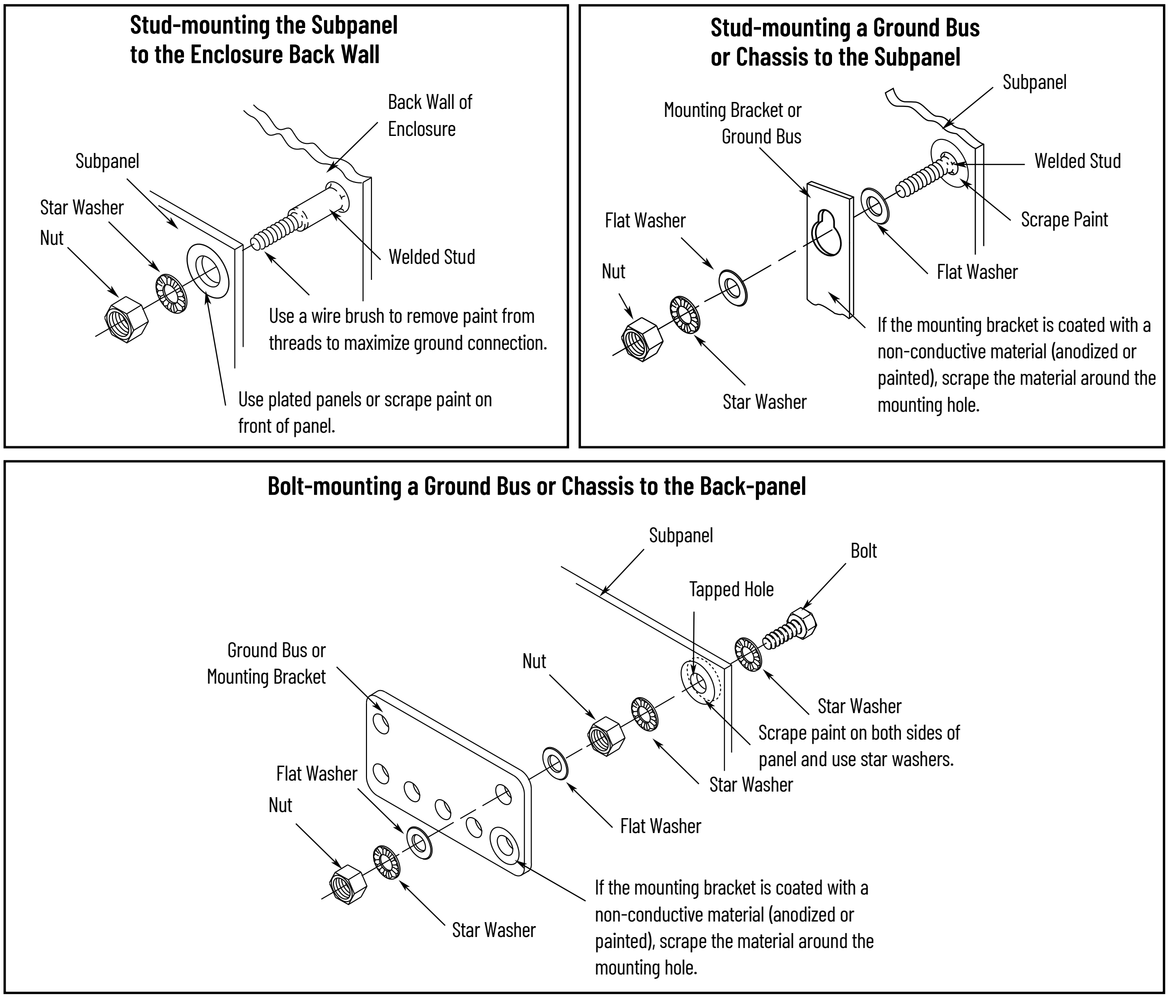
Unless specified, most paints are not conductive and act as insulators. To achieve a good bond between drive and the subpanel, surfaces must be paint-free or plated. Bonding the metal surfaces creates a low-impedance return path for high-frequency energy.

| | |
|---|---|
| **IMPORTANT** | To improve the bond between the drive and subpanel, construct your subpanel out of zinc-plated (paint-free) steel. |

Improper bonding of the metal surfaces blocks the direct return path and allows high-frequency energy to travel elsewhere in the cabinet. Excessive high-frequency energy can affect the operation of other microprocessor controlled equipment.

These illustrations show recommended practices for bonding the painted panels, enclosures, and brackets.

**Figure 11 - Recommended Bonding Practices for Painted Panels**

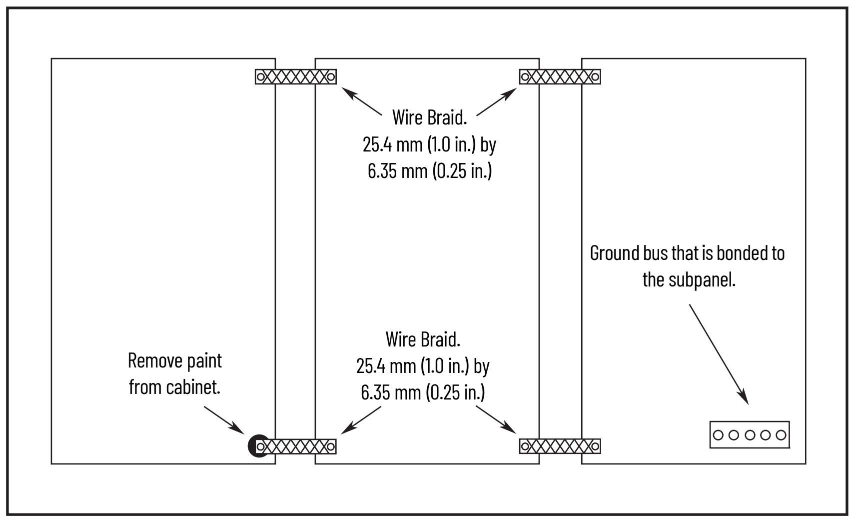


## HF Bond Multiple Subpanels

Bonding multiple subpanels creates a common low-impedance exit path for the high frequency energy inside the cabinet. Subpanels that are not bonded together do not necessarily share a common low-impedance path. This difference in impedance can affect networks and other devices that span multiple panels.

- Bond the top and bottom of each subpanel to the cabinet by using 25.4 mm (1.0 in.) by 6.35 mm (0.25 in.) wire braid. As a rule, the wider and shorter the braid is, the better the bond.
- Scrape the paint from around each fastener to maximize metal-to-metal contact.

**Figure 12 - Multiple Subpanels and Cabinet Recommendations**

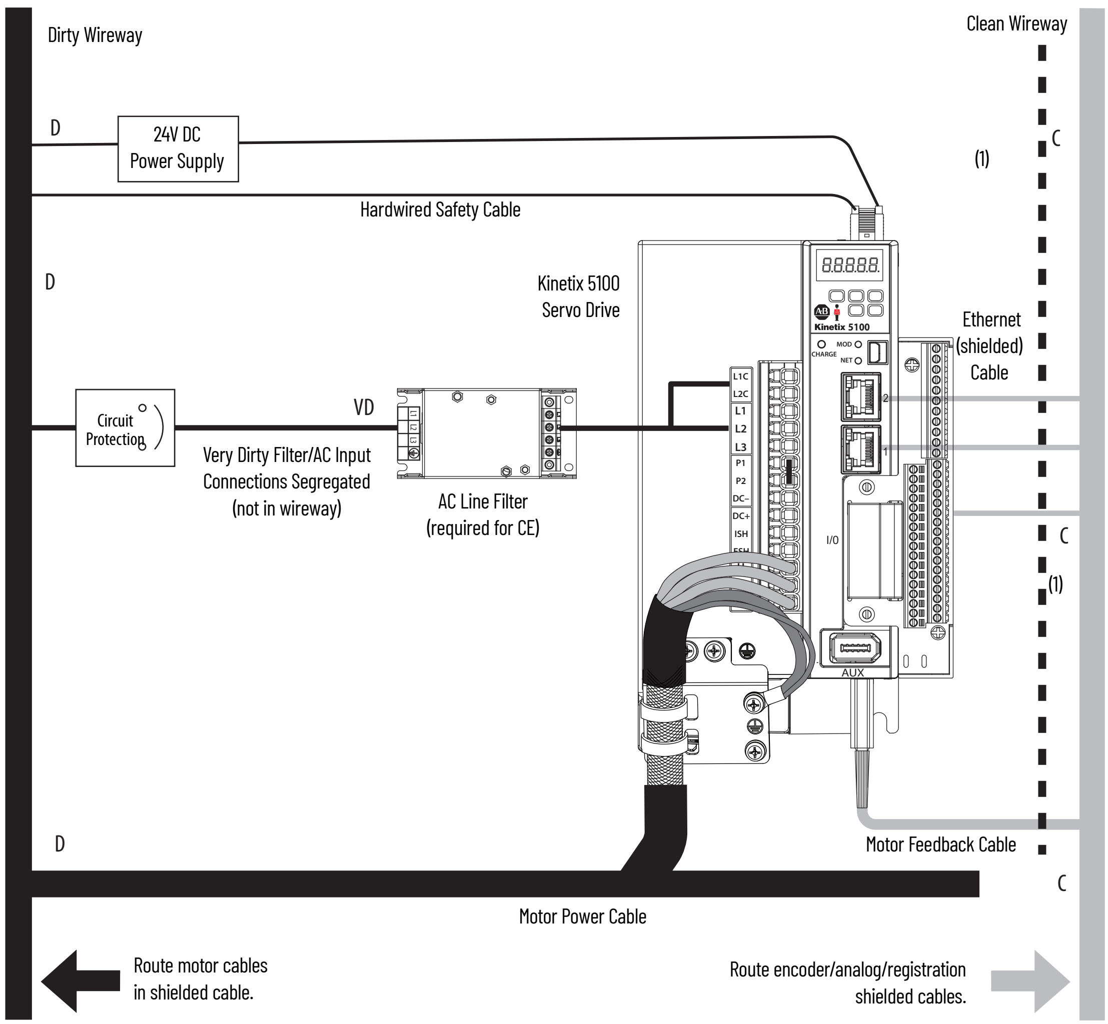


## Establish Noise Zones

Observe these guidelines when routing cables used in the Kinetix 5100 system:

- The clean zone (C) is right of the drive system and includes the digital inputs wiring and Ethernet cable (gray wireway).
- The dirty zone (D) is left and below the drive system (black wireways) and includes the circuit breakers, 24V DC power supply, safety, and motor cables.
- The very dirty zone (VD) is limited to where the AC (EMC) line filter VAC output jumpers over to the DC-bus power supply. Shielded cable is required only if the very dirty cables enter a wireway.

**Figure 13 - Noise Zones**




(1) When space to the right of the module does not permit 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

## Cable Categories for Kinetix 5100 Drive Systems

Table 12 indicates the zoning requirements of cables that connect to the Kinetix 5100 drive components.

**Table 12 - Kinetix 5100 Drive Systems**

| Wire/Cable | Connector Function | Zone | | | Method | |
|---|---|---|---|---|---|---|
| | | Very Dirty | Dirty | Clean | Ferrite Sleeve | Shielded Cable |
| L1, L2, L3 (shielded cable) | Mains input power | – | X | – | – | X |
| L1, L2, L3 (unshielded cable) | | X | – | – | – | – |
| L1C, L2C (unshielded cable) | Control input power | – | X | – | – | – |
| U, V, W (motor power) | U, V, W (motor power) | – | X | – | – | X |
| Motor feedback (MFD) | Motor feedback (MFD) | – | X | – | – | X |
| DC+, ISH, ESH | Shunt resistor | – | X | – | – | – |
| 24V DC | 24V DC for Safe Torque Off (STO) feature and control power on 2198-E4xxx-ERS (400V) drives | – | X | – | – | – |
| Digital and analog I/O | Registration and analog inputs/outputs (I/O) | – | – | X | – | X |
| | Dedicated digital inputs (other than registration inputs and other I/O signals) | – | X | – | – | – |
| Ethernet | Ethernet RJ45 (Port 1 and Port 2) | – | – | X | – | X |

## Noise Reduction Guidelines for Drive Accessories

See this section when mounting an AC line filter or shunt resistor module for guidelines that are designed to reduce system failures caused by excessive electrical noise.

### *AC Line Filters*

Observe these guidelines when mounting your AC line filter:

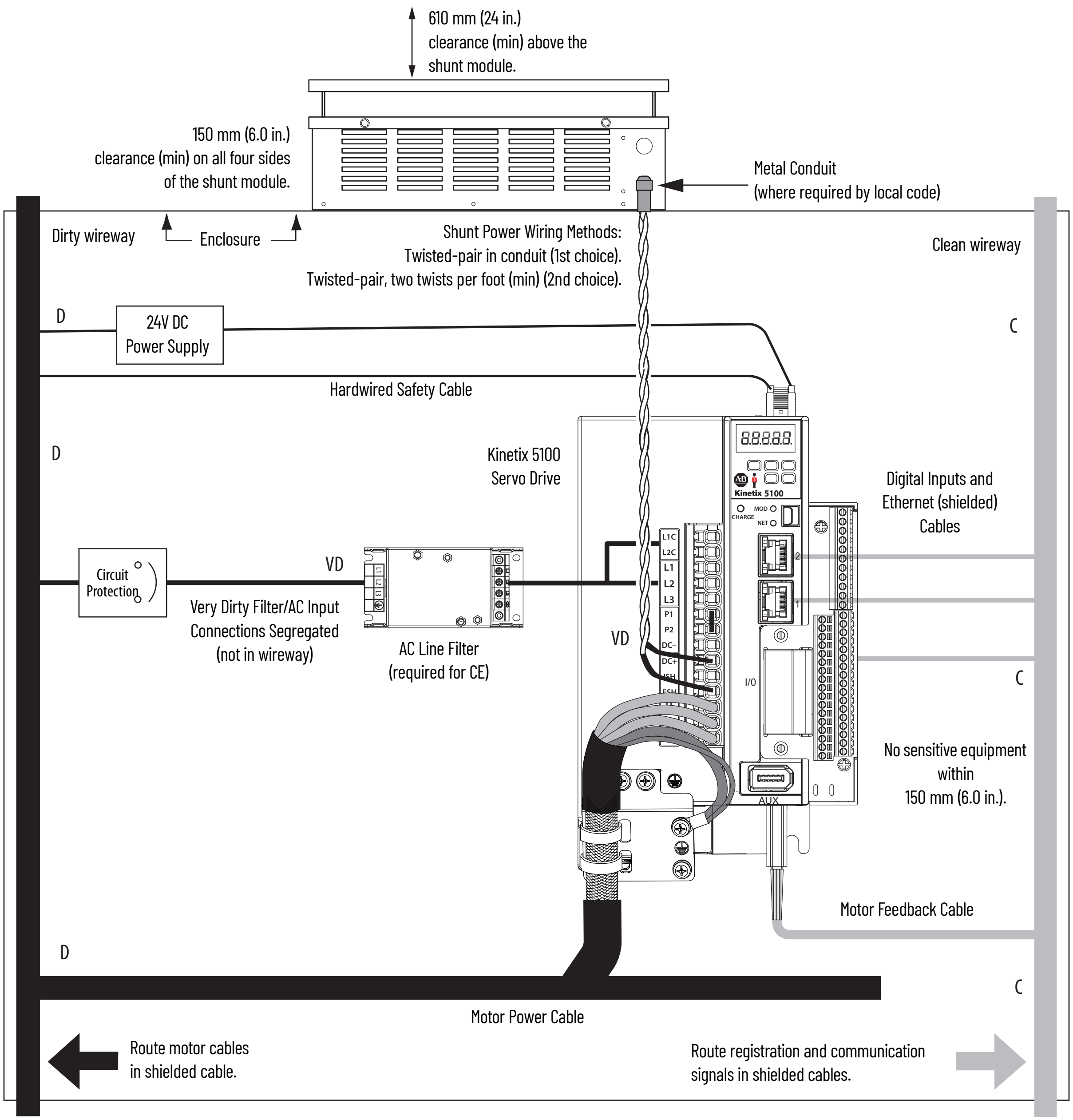
- If you are using a Bulletin 2198 line filter, mount the filter on the same panel as the Kinetix 5100 drive, and as close to the drive as possible.
- Good HF bonding to the panel is critical. For painted panels, see the examples on page 35.
- Segregate input and output wiring as far as possible.

### *External Passive Shunt Modules*

Observe these guidelines when mounting your Bulletin 2198 and 2097 external passive shunt outside of the drive system enclosure:

- Mount the shunt module so that wiring routes in the very dirty zone inside the drive system enclosure.
- Keep unshielded wiring as short as possible, not to exceed 3 m (9.8 ft). Keep shunt wiring as flat to the cabinet as possible.

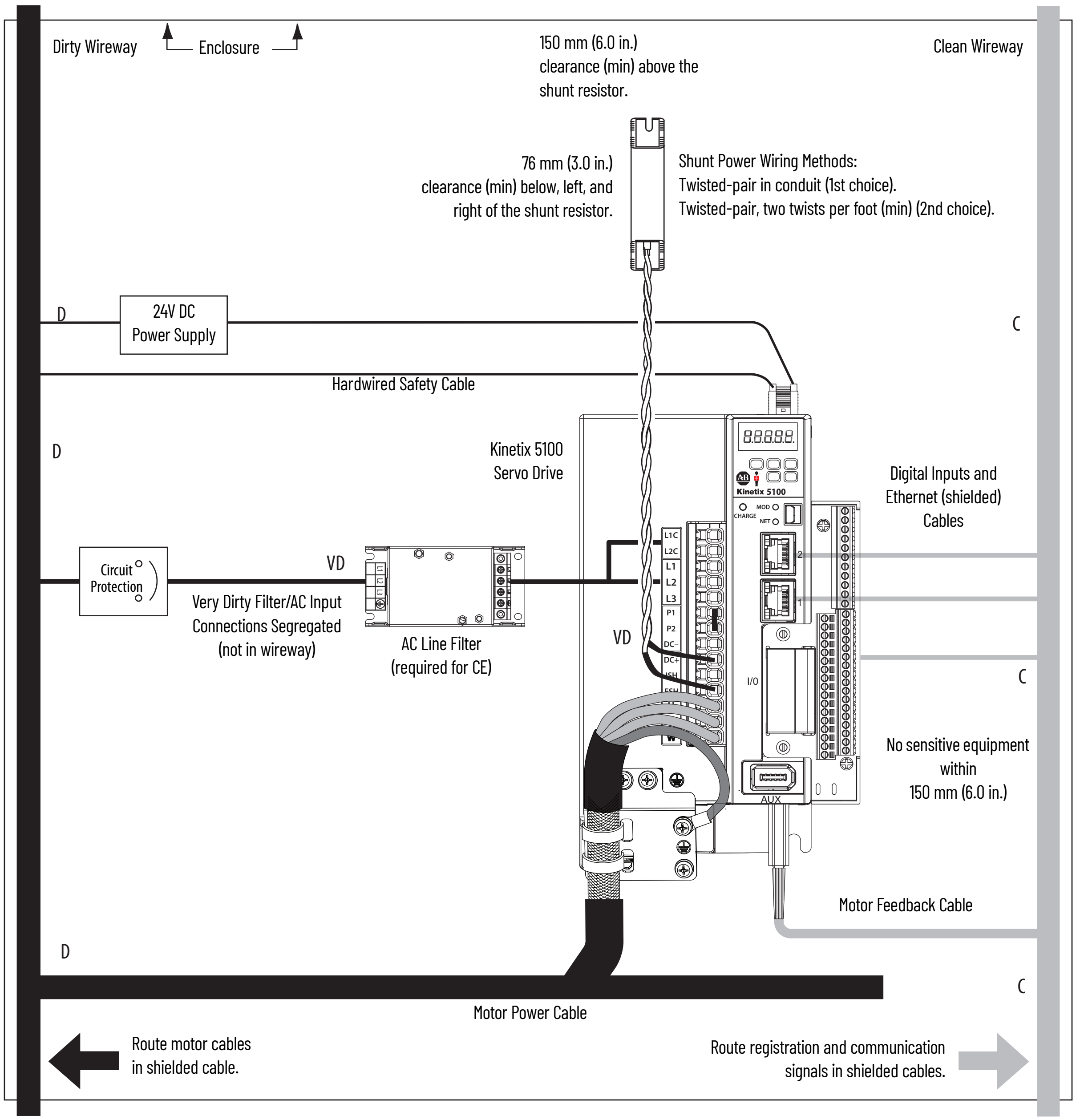
**Figure 14 - External Passive Shunt Module Mounted On Top of the Drive System Enclosure**



Observe these guidelines when mounting your Bulletin 2198 and 2097 external passive shunt inside the drive system enclosure:

- Mount the shunt resistors anywhere in the dirty zone, but as close to the Kinetix 5100 power supply as possible.
- Route the shunt power wires with other very dirty wires.
- Keep unshielded wiring as short as possible, not to exceed 457 mm (18 in.). Keep shunt wiring as flat to the cabinet as possible.
- Separate shunt power cables from other sensitive low-voltage signal cables.

**Figure 15 - External Shunt Resistor Mounted Inside the Drive System Enclosure**



## Mount Your Kinetix 5100 Drive

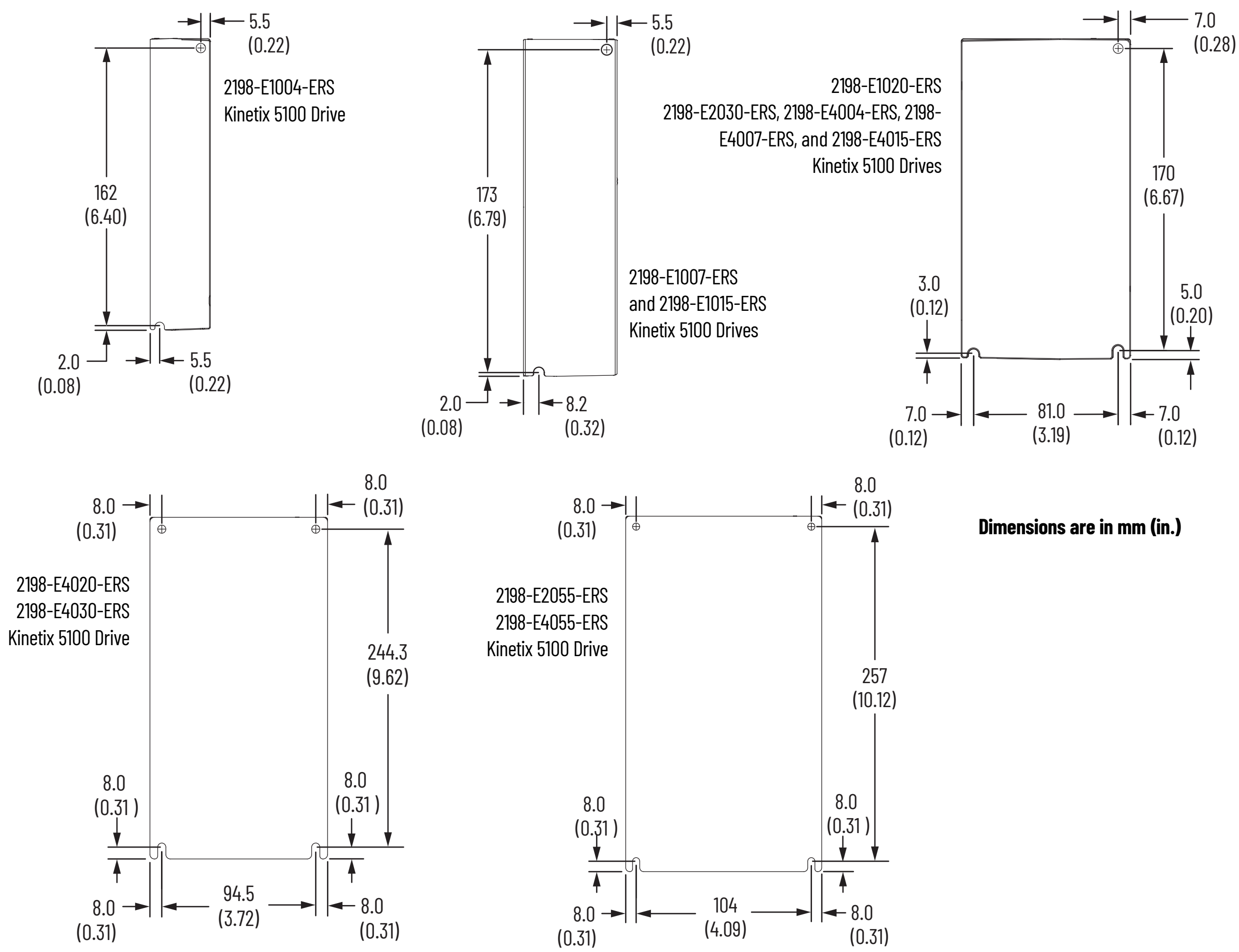
This procedure assumes that you have prepared your panel and understand how to bond your system. For installation instructions regarding other equipment and accessories, see the instructions that came with those products.

**ATTENTION:** This drive contains electrostatic discharge (ESD) sensitive parts and assemblies. You are required to follow static control precautions when you install, test, service, or repair this assembly. If you do not follow ESD control procedures, components can be damaged. If you are not familiar with static control procedures, see Allen-Bradley publication 8000-4.5.2, Guarding Against Electrostatic Damage or any other applicable ESD Protection Handbook.

### Drill-hole Patterns

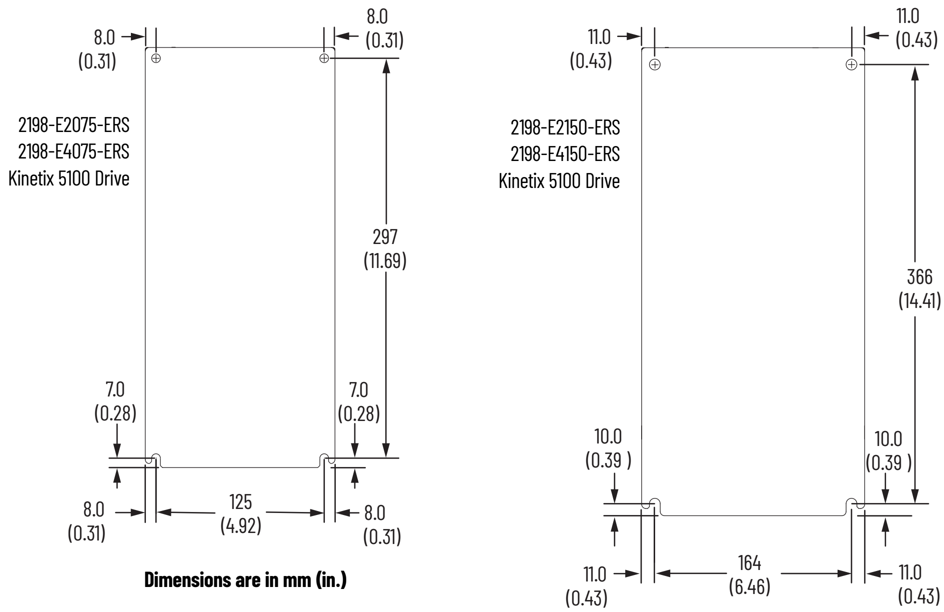
The following views provide mounting-hole dimensions for the Kinetix 5100 servo drives.

**Figure 16 - Mounting-hole Dimensions**




Dimensions are in mm (in.)

Figure 17 - Mounting-hole Dimensions (continued)




## Mount the Drive

Follow these steps to mount your Kinetix 5100 drive.

1. Lay out the position for the Kinetix 5100 drive and accessories in the enclosure.

   See Establish Noise Zones on page 37 for panel layout recommendations.

   | IMPORTANT | To improve the bond between the Kinetix 5100 drive and subpanel, construct your subpanel out of zinc-plated (paint-free) steel. |
   |---|---|

2. Drill holes in the panel for mounting your servo drive.

   Refer to Drill-hole Patterns on page 41. For drive dimensions, see the Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003.

3. Loosely attach the servo drive to the panel.

   The recommended mounting hardware is M4 (#8-32) steel machine screws. Observe bonding techniques as described in HF Bond the Drives on page 34.

4. Tighten all mounting fasteners.
5. Apply 2.0 N•m (17.7 lb•in) maximum torque to each fastener.

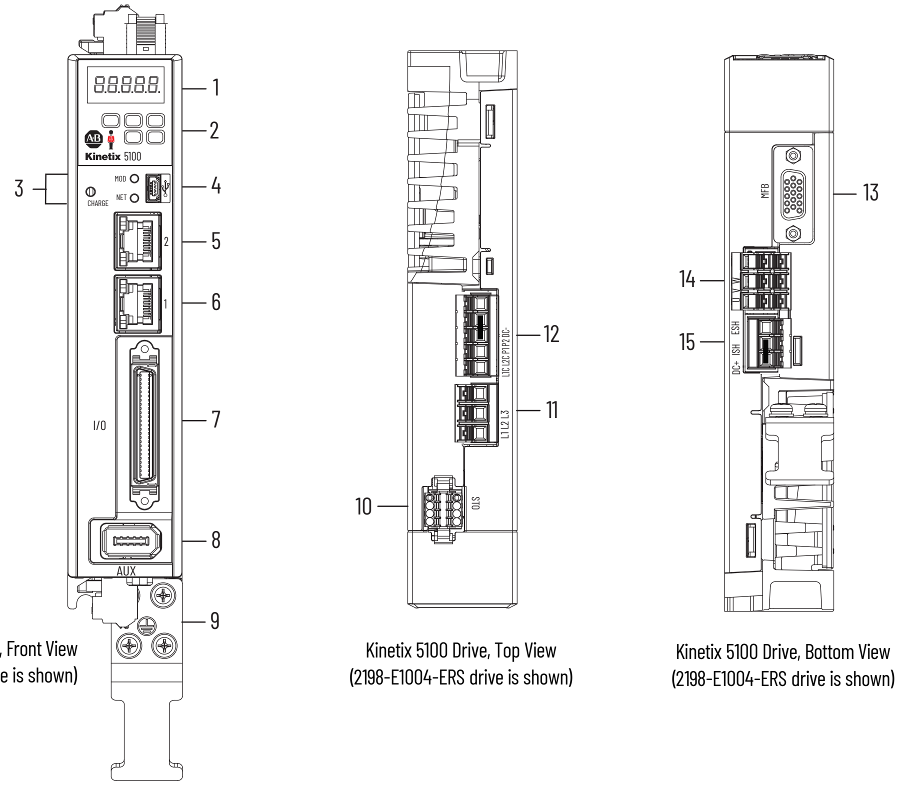
# Connector Data and Feature Descriptions

This chapter illustrates connectors and indicators for the Kinetix® 5100 servo drives. Also included in this chapter are control/feedback signal specifications and overviews of the functional safety feature and the Kinetix 5100 drive modes of operation.

## Kinetix 5100 Connector Data

Use these illustrations to identify the connectors and indicators for Kinetix 5100 servo drives.

**Figure 18 - Features and Indicators (catalog numbers 2198-E1004-ERS, 2198-E1007-ERS, and 2198-E1015-ERS)**




Kinetix 5100 Drive, Front View (2198-E1004-ERS drive is shown)

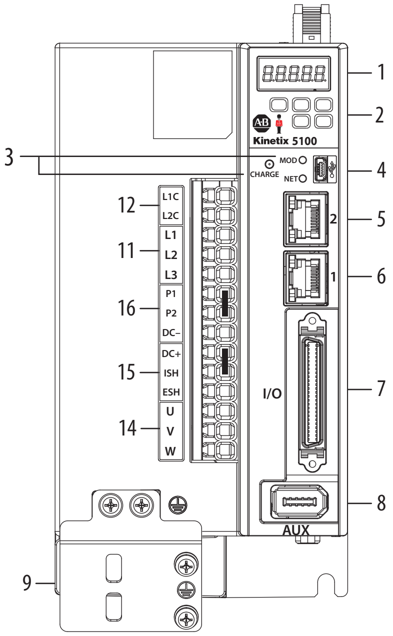
Kinetix 5100 Drive, Top View (2198-E1004-ERS drive is shown)

Kinetix 5100 Drive, Bottom View (2198-E1004-ERS drive is shown)

**Table 13 - Features and Indicators Description**

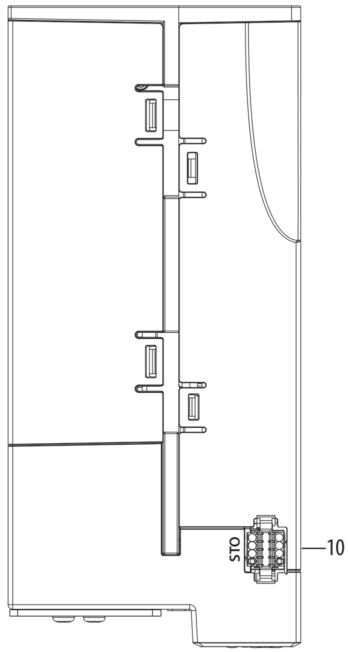
| Item | Description |
|---|---|
| 1 | Status display |
| 2 | Navigation push buttons |
| 3 | Module, Network, and Charge status indicators |
| 4 | Mini USB connector |
| 5 | Ethernet (PORT2) RJ45 connector |
| 6 | Ethernet (PORT1) RJ45 connector |
| 7 | I/O signal connector |
| 8 | Auxiliary feedback (AUX) connector |
| 9 | Motor cable ground plate |
| 10 | Safe torque-off (STO) connector |
| 11 | Mains input power connector |
| 12 | • Control power input (L1C and L2C) connections<br>• Reserved (P1, P2, and negative DC-bus are not used) |
| 13 | Motor feedback (MFB) connector |
| 14 | Motor power output terminals |
| 15 | Shunt resistor terminals |

**Figure 19 - Features and Indicators (catalog numbers 2198-E1020-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, 2198-E4015-ERS)**

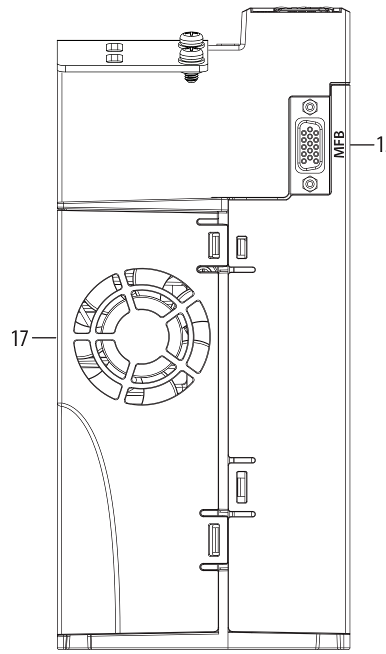



Kinetix 5100 Drive, Front View
(2198-E1020-ERS drive is shown)

For feature descriptions see table on page 46.

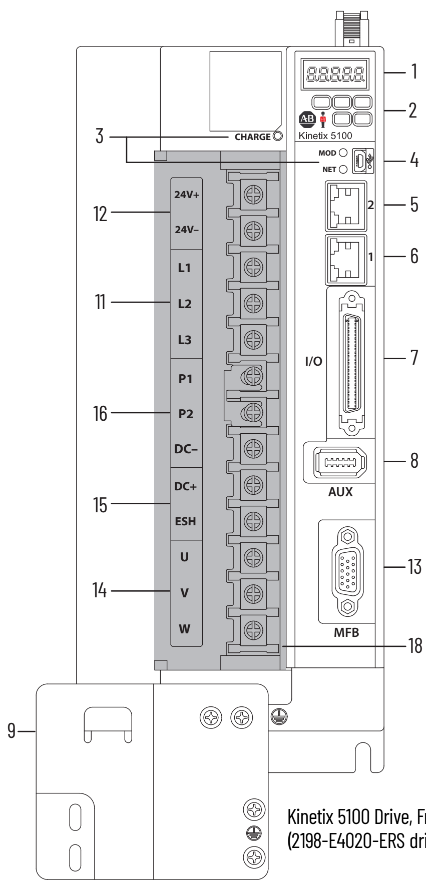



Kinetix 5100 Drive, Top View
(2198-E1020-ERS drive is shown)

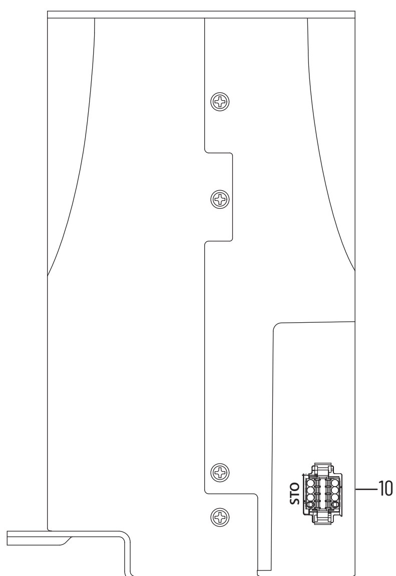



Kinetix 5100 Drive, Bottom View
(2198-E1020-ERS drive is shown)

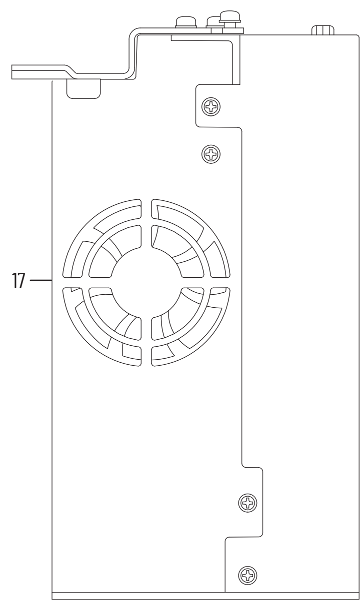
**Figure 20 - Features and Indicators (catalog numbers 2198-E4020-ERS, 2198-E4030-ERS)**




Kinetix 5100 Drive, Front View
(2198-E4020-ERS drive is shown)



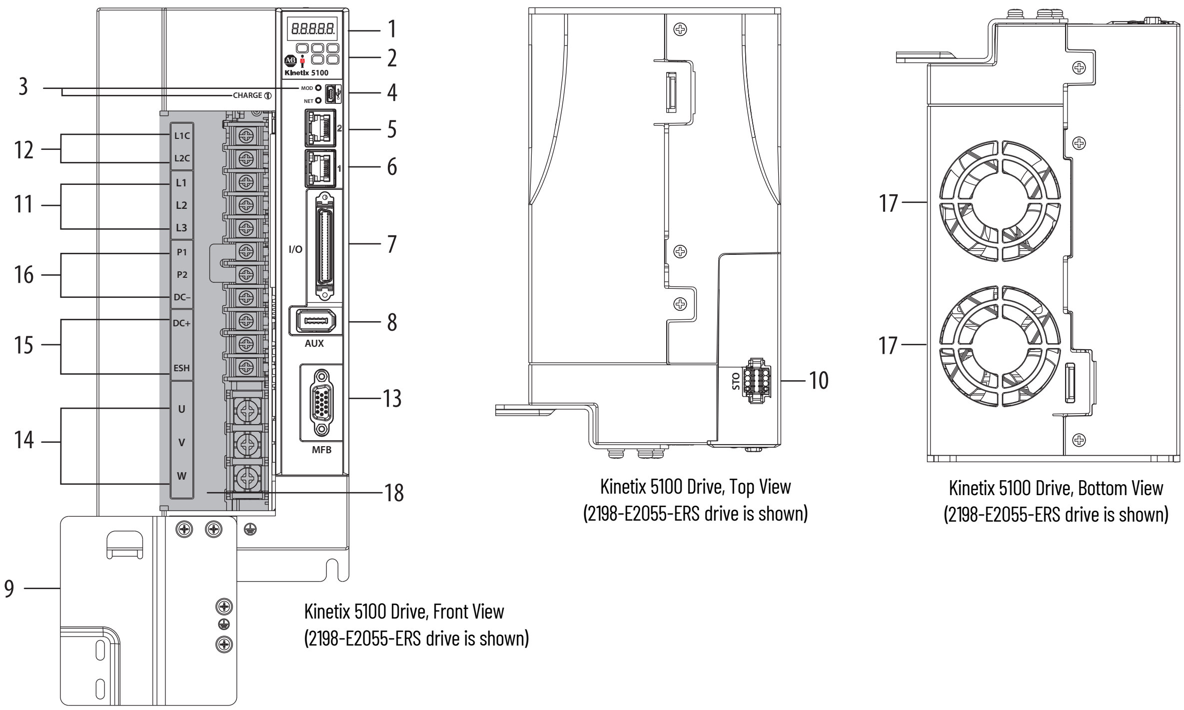

Kinetix 5100 Drive, Top View
(2198-E4020-ERS drive is shown)




Kinetix 5100 Drive, Bottom View
(2198-E4020-ERS drive is shown)

For feature descriptions see table on page 46.

**Figure 21 - Features and Indicators (catalog numbers 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS)**




Kinetix 5100 Drive, Front View
(2198-E2055-ERS drive is shown)

Kinetix 5100 Drive, Top View
(2198-E2055-ERS drive is shown)

Kinetix 5100 Drive, Bottom View
(2198-E2055-ERS drive is shown)

**Table 14 - Features and Indicators Description**

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Status display | 10 | Safe torque-off (STO) connector |
| 2 | Navigation push buttons | 11 | Mains input power terminals |
| 3 | Module, Network, and Charge status indicators | 12 | Control power input terminals (1) |
| 4 | Mini USB connector | 13 | Motor feedback (MFB) connector |
| 5 | Ethernet (PORT2) RJ45 connector | 14 | Motor power output terminals |
| 6 | Ethernet (PORT1) RJ45 connector | 15 | Shunt resistor terminals |
| 7 | I/O signal connector | 16 | Reserved (P1, P2, and negative DC-bus are not used) |
| 8 | Auxiliary feedback (AUX) connector | 17 | Cooling fans |
| 9 | Motor cable ground plate | 18 | Protective cover |

(1) Control power terminals are labeled L1C/L2C for 2198-1xxx-ERS and 2198-2xxx-ERS (200V-class) drives and 24V+/24V- for 2198-4xxx-ERS (400V-class) drives.

## Safe Torque-off Connector Pinout

The hardwired safe torque-off (STO) connector pinouts apply to all Kinetix 5100 servo drives. For feature descriptions and wiring information, refer to Chapter 13 beginning on page 407.

## Power Connector Pinouts

Catalog numbers 2198-E1004-ERS, 2198-E1007-ERS, and 2198-E1015-ERS have connector plugs on the top and bottom of the drive for power connections.

**Table 15 - AC Input Power Connector Pinouts**

| Signal | Description |
|---|---|
| L1 | AC power in - L1 phase |
| L2 | AC power in - L2 phase |
| L3 | AC power in - L3 phase |

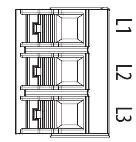



**Table 16 - Control AC Input Power Connector Pinout**

| Signal | Description |
|---|---|
| L1C | Control AC power in - L1C phase |
| L2C | Control AC power in - L2C phase |
| P1 | Reserved (not used) (1) |
| P2 | |
| DC- | Negative DC bus |

(1) P1 and P2 jumper is applied (default) at the factory. Do not remove jumper.

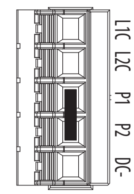



**Table 17 - Shunt Resistor Connector Pinout**

| Signal | Description |
|---|---|
| DC+ | Positive DC bus |
| ISH | Internal shunt connection (1)<br>(applies to only 2198-E1004-ERS, 2198-E1007-ERS, and 2198-E1015-ERS drives) |
| ESH | External shunt connection (applies to all drives) |

(1) For internal shunt, keep jumper applied between DC+ and ISH (default). Remove jumper and connect external shunt between DC+ and ESH.

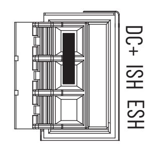
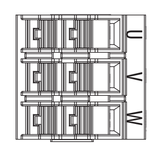



**Table 18 - Motor-Power Connector Pinout**

| Signal | Description |
|---|---|
| U | Motor power out - U phase |
| V | Motor power out - V phase |
| W | Motor power out - W phase |



Catalog numbers 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, and 2198-E4*xxx*-ERS have power connections on the I/O terminal block on the front of the drive.

**Figure 22 - Power Pinouts on I/O Terminal Block**

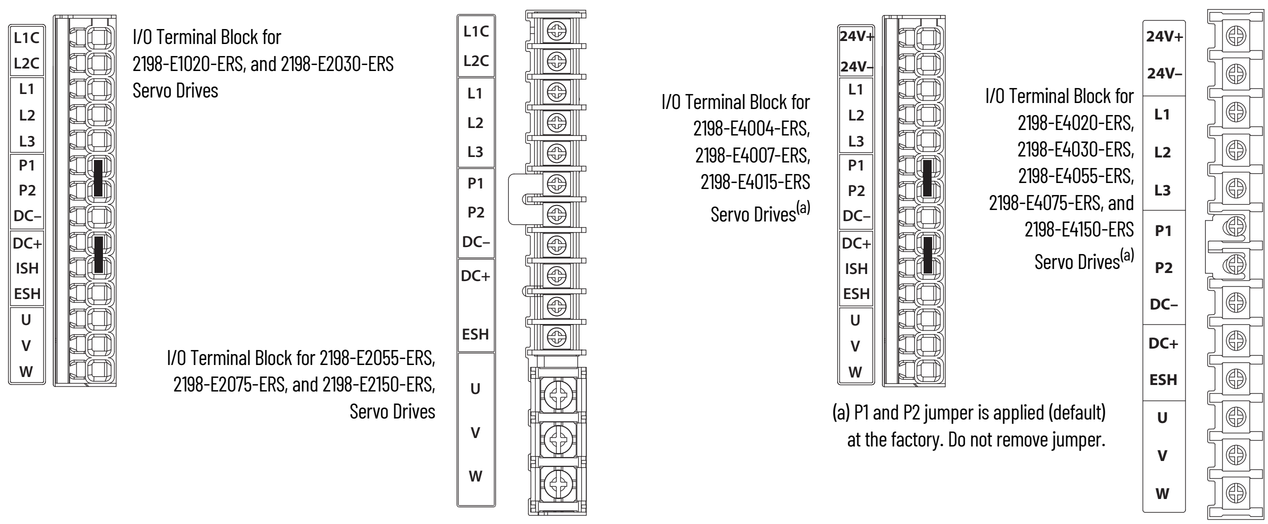



**Table 19 - Control Input Power Connector Pinout - (400V-Class Drives)**

| Signal | Description |
|---|---|
| 24V+ | Control 24V+ DC |
| 24V- | Control 24V- DC common |

For connector pinout descriptions, see Table 13 and Table 14 beginning on page 44.

The 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS, 2198-E4020-ERS, 2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS drives do not include an internal shunt resistor. However, an external shunt resistor can be connected to the DC+ and ESH terminals.

**Table 20 - Shunt Resistor Connector Pinout**

| Signal | Description |
|---|---|
| DC+ | Positive DC bus |
| ISH | Internal shunt connection (1)<br>(applies to only 2198-E1020-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, and 2198-E4015-ERS drives) |
| ESH | External shunt connection (applies to all drives) |

(1) For internal shunt, keep jumper applied between DC+ and ISH (default). Remove jumper and connect external shunt between DC+ and ESH.

### Table 21 - I/O Connector Pinout

| I/O Pin | Signal | Description |
|---|---|---|
| 1 | OUTPUT4+ | Digital output 4+ |
| 2 | OUTPUT3– | Digital output 3– |
| 3 | OUTPUT3+ | Digital output 3+ |
| 4 | OUTPUT2– | Digital output 2– |
| 5 | OUTPUT2+ | Digital output 2+ |
| 6 | OUTPUT1– | Digital output 1– |
| 7 | OUTPUT1+ | Digital output1+ |
| 8 | INPUT4 | Digital input 4 |
| 9 | INPUT1 | Digital input 1 |
| 10 | INPUT2 | Digital input 2 |
| 11 | DCOM | Common for digital inputs, connected to +24 or 0V DC |
| 12 | AGND | Analog input signal ground |
| 13 | AGND | Analog input signal ground |
| 14 | — | Reserved [1] |
| 15 | AOUT2 | Analog monitor output 2 |
| 16 | AOUT1 | Analog monitor output 1 |
| 17 | — | Reserved [1] |
| 18 | COMMAND1 | Analog torque input |
| 19 | AGND | Analog input signal ground |
| 20 | — | Reserved [1] |
| 21 | AMOUT+ | Buffered encoder output Ch A+ |
| 22 | AMOUT– | Buffered encoder output Ch A– |
| 23 | BMOUT– | Buffered encoder output Ch B– |
| 24 | ZMOUT– | Buffered encoder output Ch Z– |
| 25 | BMOUT+ | Buffered encoder output Ch B+ |
| 26 | OUTPUT4– | Digital output 4– |
| 27 | OUTPUT5– | Digital output 5– |
| 28 | OUTPUT5+ | Digital output 5+ |
| 29 | INPUT9 | Digital input 9 (high speed) |
| 30 | INPUT8 | Digital input 8 |
| 31 | INPUT7 | Digital input 7 |
| 32 | INPUT6 | Digital input 6 |
| 33 | INPUT5 | Digital input 5 |
| 34 | INPUT3 | Digital input 3 |
| 35 | BPWR | External power input of BX+/BX– for single-end operation |
| 36 | BX+ | Pulse input B+/DIR+/CCW+ |
| 37 | BX– | Pulse input B–/DIR–/CCW– |
| 38 | INPUT10 | Digital input 10 (high speed) |
| 39 | APWR | External power input of AX+/AX– for single-end operation |
| 40 | OUTPUT6– | Digital output 6– |
| 41 | AX– | Pulse input A–/Step–/CW– |
| 42 | COMMAND2 | Analog position or speed command input |
| 43 | AX+ | Pulse input A+/Step+/CW+ |
| 44 | AGND | Analog input signal ground |
| 45 | — | Reserved [1] |
| 46 | OUTPUT6+ | Digital output 6+ |
| 47 | — | Reserved [1] |
| 48 | OCZMOUT | Buffered Encoder Output Ch Z open collector |
| 49 | — | Reserved [1] |
| 50 | ZMOUT+ | Buffered encoder output Ch Z+ |
| ⏚ | ⏚ | Drain wire |

(1) The reserved pins are not present on the 2198-TBIO terminal expansion block.

**Figure 23 - Pin Orientation for 50-pin SCSI I/O Connector**

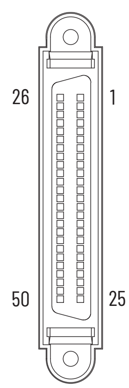


**Table 22 - Motor Feedback (MFB) Connector Pinout**

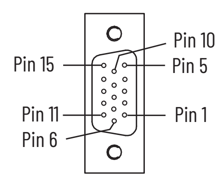
| MFB Pin | Signal | Description |
|---|---|---|
| 1 | SIN+<br>AM+ | Sine differential input+<br>AM+ differential input+ |
| 2 | SIN–<br>AM– | Sine differential input–<br>AM– differential input– |
| 3 | COS+<br>BM+ | Cosine differential input+<br>BM+ differential input+ |
| 4 | COS–<br>BM– | Cosine differential input–<br>BM– differential input– |
| 5 | DATA+<br>IM+ | Data differential input +<br>Index pulse+ |
| 6 | ECOM | Common |
| 7 | EPWR_9V [2] | Encoder power (+9V) |
| 8 | S3 | Single-ended 5V Hall effect commutation |
| 9 | – | Reserved |
| 10 | DATA–<br>IM– | Data differential input -<br>Index pulse– |
| 11 | TS | Motor thermal switch (normally closed) [1] |
| 12 | S1 | Single-ended 5V Hall effect commutation |
| 13 | S2 | Single-ended 5V Hall effect commutation |
| 14 | EPWR_5V [2] | Encoder power (+5V) |
| 15 | – | Reserved |

(1) Not applicable unless motor has integrated thermal protection.
(2) Determine which power supply your encoder requires and connect to only the specified supply. Do not make connections to both.

**ATTENTION:** The motor feedback will determine which encoder power source is used. Be sure you use the correct power source for your encoder to avoid equipment damage.

**IMPORTANT** For the maximum length of the drive to motor power and feedback cable, see Maximum Cable Length on page 89. System performance was tested at these specifications and also applies when meeting CE requirements.

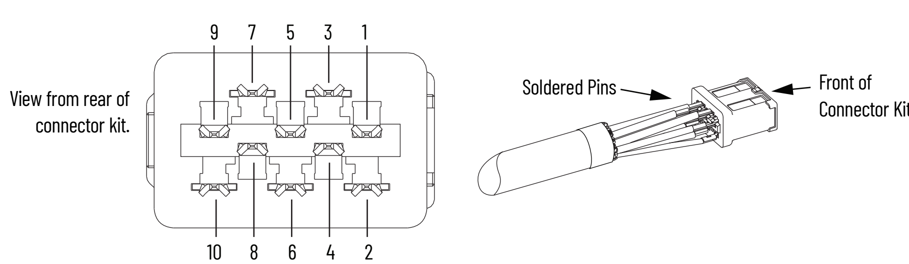
**Figure 24 - Pin Orientation for 15-pin Motor Feedback (MFB) Connector**




# Auxiliary Feedback Connector Pinout

| Pin | Signal | Description |
|---|---|---|
| 1 | AM+ | Channel A Differential Input + |
| 2 | AM– | Channel A Differential Input - |
| 3 | BM+ | Channel B Differential Input + |
| 4 | BM– | Channel B Differential Input - |
| 5 | IM+ | Channel Index Differential Input + |
| 6 | IM– | Channel Index Differential Input - |
| 7 | ECOM | Encoder Common |
| 8 | EPWR5V | Encoder 5V Power Output |
| 9 | Reserved | Reserved |
| 10 | Reserved | Reserved |

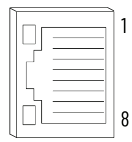
**Figure 25 - Pin Orientation for Auxiliary Feedback (AUX) Connector**



### Ethernet Communication Connector Pinout

| Port 1 Pin | Signal | Description | Port 1 Pin | Signal | Description |
|---|---|---|---|---|---|
| 1 | + TX | Transmit Port (+) Data Terminal | 5 | – | – |
| 2 | - TX | Transmit Port (-) Data Terminal | 6 | - RX | Receive Port (-) Data Terminal |
| 3 | + RX | Receive Port (+) Data Terminal | 7 | – | – |
| 4 | – | – | 8 | – | – |

Figure 26 - Pin Orientation for 8-pin Ethernet Communication Port




## Control Signal Specifications

This section provides a description of the Kinetix 5100 drive digital I/O, analog outputs, Ethernet communication, motor brake circuitry, and control power current specifications.

### Digital Inputs

The Kinetix 5100 drive supports ten customer-defined digital input (DI) points to provide maximum flexibility. All inputs are configurable with KNX5100C software.

Registration inputs can only be assigned to high-speed inputs as shown in Table 23.

Table 23 - Digital Input Assignments

| Digital Input | Function | Function |
|---|---|---|
| INPUT1 | Digital input 1 | User configurable, excluding registration |
| INPUT2 | Digital input 2 | |
| INPUT3 | Digital input 3 | |
| INPUT4 | Digital input 4 | |
| INPUT5 | Digital input 5 | |
| INPUT6 | Digital input 6 | |
| INPUT7 | Digital input 7 | |
| INPUT8 | Digital input 8 | |
| INPUT9 | Digital input 9 (high speed) | User configurable, including registration |
| INPUT10 | Digital input 10 (high speed) | |

The default input configuration is disabled for all modes. Assignments can be changed via KNX5100C software > Digital IO/Jog Control in the Function List.

The digital input functions are defined in Description of Digital Input Functions on page 425. If the defined digital input function needs to change to meet your application requirements, you can change the functions by using a PR Write to Parameters program type for the function of INPUT1…INPUT10 by using the corresponding parameters listed in Table 24.

**Table 24 - Digital Input Signal Parameters**

| Signal | Pin | Configuration Parameter |
|---|---|---|
| INPUT1 | 9 | ID195 (P2.010) |
| INPUT2 | 10 | ID196 (P2.011) |
| INPUT3 | 34 | ID197 (P2.012) |
| INPUT4 | 8 | ID198 (P2.013) |
| INPUT5 | 33 | ID199 (P2.014) |
| INPUT6 | 32 | ID200 (P2.015) |
| INPUT7 | 31 | ID201 (P2.016) |
| INPUT8 | 30 | ID202 (P2.017) |
| INPUT9 | 29 | ID220 (P2.036) |
| INPUT10 | 38 | ID221 (P2.037) |

### *Wiring and Signal Specifications*

The digital inputs are optically isolated and sink up to 24V DC. Electrical details are shown in Table 25. You can configure the inputs for PNP sourcing or NPN sinking.

**Figure 27 - Digital Input Circuitry**

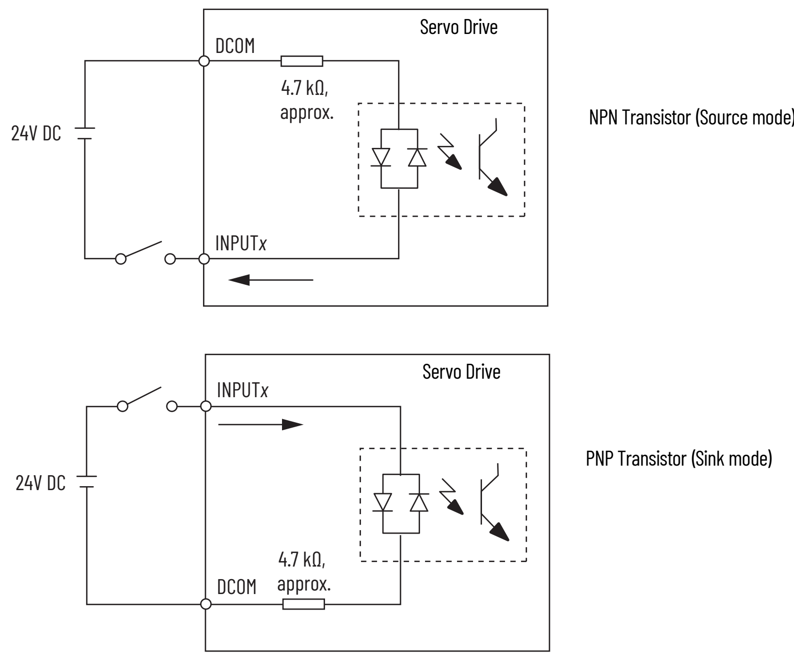


**Table 25 - Digital Input Specifications**

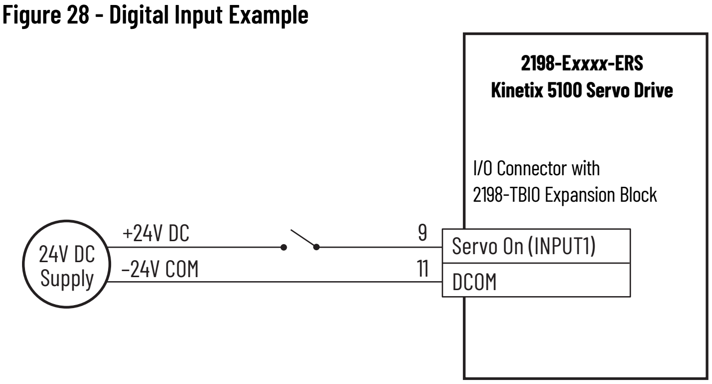
| Attribute | Value |
|---|---|
| Digital input response (delay) | • Standard inputs: 1.25 ms, max<br>• High speed inputs: 3 μs |
| Digital inputs scan time | • Standard inputs: 500 μs, max<br>• High speed inputs: 1 μs |
| Type | Current sourcing and current sinking (IEC61131-2 Type 1) |
| Dedicated functions | • Standard inputs: INPUT1…INPUT8 and DCOM.<br>• High speed inputs (registration inputs): INPUT9, INPUT10, and DCOM.<br>• When configured as Disabled, inputs can be used by programs as a programming condition.<br>Only one function at a time is possible. |
| Input current (with 26.4V applied) | 6 mA, max |
| ON state voltage | 15…26.4V |
| OFF state voltage | -1.0…5.0V |
| Pulse reject filtering (all digital inputs) | 0.5 μs |
| Propagation delay (registration functions) | 3 μs |
| Registration accuracy | 3 μs |
| Registration repeatability | 1 μs |

### *Digital Input Wiring*

See Digital Inputs on page 51 for the default digital input assignments for Kinetix 5100 drives.

In this example, Servo On is assigned to digital input 1 as a sinking type input.

**Figure 28 - Digital Input Example**



## Digital Outputs

The Kinetix 5100 drives support six customer-defined digital output (DO) points to provide maximum flexibility. OUTPUT1…OUTPUT6 are available on the 2198-TBIO connector. Outputs are optically isolated open-collector/emitter and are fully isolated from the drive circuits. Each output, OUTPUT1…OUTPUT6, is disabled for all modes by default.

The digital output functions are defined in Description of Digital Output Functions on page 429.

If the defined digital output function needs to change to meet your application requirements, you can use a PR Write to Parameters program type to change the function of OUTPUT1…OUTPUT6 by using the corresponding parameters listed in Table 26.

**Table 26 - Digital Output Signal Parameters**

| Signal | Pin | Configuration Parameter |
|---|---|---|
| OUTPUT1+ | 7 | ID203 (P2.018) |
| OUTPUT1- | 6 | |
| OUTPUT2+ | 5 | ID204 (P2.019) |
| OUTPUT2- | 4 | |
| OUTPUT3+ | 3 | ID205 (P2.020) |
| OUTPUT3- | 2 | |

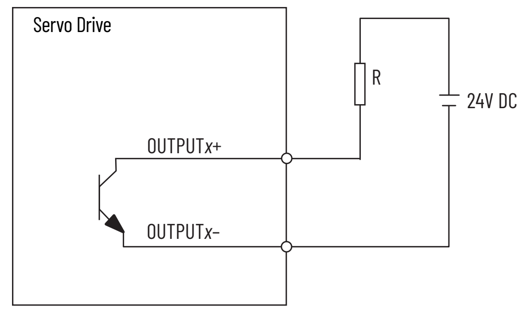
| Signal | Pin | Configuration Parameter |
|---|---|---|
| OUTPUT4+ | 1 | ID206 (P2.021) |
| OUTPUT4- | 26 | |
| OUTPUT5+ | 28 | ID207 (P2.022) |
| OUTPUT5- | 27 | |
| OUTPUT6+ | 46 | ID225 (P2.041) |
| OUTPUT6- | 40 | |

### *Wiring and Signal Specifications*

The digital outputs are optically isolated and sink up to 24V DC. Electrical details are shown in Table 27.

**Figure 29 - Digital Output Circuitry**

In this example, the drive applies the external 24V DC power supply to a resistive load.




In this example, the drive applies the external 24V DC power supply to an inductive load.

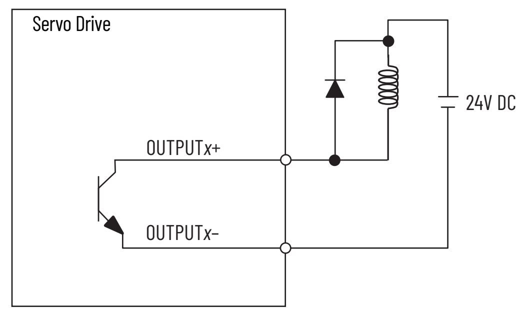


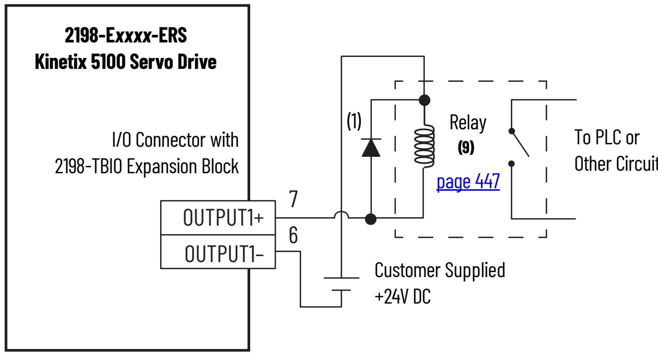

**Table 27 - Digital Output Signal Specifications**

| Parameter | Description | Min | Max |
|---|---|---|---|
| ON state current | Current flow when the output transistor is ON | – | 40 mA |
| OFF state current | Current flow when the output transistor is OFF | – | 0.1 mA |
| ON state voltage | Voltage across the output transistor when ON | – | 1.5V @ 40 mA |
| OFF state voltage | Voltage across the output transistor when OFF | – | 30V |
| Scan time | Interval of the digital outputs status updating in drive firmware | – | 250 µs |
| Pass through delay | Signal propagation delay from the firmware-accessible registers to the digital output | – | 1.0 ms |

### *Digital Output Wiring*

In this example, digital output 1 (pin 7+, pin 6–) is connected to an output relay that changes a contact state used in a PLC or other circuit as shown.

**Figure 30 - Digital Output Example**




(1) Customer-supplied diode or MOV suppression device.

The I/O connector provides up to six digital outputs. Digital outputs are open-collector type and are configurable with KNX5100C software.

An example brake circuit contains the following components:
- Digital output 40 mA (max) continuous current.

Choose a relay rated for 40 mA continuous current or less.

- Relay 700-HK36Z24 with DIN mount 700-HN121 or equivalent
- Choose from these suppression devices:
  - 1N4004 diodes or equivalent
  - Bulletin 199-MSMV1 MOV or equivalent

See Digital Outputs on page 54 for the default digital output assignments for Kinetix 5100 drives.

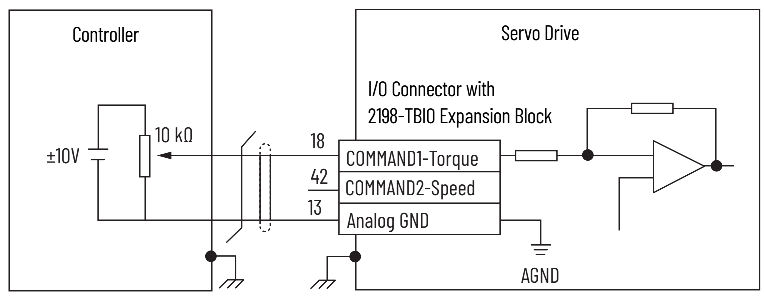
## Analog Inputs

There are two analog inputs, COMMAND1 and COMMAND2, available on the I/O connector. When the drive mode is configured for Speed or Torque, the analog inputs are used for Torque and Speed commands.

**Table 28 - Analog Input Specifications**

| Parameter | Description |
|---|---|
| Analog inputs voltage | -10 V… +10 Vs |
| Analog inputs resolution | 11 bits, min |
| Analog inputs scan time | 0.0625 ms, max |
| Analog inputs impedance | 12 kΩ typical, approx. |

**Figure 31 - Analog COMMAND Input Configuration**




## Pulse Inputs

There are pulse inputs available on the 2198-TBIO connector. They support either single-ended or differential pulse signals. When using the single-ended signals, they can be wired as current sinking (PNP) or sourcing (NPN) inputs.

**Figure 32 - Pulse Input - Single-ended Configuration (current sourcing)**

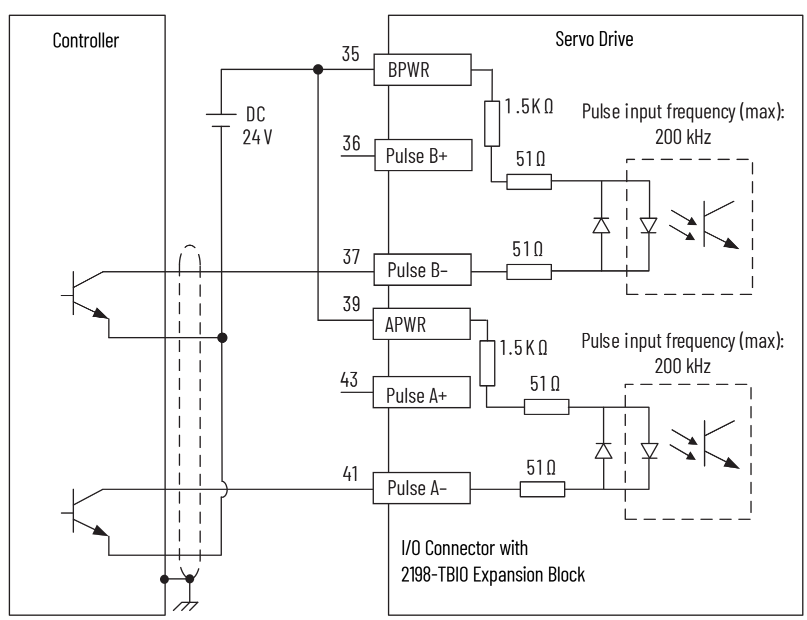
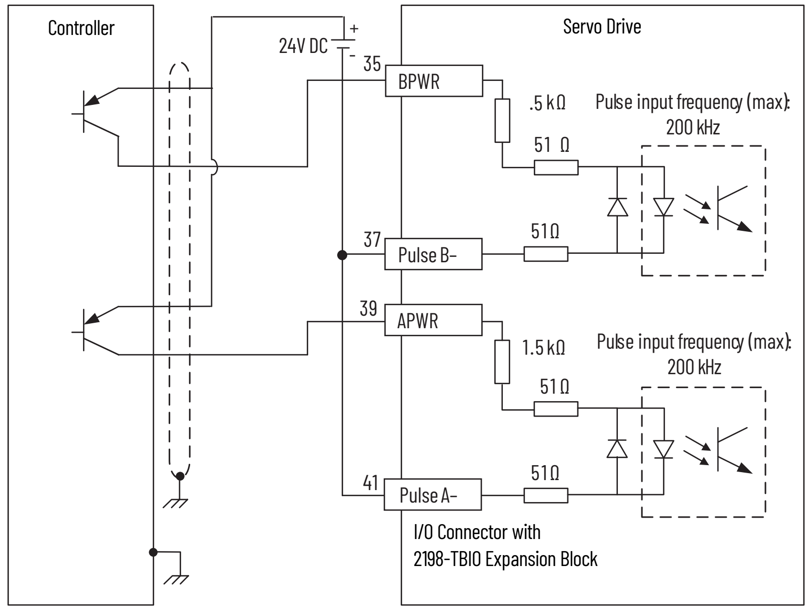
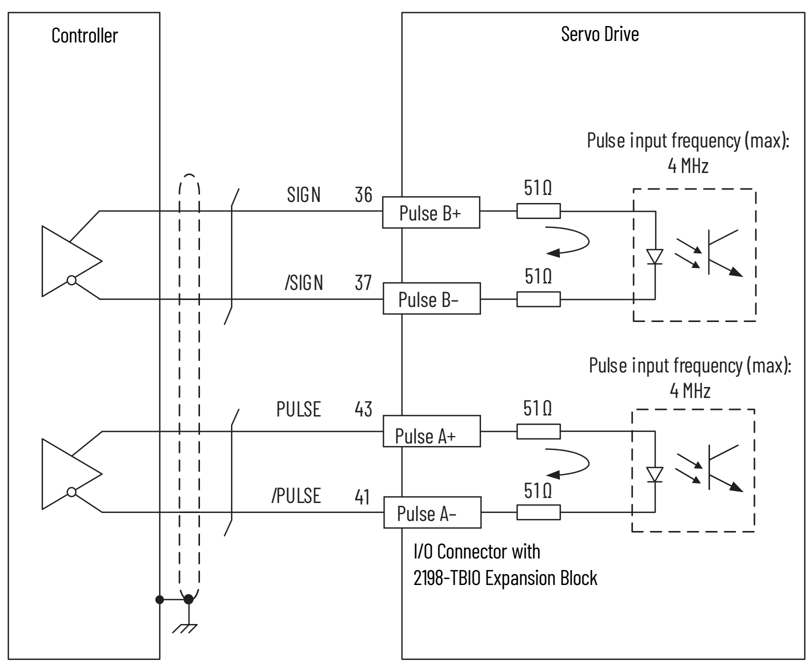


**Figure 33 - Pulse Input - Single-ended Configuration (current sinking)**




In Differential mode, the pulse input (line driver) only accepts 2.8…3.6V DC (5V DC nominal). Do not apply 24V power.

**Figure 34 - Pulse Input (line driver) Configuration**



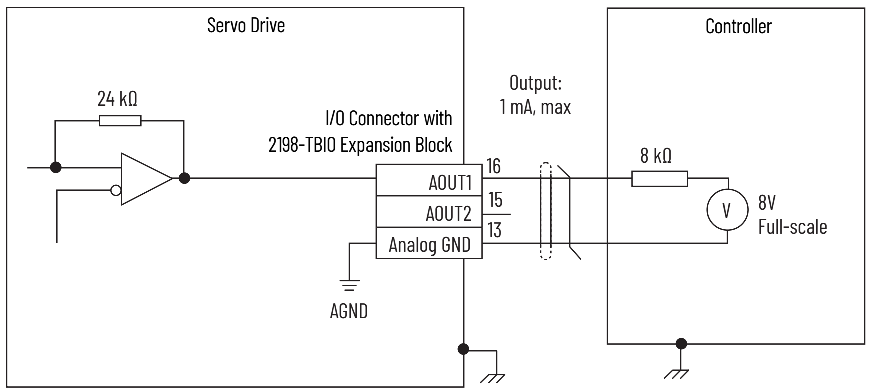
## Analog Outputs

There are two analog outputs, AOUT1 and AOUT2, available on the I/O connector. Assignments are changed via KNX5100C software > Function List > Analog IO > Output Monitor.

**Table 29 - Analog Output Specifications**

| Parameter | Description |
|---|---|
| Analog outputs voltage | -8V… +8V DC or -10V…+10VDC, user configurable |
| Analog outputs resolution | 10 bits, min |
| Analog outputs current | 1 mA, max |
| Analog outputs scan time | 0.25 ms, max |

**Figure 35 - Analog Output Circuitry**




## Buffered Encoder Outputs

Encoder output signals can be connected to the receiving device with line receiver (differential) or opto-coupler isolated inputs. The encoder output signals are flexible. The signals are scaled and programmed by using KNX5100C software > Function List > Pulse Output.

**Figure 36 - Encoder Output Position (line driver)**

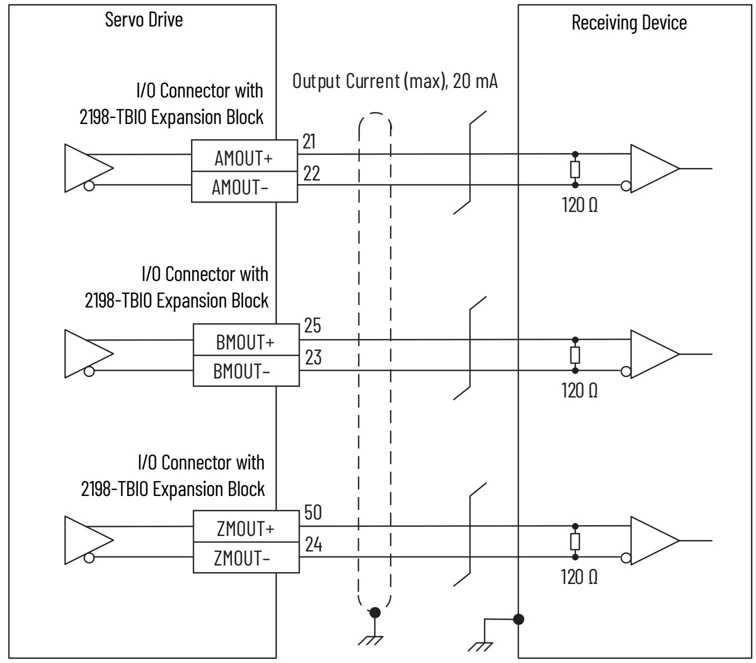



**Figure 37 - Encoder Output Position (opto-isolator)**

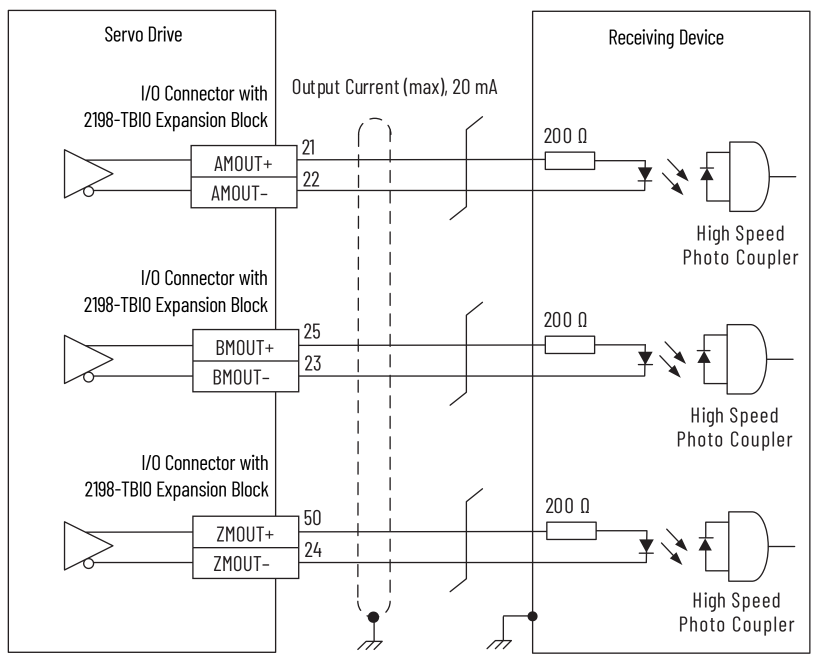
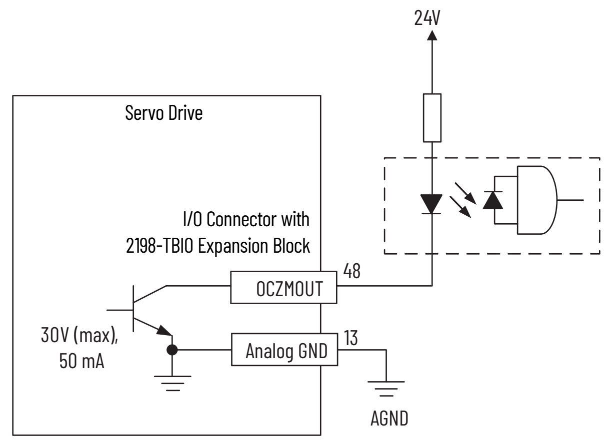


Figure 38 - Encoder OCA Output (open collector Z pulse output)




## Ethernet Communication Specifications

The PORT1 and PORT2 (RJ45) Ethernet connectors provide EtherNet/IP communication.

Table 30 - Ethernet Communication Specifications

| Attribute | Value |
|---|---|
| Communication | The drive auto-negotiates Speed and Duplex modes. These modes can be forced through the Logix Designer application. 100BASE-TX, full-duplex is recommended for maximum performance. |
| Request Packet Interval (RPI) | 2.0 ms, min (20 ms default) |
| Auto MDI/MDIX crossover detection/correction | Yes |
| Cabling | CAT5e shielded, 100 m (328 ft), max |

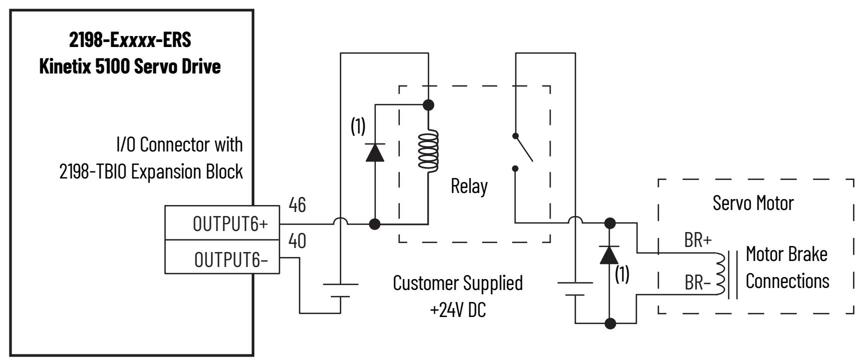
## Motor Brake Circuit

The brake option is a motor mounted spring-set holding brake that releases when voltage is applied to the brake coil in the motor. The customer-supplied 24V power supply drives the brake output through a relay.

*Wire the Brake Control Circuit*

One digital output can be used for motor brake control. In this example, OUTPUT6 is used. Wire the brake control circuit according to the appropriate interconnect diagram in Kinetix 5100 Drive/Rotary Motor Wiring Examples beginning on page 454. An external customer-supplied 24V power supply is required.

**Figure 39 - Brake Control Circuit Example**




(1) Customer-supplied diode or MOV suppression device.

An example brake circuit contains the following components:

- Digital output 40 mA (max) continuous current.

Choose a relay rated for 40 mA continuous current or less.

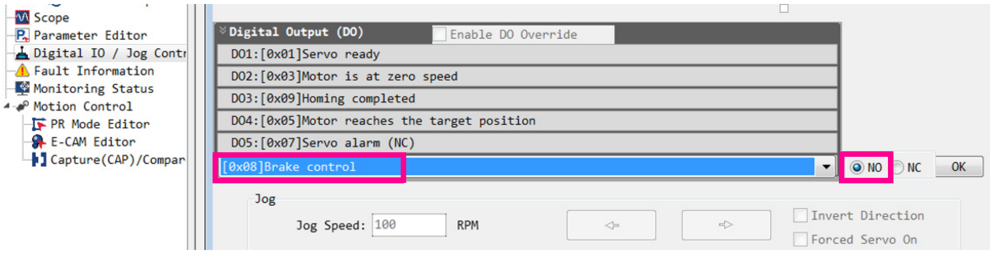
- Relay 700-HK36Z24 with DIN mount 700-HN121 or equivalent
- Suppression device examples include 1N4004 diode, Bulletin 199-MSMV1 MOV, or equivalent

See Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001, for coil current ratings and brake response times.

### *Configure the Brake Control Circuit*

Follow these steps to configure brake control in KNX5100C software.

1. Double-click Function List > Digital IO/Jog Control
2. Check Edit DIO configurations.
3. From the Digital Output (DO) pull-down menu, choose Brake Control.



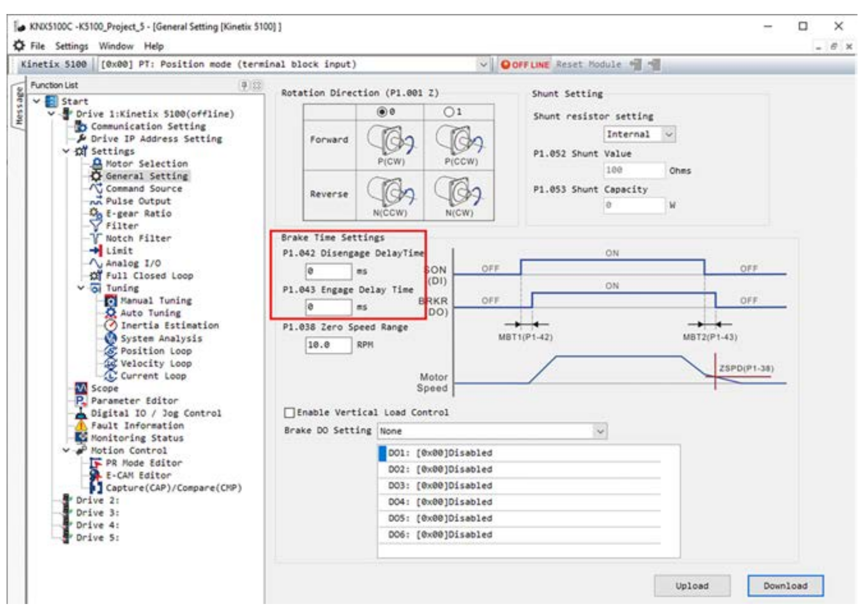

4. Verify that N.O. (normally open) is selected.
5. Uncheck Edit DIO configurations.
6. Click Settings>General Setting and configure the brake response engage and disengage delay times based on the motor selected.

   For motor brake coil-current and response time specifications for all Allen-Bradley® motor families, see Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001.

   Brake control is configurable in KNX5100C software. An active signal releases the motor brake. Turn-on and turn-off delays are specified by ID149 (P1.042) Disengage Delay Time and ID150 (P1.043) Engage Delay Time parameter settings.

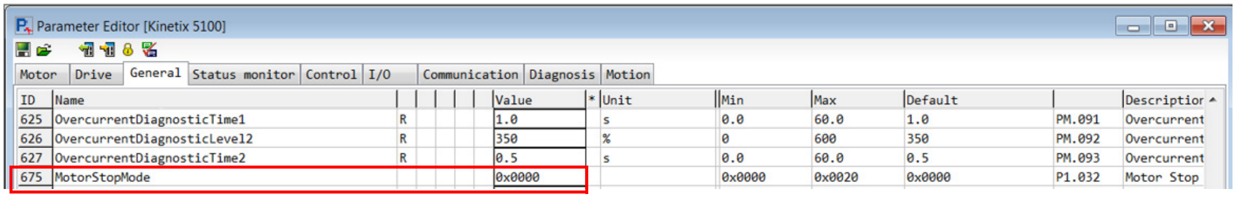
| IMPORTANT | Holding brakes that are available on Allen-Bradley rotary motors are designed to hold a motor shaft at 0 rpm for up to the rated brake-holding torque, not to stop the rotation of the motor shaft, or to be used as a safety device.<br>You must command the servo drive to 0 rpm and engage the brake only after verifying that the motor shaft is at 0 rpm. |
|---|---|

7. In Brake Time Settings, enter ID149 (P1.042) Disengage Delay Time and ID150 (P1.043) Engage Delay Time parameter values.



8. Verify that the MotorStopMode ID675 (P1.032) parameter is set to 0000.

   Refer to Parameter Editor screen General parameter group.


Parameter Editor [Kinetix 5100]

Motor | Drive | General | Status monitor | Control | I/O | Communication | Diagnosis | Motion

| ID | Name | | | | | Value | * | Unit | Min | Max | Default | | Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 625 | OvercurrentDiagnosticTime1 | R | | | | 1.0 | | s | 0.0 | 60.0 | 1.0 | PM.091 | Overcurrent |
| 626 | OvercurrentDiagnosticLevel2 | R | | | | 350 | | % | 0 | 600 | 350 | PM.092 | Overcurrent |
| 627 | OvercurrentDiagnosticTime2 | R | | | | 0.5 | | s | 0.0 | 60.0 | 0.5 | PM.093 | Overcurrent |
| 675 | MotorStopMode | | | | | 0x0000 | | | 0x0000 | 0x0020 | 0x0000 | P1.032 | Motor Stop |

For vertical loads, MotorStopMode 0000 controls the motor to below the ZeroSpeedWindow ID145 (P1.038) where the brake function executes (see Figure 40).

| | |
|---|---|
| **IMPORTANT** | For MPL-A/B15*xxx* and MPL-A/B2*xxx* motors when MotorStopMode is set at 0000 or 0020 (dynamic brake is enabled), there is a risk that these motors can demagnetize during the stop. For these motors, set MotorStopMode at 0010 (disable and coast). |

### *Motor Brake Control Operation*

Brake control is automatic. Figure 40 shows the timing of the brake control in two different scenarios. Below is a description of the brake control operation shown in Figure 40:

- Brake Disengage (physically release the brake)

  When the Servo On condition is ON (digital input ‘Servo On’ activates or Add-On Instruction command raC_*xxx*_k5100_MSO is issued), ID149 (P1.042) DisengageDelayTime begins timing. When this delay expires, the brake output is set and motion can occur.

- Brake Engage

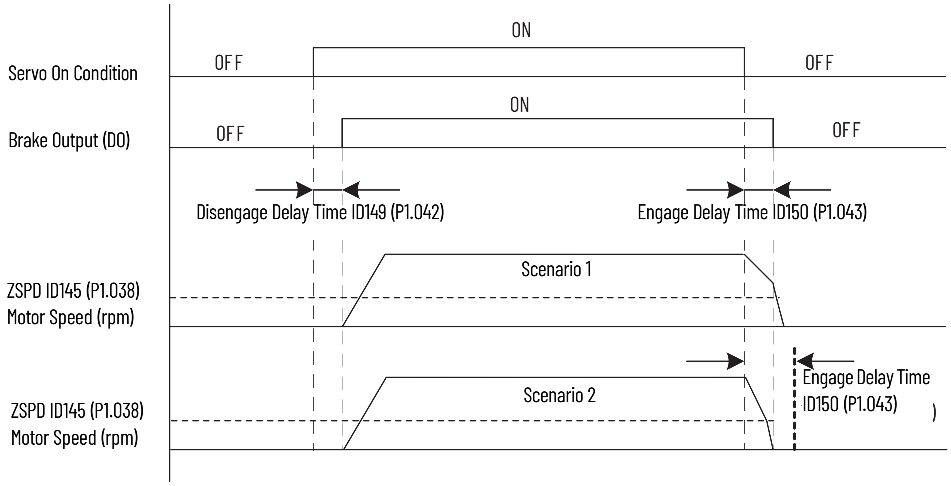
  This operation involves parameters ID145 (P1.038) ZeroSpeedWindow rpm and ID150 (P1.043) EngageDelayTime.

  ZeroSpeedWindow is a programmable value. When the motor speed (rpm) is below the ZeroSpeedWindow value, the zero speed condition is met.

  When the Servo On condition is OFF (digital input 'Servo On' is removed, Add-On Instruction command raC_*xxx*_k5100_MSF is issued, or the drive faults), ID150 (P1.043) Engage Delay Time begins timing. The ZeroSpeedWindow condition is actively evaluated. If the zero speed condition occurs before the Engage Delay Time expires, the brake output is OFF (scenario 2). If the zero speed condition is not met and the Engage Delay Time expires, the brake output is OFF (scenario 1).

| | |
|---|---|
| **IMPORTANT** | If the ZeroSpeedWindow and Brake Delay parameters are not set correctly, the brake can set while the motor is in motion. |

Figure 40 - Brake Control Timing Diagram




For motor brake specifications to size the interposing relay, see Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001. See the interconnect diagram for your Kinetix 5100 drive/motor beginning on page 454 for typical motor brake wiring.

More information on the Vertical Load Control setting (which populates default brake settings) is found on page 155.

## Control Power

Kinetix 5100 200V-class drives require 95…132V AC (120V nom) single-phase, with 120V AC input power or 170…253V AC (200…230V nom) single-phase, with 200…230V AC input power.

Table 31 - Control Power Specifications - 200V-class Drives

| **Kinetix 5100 (200V-class) Drives Cat. No.** | **Input Current of Control Power** A rms at 120V rms, nom | **Inrush Current of Control Power, max** A 0-pk at 120V rms, nom | **Input Current of Control Power** A rms at 230V rms, nom | **Inrush current of Control Power, max** A 0-pk at 230V rms, nom |
|---|---|---|---|---|
| 2198-E1004-ERS | 0.34 | 15.80 | 0.20 | 37.0 |
| 2198-E1007-ERS | 0.38 | 18.20 | 0.22 | 37.40 |
| 2198-E1015-ERS | 0.38 | 19.20 | 0.22 | 39.80 |
| 2198-E1020-ERS | 0.63 | 19.20 | 0.35 | 32.40 |
| 2198-E2030-ERS | – | – | 0.35 | 36.40 |
| 2198-E2055-ERS | – | – | 0.46 | 32.80 |
| 2198-E2075-ERS | – | – | 0.48 | 40.0 |
| 2198-E2150-ERS | – | – | 0.92 | 37.0 |

Kinetix 5100 400V-class drives require 21.6…26.4V DC (24v, nom) input control power.

**Table 32 - Control Power Specifications - 400V-class Drives**

| Cat. No. | Maximum Input Current of Control Power<br>A rms at 24V DC | Inrush current of Control Power<br>A at 24V DC |
|---|---|---|
| 2198-E4004-ERS | 1.27 | 4.14 |
| 2198-E4007-ERS | | |
| 2198-E4015-ERS | | |
| 2198-E4020-ERS | 1.40 | 4.97 |
| 2198-E4030-ERS | 1.77 | 4.97 |
| 2198-E4055-ERS | 2.03 | 3.24 |
| 2198-E4075-ERS | | |
| 2198-E4150-ERS | 4.43 | 3.40 |

## Feedback Specifications

The Kinetix 5100 drive uses the MFB connector for various types of motor feedback. The AUX connector uses TTL incremental feedback only.

Use the 2198-K51CK-D15M feedback connector kit for terminating feedback conductors when building your own cables.

**Table 33 - Feedback General Specifications**

| Attribute | Motor Feedback | Auxiliary Feedback |
|---|---|---|
| Feedback device support | • Nikon (24-bit) serial (Kinetix TLP motors)<br>• Hiperface<br>• Tamagawa (17-bit) serial (Kinetix TL/TLY motors)<br>• Digital AqB with or without UVW, incremental | Digital AqB incremental |
| Power supply (EPWR5V) | 5.09…5.41V, 300 mA, max | |
| Power supply (EPWR9V) | 8.3…9.9V, 150 mA, max | |
| Motor thermostat | Single-ended input:<br>• Under 500 Ω = No Fault<br>• Over 10 kΩ = Fault | |

## Motor Feedback Supported by Using the MFB Connector

The Kinetix 5100 drive accepts motor feedback signals from Hiperface, Nikon, Tamagawa, and TTL incremental encoders on the MFB connector.

### Table 34 - Feedback Signals by Device Type

| Pin | Hiperface (all compatible motors and actuators) | Nikon (Kinetix TLP) | Tamagawa (Kinetix TL/TLY-B) | Digital AqB with UVW (all compatible motors and actuators) | Incremental (Kinetix TLY-H) | Generic TTL Incremental | Generic Sine/Cosine |
|---|---|---|---|---|---|---|---|
| 1 | MTR_SIN+ | – | – | MTR_AM+ | MTR_AM+ | MTR_AM+ | MTR_SIN+ |
| 2 | MTR_SIN- | – | – | MTR_AM- | MTR_AM- | MTR_AM- | MTR_SIN- |
| 3 | MTR_COS+ | – | – | MTR_BM+ | MTR_BM+ | MTR_BM+ | MTR_COS+ |
| 4 | MTR_COS- | – | – | MTR_BM- | MTR_BM- | MTR_BM- | MTR_COS- |
| 5 | MTR_DATA+ | MTR_T+ | MTR_DATA+ (TLY-B)<br>MTR_SD+ (TL-B) | MTR_IM+ | MTR_IM+ | MTR_IM+ | MTR_IM+ |
| 6 | MTR_ECOM | MTR_ECOM | MTR_ECOM | MTR_ECOM | MTR_ECOM | MTR_ECOM | MTR_ECOM |
| 7 | MTR_EPWR9V (1) | – | – | – | – | – | – |
| 8 | – | – | – | MTR_S3 | MTR_S3 | MTR_S3 | MTR_S3 |
| 9 | – | – | – | – | – | – | – |
| 10 | MTR_DATA- | MTR_T- | MTR_DATA- (TLY-B)<br>MTR_SD- (TL-B) | MTR_IM- | MTR_IM- | MTR_IM- | MTR_IM- |
| 11 | MTR_TS | – | – | – | – | MTR_TS | MTR_TS |
| 12 | – | – | – | MTR_S1 | MTR_S1 | MTR_S1 | MTR_S1 |
| 13 | – | – | – | MTR_S2 | MTR_S2 | MTR_S2 | MTR_S2 |
| 14 | MTR_EPWR5V (1) | MTR_EPWR5V | MTR_EPWR5V | MTR_EPWR5V | MTR_EPWR5V | MTR_EPWR5V | MTR_EPWR5V |
| 15 | – | – | – | – | – | – | – |

(1) Determine which power supply your encoder requires and connect to that supply only. Do not make connections to both supplies.

**ATTENTION:** The motor feedback determines which encoder power source is used. Be sure you use the correct power source for your encoder to avoid equipment damage.

The selected motor determines if the motor thermostat connections (MTR_TS) are used.

### Table 35 - Hiperface Encoder Specifications

| Attribute | Value |
|---|---|
| Protocol | Hiperface |
| Memory support | Encoders programmed with Allen-Bradley motor data |
| Hiperface data communication | RS-485, 9600 communication, 8 data bits, no parity |
| Sine/Cosine interpolation | 2048 counts/sine period |
| Input frequency (AM/BM) | 250 kHz, max |
| Input voltage (AM/BM) | 0.6…1.2V, p-p, which is measured at the drive inputs |
| Line loss detection (AM/BM) | Average ($sin^2 + cos^2$) > constant |

### Table 36 - Nikon Encoder Specifications

| Attribute | Value |
|---|---|
| Communication protocol | Proprietary format |
| Encoder nonvolatile memory usage | Programmed with Kinetix TLP motor data as Allen-Bradley memory format |
| Differential input voltage | 1.0…7.0V |
| Data communication | 8 Mbps, 21 data bits with ECC, no parity |
| Battery type | 3.6V, ER14252 or equivalent, 1/2AA size |

**Table 37 - Tamagawa Serial Specifications**

| Attribute | Value |
|---|---|
| Encoder nonvolatile memory usage | Programmed with TL-*Axxxx*-B and TLY-*Axxxx*-B motor data as Allen-Bradley memory format. |
| Differential input voltage | 1.0…7.0V |
| Data communication | 2.5 Mbps, 8 data bits, no parity |
| Battery | 3.6V, ER14252 or equivalent, 1/2AA size |

**Table 38 - Generic TTL Encoder Feedback Specifications**

| Attribute | Value |
|---|---|
| TTL incremental encoder support | 5V, differential A quad B |
| Quadrature interpolation | 4 counts / square wave period |
| Differential input voltage (MTR_AM, MTR_BM, and MTR_IM) | 5V DC, differential line driver (DLD) output compatible |
| DC current draw (MTR_AM, MTR_BM, and MTR_IM) | 30 mA, max |
| Input signal frequency (MTR_AM, MTR_BM, and MTR_IM) | 5.0 MHz, max |
| Edge separation (MTR_AM and MTR_BM) | 42 ns min, between any two edges |
| Commutation verification | Commutation angle verification performed at the first Hall signal transition and periodically verifies thereafter |
| Hall inputs (MTR_S1, MTR_S2, and MTR_S3) | Single-ended, TTL, open collector, or none |

**Table 39 - Generic Sine/Cosine Incremental Specifications**

| Attribute | Value |
|---|---|
| Input frequency (MTR_SIN and MTR_COS) | 250 kHz, max |
| Differential input voltage (MTR_SIN and MTR_COS) | 0.6…1.2V, peak to peak |
| Commutation verification | Commutation angle verification performed at the first Hall signal transition and periodically verifies thereafter. |
| Hall inputs (MTR_S1, MTR_S2, and MTR_S3) | Single-ended, TTL, open collector, or none. |

## Auxiliary Feedback Specifications

The Kinetix 5100 drives support TTL incremental feedback devices on the 10-pin auxiliary feedback connector (AUX). See Table 38 on page 68 for Digital AqB encoder feedback specifications.

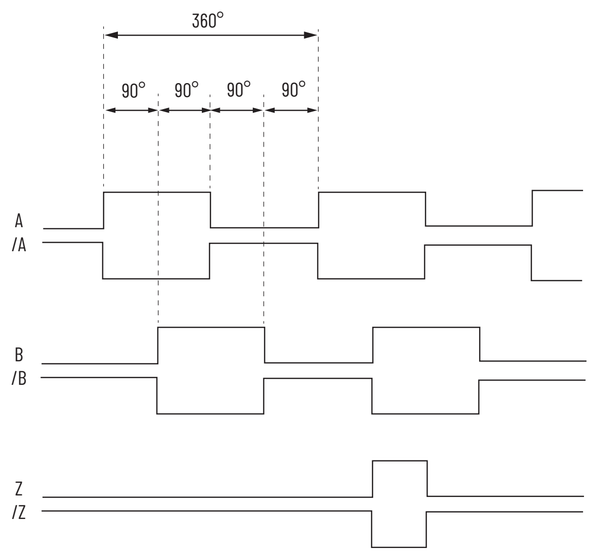
**Table 40 - Auxiliary Feedback Signals by Device Type**

| Pin | Digital AqB Incremental |
|---|---|
| 1 | AUX_AM+ |
| 2 | AUX_AM- |
| 3 | AUX_BM+ |
| 4 | AUX_BM- |
| 5 | AUX_IM+ |
| 6 | AUX_IM- |
| 7 | AUX_ECOM |
| 8 | AUX_EPWR5V |
| 9 | Reserved |
| 10 | Reserved |

## Encoder Phasing Definitions

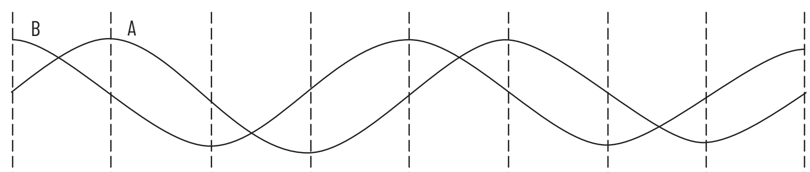
For TTL encoders, the drive position increases when A leads B. Clockwise motor rotation is assumed, when looking at the motor shaft.

**Figure 41 - TTL Encoder Phasing**




For Sin/Cos encoders, Hiperface for example, the drive position increases when Cosine (B) leads Sine (A). Clockwise motor rotation is assumed, when looking at the motor shaft.

**Figure 42 - Sine/Cosine Encoder Phasing**

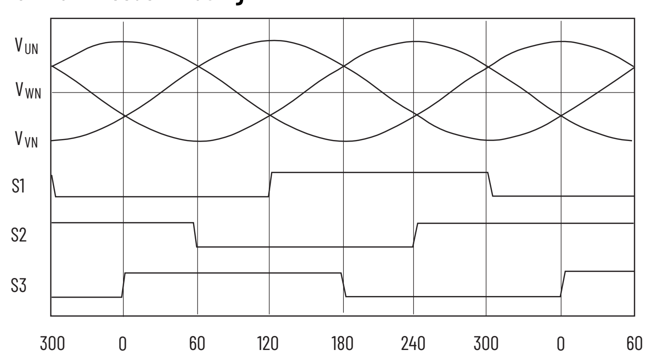



| | |
|---|---|
| **IMPORTANT** | The Sine/Cosine encoder signal phasing is different than the TTL encoder signal phasing. |

| | |
|---|---|
| **IMPORTANT** | When using absolute feedback devices (for example, Hiperface) the drive simulates a marker signal because these devices don't have a marker signal required for the home-to-marker sequence to complete. |

The drive MFB connector uses Hall signals to initialize the commutation angle for permanent magnet motor commutation.

**Figure 43 - Hall Encoder Phasing**



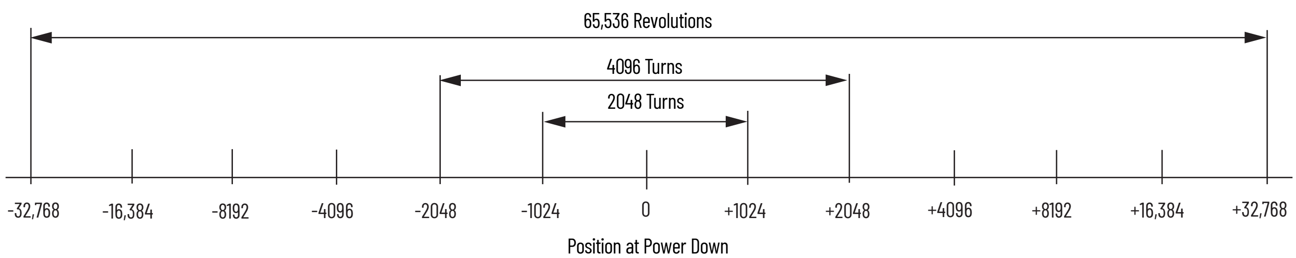
## Absolute Position Feature

The absolute position feature tracks the position of the motor, within the multi-turn retention limits, while the drive is powered off. The absolute position feature is available with only multi-turn encoders.

**Table 41 - Absolute Position Retention Limits**

| Encoder Type | Cat. No. Designator | Motor Cat. No. | Linear Cat. No. | Retention Limits | |
|---|---|---|---|---|---|
| | | | | Turns (rotary) | mm (linear) |
| Hiperface | -M | MPL-A/B*xxxxx*-M<br>MPM-A/B*xxxxx*-M<br>MPF-A/B*xxxxx*-M<br>MPS-A/B*xxxxx*-M | MPAR-A/B3*xxxx*-M<br>MPAI-A/B*xxxxx*M | 2048 (±1024) | – |
| | -V | MPL-A/B*xxxxx*-V | MPAS-A/B*xxxx*1-V05, MPAS-A/B*xxxx*2-V20<br>MPAR-A/B1*xxxx*-V, MPAR-A/B2*xxxx*-V<br>MPAI-A/B*xxxxx*V | 4096 (±2048) | – |
| Nikon (24-bit) serial with battery backup | -D | TLP-A/B*xxxx*-D | – | 65,536 (±32,768) | – |
| Tamagawa (17-bit) serial with battery backup | -B | TL-A*xxxx*-B<br>TLY-A*xxxx*-B | – | | |

**Figure 44 - Absolute Position Limits (measured in turns or revolutions)**



## Safe Torque Off Feature

Kinetix 5100 servo drives have Safe Torque Off (STO) capability and can safely remove inverter power when the STO signals are removed, resulting in Stop Category 0 behavior.

2198-E*xxxx*-ERS (hardwired) servo drives support parallel input connections for cascading additional drives. For applications that do not require the STO safety capability, you must install jumper wires to bypass the safe torque-off feature.

Refer to Safe Torque Off Feature on page 408 for the STO connector pinout, installation, and wiring information.

## Operation Modes

The Kinetix 5100 servo drive supports three basic modes of operation: Position, Speed, and Torque. You can switch between these modes by using Dual or Multi mode selections. IO Mode uses a Class 1 Ethernet/IP connection with a Logix Controller.

**Table 42 - Single Mode**

| Mode | Mode Abbreviation | Code | Description |
|---|---|---|---|
| Position mode (I/O terminal block input) | PT | 00 | This mode is sometimes referred to as Pulse Train Output or Step and Direction. The servo drive receives the Position command and commands the motor to run to the target position. The Position command is communicated through the I/O terminal block and the signal type is pulse. You can configure this mode for pulse-pulse following, which is a form of gearing. |
| Position mode (register input) | PR | 01 | The servo drive receives the Position command and commands the motor to run to the target position. Position commands are issued from the program registers (99 sets in total). You can select the register number with binary-weighted Digital Input (DI) signals or through communication. |
| Speed mode | S | 02 | The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command is issued from the internal registers (3 sets in total) or by analog voltage (-10V…+10V) that is communicated through the I/O terminal block. You can select the command with binary-weighted DI signals. |
| Speed mode (no analog input) | Sz | 04 | The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command can only be issued from the internal registers (3 sets in total). You can select the command with binary-weighted DI signals. |
| Torque mode | T | 03 | The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque commands can be issued from the internal registers (3 sets in total) and by analog voltage (-10V…+10V) that is communicated through the I/O terminal block. You can select the command with binary-weighted DI signals. |
| Torque mode (no analog input) | Tz | 05 | The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque command can only be issued from the internal registers (3 sets in total). You can select the command with binary-weighted DI signals. |
| IO mode | IO | 0C | The servo drive receives commands from the Logix controller through the EtherNet/IP network connection. Commands are issued through the Add-On Instruction in the Logix Designer application. |

**Table 43 - Dual Mode**

| Mode | Mode Abbreviation | Code | Description |
|---|---|---|---|
| Position mode PT (I/O terminal block input) and Speed mode | PT-S | 06 | Switches PT and S mode with DI signals. |
| Position mode PT (I/O terminal block input) and Torque mode | PT-T | 07 | Switches PT and T mode with DI signals. |
| Position mode PR (register input) and Speed mode | PR-S | 08 | Switches PR and S mode with DI signals. |
| Position mode PR (register input) and Torque mode | PR-T | 09 | Switches PR and T mode with DI signals. |
| Speed mode and Torque mode | S-T | 0A | Switches S and T mode with DI signals. |
| – | – | 0B | Reserved |
| Position mode PT (I/O terminal block input) and Position mode PR (register input) | PT-PR | 0D | Switches PT and PR Mode with DI signals. |

The Multi Mode is a combination that uses the Dual Mode and a Single Mode of operation.

**Table 44 - Multi Mode**

| Mode | Mode Abbreviation | Code | Description |
|---|---|---|---|
| Position mode PT (I/O terminal block input), Position mode PR (register input), and Speed mode | PT-PR-S | 0E | Switches PT, PR, and S mode with DI signals. |
| Position mode PT (I/O terminal block input), Position mode PR (register input), and Torque mode | PT-PR-T | 0F | Switches PT, PR, and T mode with DI signals. |

# Connect the Kinetix 5100 Drive System

This chapter provides procedures for wiring your Kinetix® 5100 drive system and making cable connections.



## Basic Wiring Requirements

This section contains basic information on how to wire the Kinetix 5100 drive.

**ATTENTION:** Plan the installation of your system so that you can cut, drill, tap, and weld with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

**SHOCK HAZARD:** To avoid hazard of electrical shock, mount and wire the Kinetix 5100 drive before you apply power. Once power is applied, connector terminals can have voltage present even when not in use.

**IMPORTANT** This section contains common PWM servo system wire configurations, size, and practices that can be used in most applications. National Electrical Code, local electrical codes, special operating temperatures, duty cycles, or system configurations take precedence over the values and methods provided.

### Build Your Own Cables

| | |
|---|---|
| **IMPORTANT** | Factory-made cables are designed to minimize EMI and are recommended over hand-built cables to optimize system performance. |

- Connect the cable shield to the connector shells on both ends of the cable with a complete 360° connection.
- Use twisted-pair cable whenever possible. Twist differential signals with each other and twist single-ended signals with the appropriate ground return.

When using Kinetix TLP servo motors, see Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, to attach motor-side power and feedback connector kits to bulk cable.

When using other Allen-Bradley® servo motors and actuators compatible with 2090-C*xx*M7DF motor cables, see 2090-Series Circular-DIN Connector Kits, Flange Kits, and Crimp Tools Installation Instructions, publication 2090-IN042, to attach motor-side power and feedback connector kits to bulk cable.

Also, see Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, to terminate the flying lead feedback-cable connections.

### Route Power and Signal Wiring

Be aware that when you route wiring on a machine or system, radiated noise from nearby relays, transformers, and other electronic drives can be induced into motor or encoder feedback signals, input/output communication, or other sensitive low voltage signals. Radiated noise can cause system and communication faults.

See Electrical Noise Reduction on page 34 for examples of routing high and low voltage wiring. See the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, for more information.

## Determine the Input Power Configuration

Before wiring input power to your Kinetix 5100 drive, you must know the type of input power within your facility. The drive is designed to operate with only grounded wye input power.

This section contains examples of typical single-phase and three-phase input power that is wired to single-phase and three-phase Kinetix 5100 drives.

The grounded power configuration lets you ground your single-phase or three-phase power to a neutral point. When you use one of the examples, be certain to include the grounded neutral connection.

For Kinetix 5100 drive power specifications, see Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003. For Kinetix 5100 drive input-wiring diagrams, see Power Wiring Examples on page 448.

## Three-phase Power Wired to Three-phase Drives

These examples illustrate grounded three-phase systems that are wired to three-phase Kinetix 5100 drives.

**ATTENTION:** The power system must be center-grounded wye secondary configuration for 230V AC and 480V AC mains.

Figure 45 - Three-phase (200...230V) Grounded Power Configuration (wye secondary)

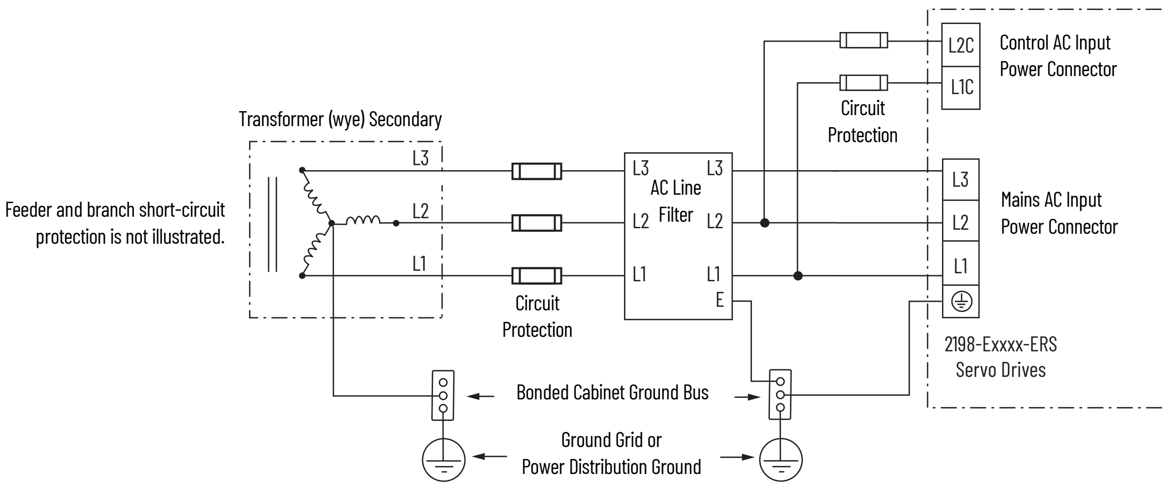
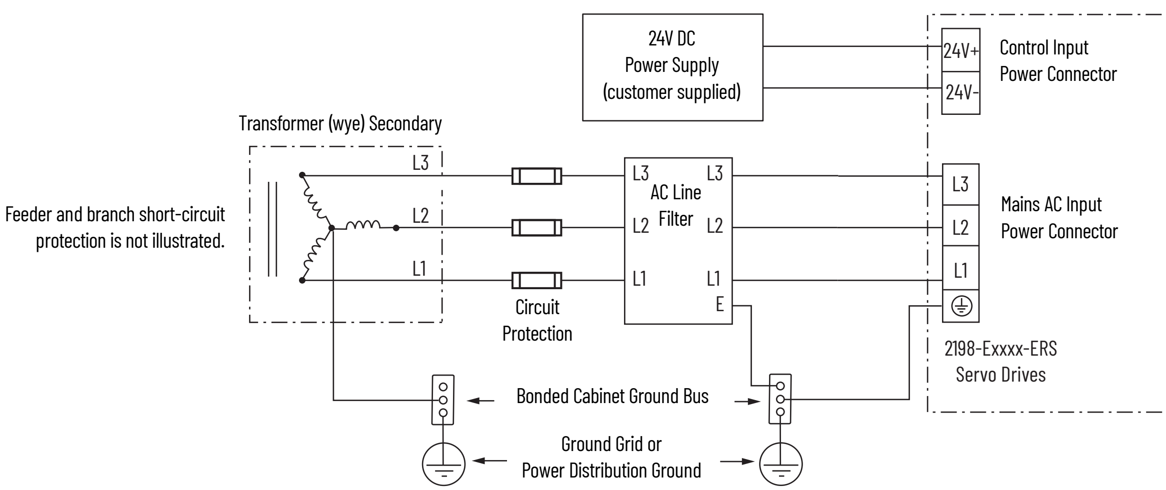


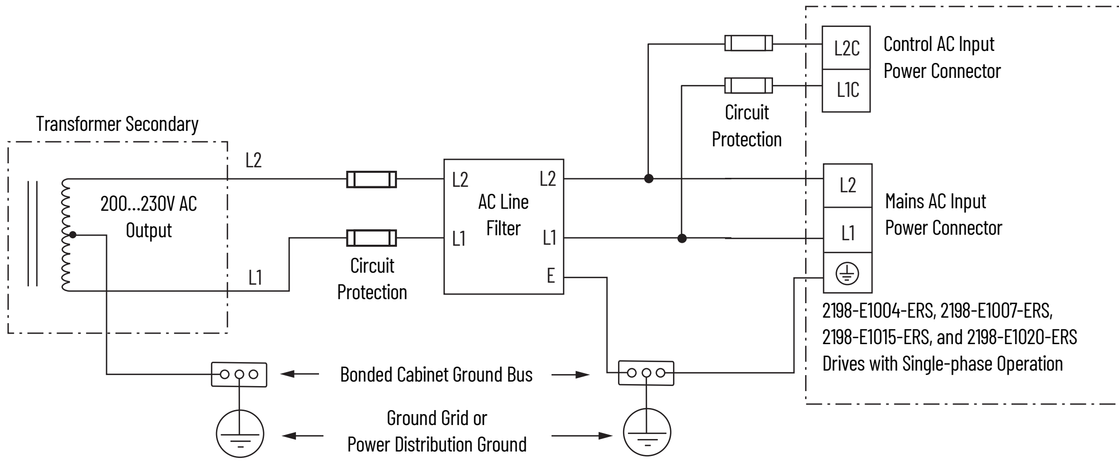

Figure 46 - Three-phase (380...480V) Grounded Power Configuration (wye secondary)



## Single-phase Input Power used with Single-phase Drives

These examples illustrate grounded single-phase power that is wired to single-phase Kinetix 5100 drives.

**Figure 47 - Single-phase (200...230V) Grounded Power Configuration**




Reducing the transformer output reduces motor speed. Feeder and branch short-circuit protection is not illustrated.

**Figure 48 - Single-phase (120V) Grounded Power Configuration**

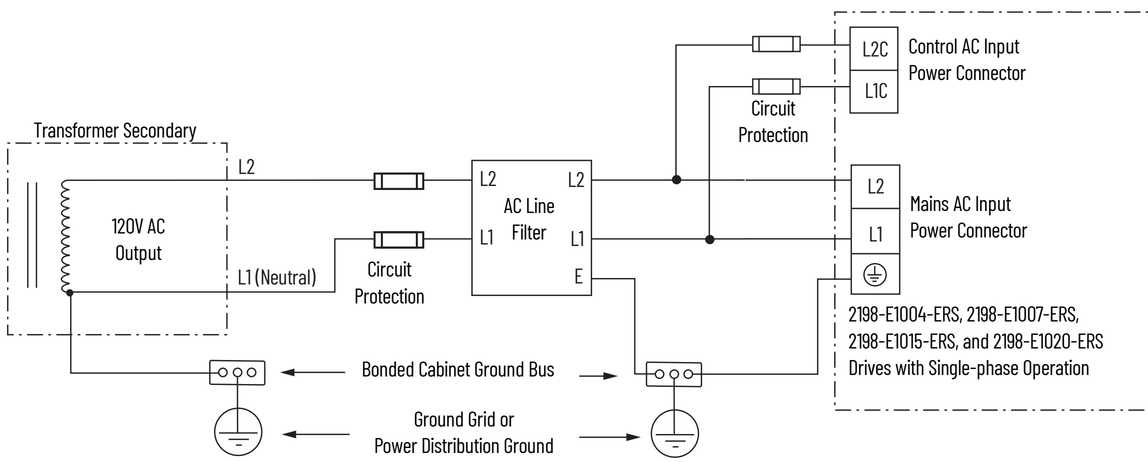



**Figure 49 - Single-phase (230V) Grounded Power Configuration**

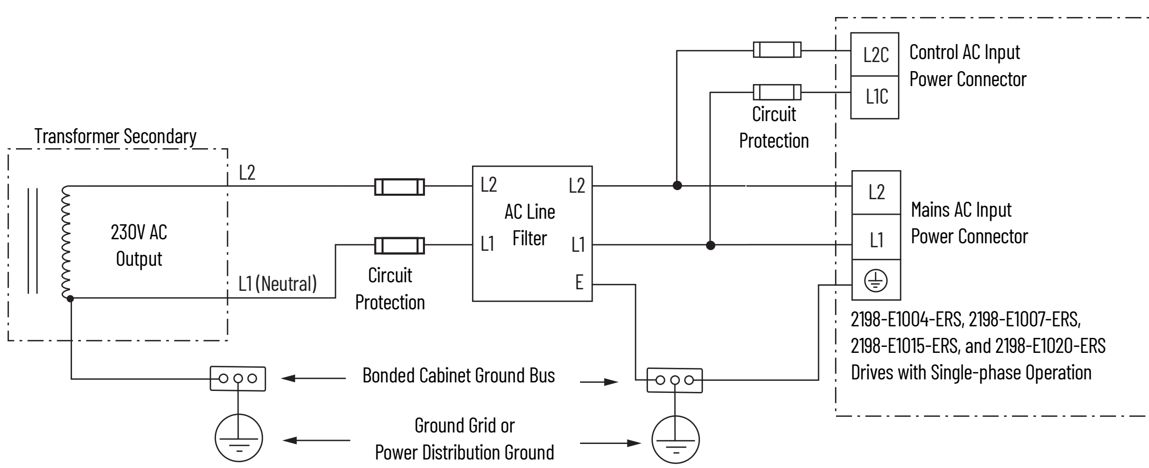
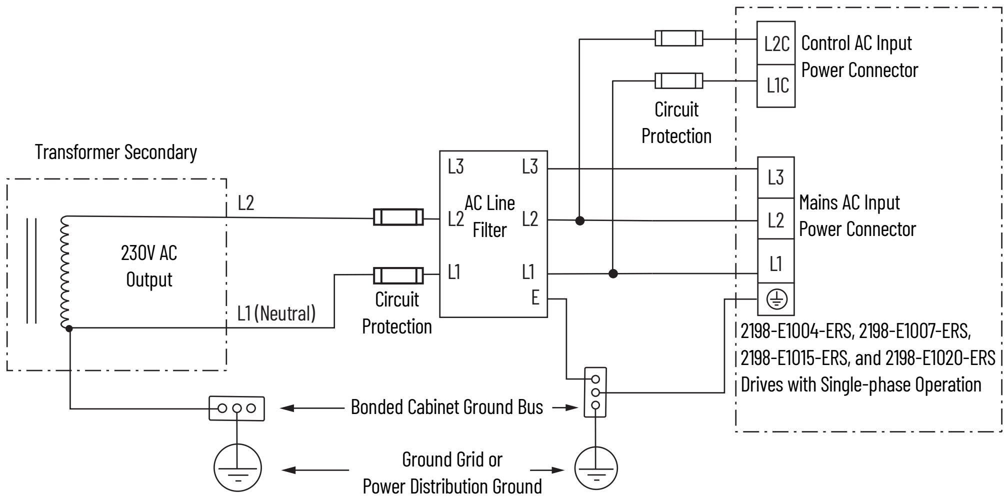


Figure 50 - Single-phase (230V) with Three-phase AC Line Filter Grounded Power Configuration



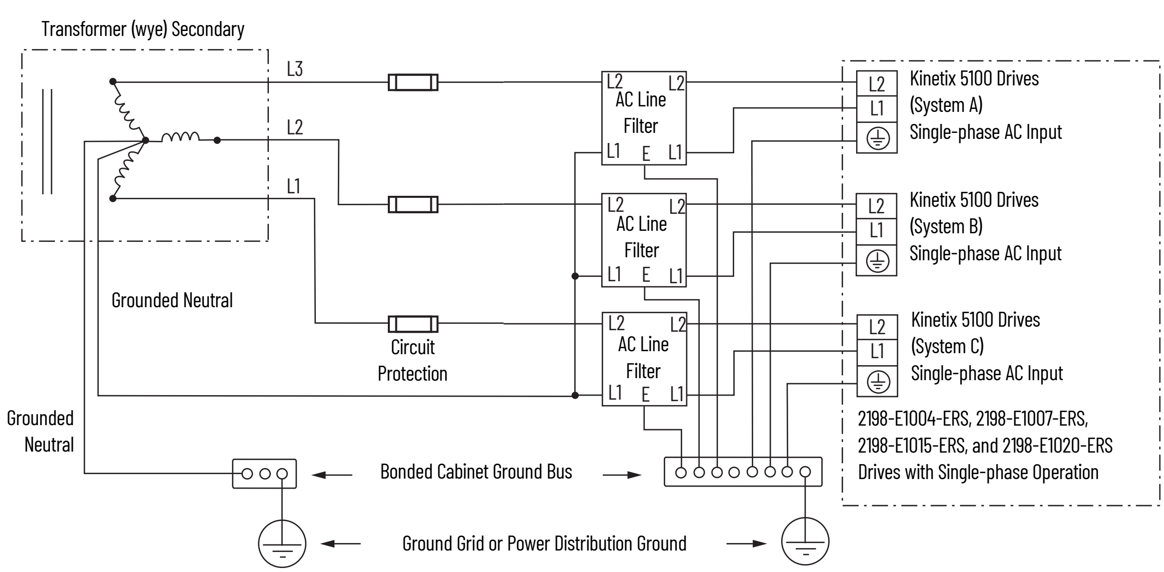

## Three-phase Input Power used with Single-phase Drives

This example illustrates grounded three-phase power that is wired to single-phase Kinetix 5100 drives when phase-to-phase voltage exceeds drive specifications.

A neutral must be connected when single-phase drives are attached to a three-phase isolating transformer secondary. It is not necessary that all three-phases be loaded with drives, but each drive must have its power return via the neutral connection.

**ATTENTION:** Failure to connect the neutral can result in supply voltage swings at the individual drives. Voltage swings occur when the neutral point changes as a result of load variations experienced by the individual drives. The supply voltage swing can cause undervoltage and overvoltage trips on the drives, and the drive can be damaged if the overvoltage limit is exceeded.

Figure 51 - Single-phase Amplifiers (one AC line filter per drive)



Feeder and branch short-circuit protection is not illustrated.

| | |
|---|---|
| **IMPORTANT** | An AC line filter for each drive is the preferred configuration, and required for CE compliance. |

If a three-phase line filter is used to feed multiple single-phase drives (not recommended), it is important that the filter has a neutral connection as shown in Figure 51. This neutral connection applies if three-phase power is wired directly into the filter and no isolation transformer is present.

## Voiding of CE Compliance

The three-phase with neutral in-line filter applications that are described in Three-phase Input Power used with Single-phase Drives are not adequate for EMC and aspect for CE compliance. Therefore, EMC validity and CE marking by Rockwell Automation is voided when three-phase and neutral in-line filters are used.

**ATTENTION:** The three-phase isolation transformers with neutral in-line filter applications described in this document have not been tested for EMC compliance and products that are used in such installations are not considered CE compliant.
If this three-phase isolation transformer and neutral in-line filter application is used, you are responsible for EMC validation and CE marking of the system.

If CE compliance is a customer requirement, single-phase or three-phase line filters, tested by Rockwell Automation, and specified for the product must be used. See Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003 for catalog numbers.

## Using Isolation Transformers with Grounded Power Configurations

When using an isolation transformer, attach a chassis ground wire to the neutral connection. This grounded neutral connection does the following:

- Prevents the system voltage from floating and avoids high voltages that can otherwise occur, for example due to static electricity
- Provides a solid earth path for fault conditions

| | |
|---|---|
| **IMPORTANT** | Transformers (auto transformers are not supported) must have a WYE secondary with grounded neutral. Phase to neutral voltage must not exceed the input voltage rating of the drive. |

## Ground the Drive System

All equipment and components of a machine or process system must have a common earth ground point connected to chassis. A grounded system provides a ground path for protection against electrical shock. Grounding your drives and panels minimize the shock hazard to personnel and damage to equipment caused by short circuits, transient overvoltages, and accidental connection of energized conductors to the equipment chassis.

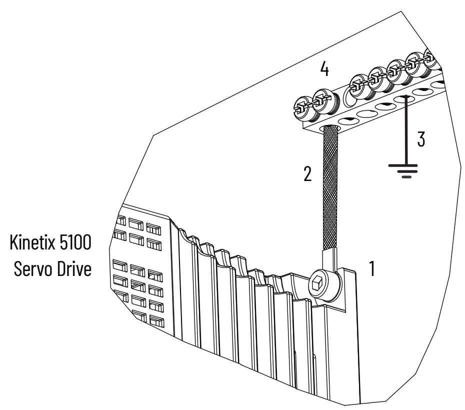
**IMPORTANT** To improve the bond between the Kinetix 5100 drive and subpanel, construct your subpanel out of zinc-plated (paint-free) steel.

**ATTENTION:** The National Electrical Code contains grounding requirements, conventions, and definitions. Follow all applicable local codes and regulations to safely ground your system.
For CE grounding requirements, refer to Agency Compliance on page 23.

### Ground Your Drive to the System Subpanel

Ground Kinetix 5100 drives to a bonded cabinet ground bus with a braided ground strap with at least 10 $mm^2$ (0.0155 $in^2$) cross-sectional area. Keep the braided ground strap as short as possible for optimum bonding.

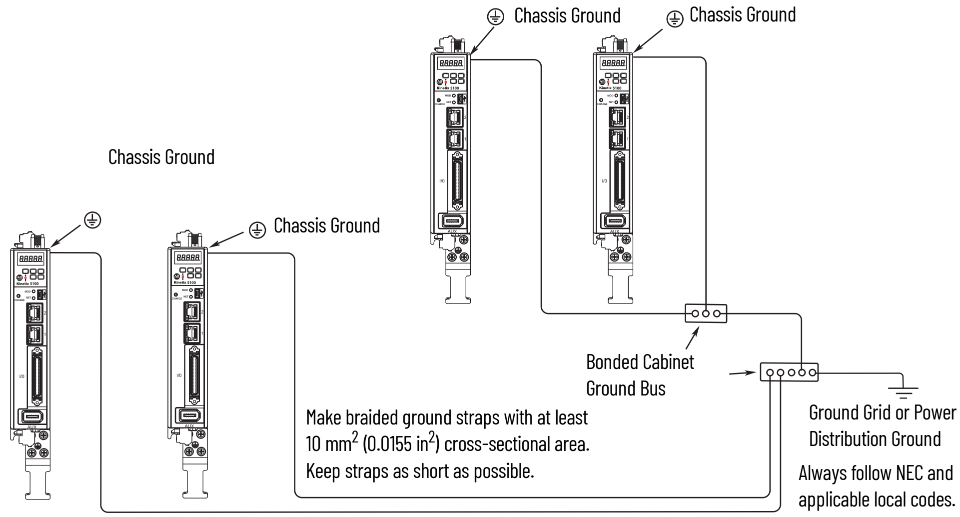
**Figure 52 - Connect the Braided Ground Strap Example**




| Item | Description |
|---|---|
| 1 | Ground lug attached to mounting fastener, 2.0 N•m (17.7 lb•in), max |
| 2 | Braided ground strap (customer supplied) |
| 3 | Ground grid or power distribution ground |
| 4 | Bonded cabinet ground bus (customer supplied) |

Refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, for more information.

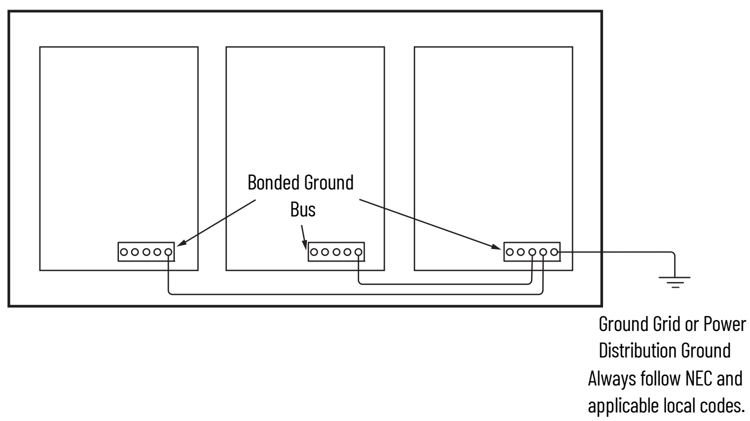
**Figure 53 - Chassis Ground Configuration (multiple Kinetix 5100 drives on one panel)**




## Ground Multiple Subpanels

In this figure, the chassis ground is extended to multiple subpanels.

**Figure 54 - Subpanels Connected to a Single Ground Point**




## Wiring Requirements

Wire must be copper with 75 °C (167 °F) minimum rating. Phasing of main AC power is arbitrary and earth ground connection is required.

See Appendix A beginning on page 447 for interconnect diagrams.

| | |
|---|---|
| **IMPORTANT** | The National Electrical Code and local electrical codes take precedence over the values and methods provided. |

### Table 45 - Wiring Requirements

| Kinetix 5100 (200V) Drives Cat. No. | Kinetix 5100 (400V) Drives Cat. No. | Description | Connects to Terminals | Recommended Wire Size mm$^2$ (AWG) | Strip Length mm (in.) | Torque Value N•m (lb•in) |
|---|---|---|---|---|---|---|
| 2198-E1004-ERS<br>2198-E1007-ERS<br>2198-E1015-ERS | – | Mains V AC input power<br><br>Control V AC input power<br><br>Control 24V DC input power | L1<br>L2<br>L3<br><br>L1C [1]<br>L2C<br><br>24V+ [2]<br>24V- | 0.20…3.31<br>(24…12) | 11 (0.4) | N/A [3] |
| 2198-E1020-ERS<br>2198-E2030-ERS | 2198-E4004-ERS<br>2198-E4007-ERS<br>2198-E4015-ERS | | | 0.20…5.26<br>(24…10) | 13 (0.5) | N/A [3] |
| – | 2198-E4020-ERS<br>2198-E4030-ERS<br>2198-E4055-ERS | | | 0.82…8.36<br>(18…8) | | 1.6 [5]<br>(13.90) |
| 2198-E2055-ERS | – | | | | | 1.8 [5]<br>(15.49) |
| 2198-E2075-ERS | 2198-E4075-ERS | | | | 11 (0.4) | 1.6 [5]<br>(13.90) |
| 2198-E2150-ERS | 2198-E4150-ERS | | | 2.08…21.1<br>(14…4) | 13 (0.5) | 3.1 [5]<br>(27.44) |
| 2198-E1004-ERS<br>2198-E1007-ERS<br>2198-E1015-ERS | – | Motor power [4] | U<br>V<br>W | 0.20…3.31<br>(24…12) | 11 (0.4) | N/A [3] |
| 2198-E1020-ERS<br>2198-E2030-ERS | 2198-E4004-ERS<br>2198-E4007-ERS<br>2198-E4015-ERS | | | 0.20…5.26<br>(24…10) | 13 (0.5) | N/A [3] |
| – | 2198-E4020-ERS<br>2198-E4030-ERS<br>2198-E4055-ERS | | | 0.82…8.36<br>(18…8) | | 1.6 [5]<br>(13.90) |
| 2198-E2055-ERS | 2198-E4075-ERS<br>2198-E4150-ERS | | | 2.08…21.1<br>(14…4) | | 3.1 [5]<br>(27.44) |
| 2198-E2075-ERS | | | | | | |
| 2198-E2150-ERS | | | | | | |
| 2198-E1004-ERS<br>2198-E1007-ERS<br>2198-E1015-ERS | – | Shunt resistor | DC+<br>ISH<br>ESH | 0.20…3.31<br>(24…12) | 11 (0.4) | N/A [3] |
| 2198-E1020-ERS<br>2198-E2030-ERS | 2198-E4004-ERS<br>2198-E4007-ERS<br>2198-E4015-ERS | | | 0.20…5.26<br>(24…10) | 13 (0.5) | N/A [3] |
| – | 2198-E4020-ERS<br>2198-E4030-ERS<br>2198-E4055-ERS | | | 0.82…8.36<br>(18…8) | | 1.6 [5]<br>(13.90) |
| 2198-E2055-ERS | – | | | | | 1.8 [5]<br>(15.49) |
| 2198-E2075-ERS | 2198-E4075-ERS | | | | 11 (0.4) | 1.6 [5]<br>(13.90) |
| 2198-E2150-ERS | 2198-E4150-ERS | | | 2.08…21.1<br>(14…4) | 13 (0.5) | 3.1 [5]<br>(27.44) |
| 2198-E1004-ERS<br>2198-E1007-ERS<br>2198-E1015-ERS<br>2198-E1020-ERS<br>2198-E2030-ERS<br>2198-E2055-ERS<br>2198-E2075-ERS<br>2198-E2150-ERS | 2198-E4004-ERS<br>2198-E4007-ERS<br>2198-E4015-ERS<br>2198-E4020-ERS<br>2198-E4030-ERS<br>2198-E4055-ERS<br>2198-E4075-ERS<br>2198-E4150-ERS | Safe Torque Off | SB+<br>SB-<br>S1<br>S1C<br>S2<br>S2C<br>SS+<br>SS- | 0.75 (18)<br>(stranded wire with ferrule)<br><br>1.5 (16)<br>(solid wire) | 8.0 (0.31) | N/A [3] |

(1) Applies to 2198-E1*xxx*-ERS and 2198-E2*xxx*-ERS (200V) drives.
(2) Applies to 2198-E4*xxx*-ERS (400V) drives.
(3) This connector uses spring tension to hold wires in place.
(4) Motor power wire size depends on drive and motor combination. See Kinetix 5100 Drive Systems Design Guide, publication KNX-RM011, for specific drive and motor combination.
(5) Attach using a terminal crimp lug.

## Wiring Guidelines

Use these guidelines when wiring the connectors on your Kinetix 5100 servo drives.

**SHOCK HAZARD:** DC-bus capacitors can retain hazardous voltages after input power has been removed. DO NOT touch the P1, P2, DC-, DC+, ISH or ESH terminals within the capacitor discharge time (listed in Table 46). Before working on the drive, measure the DC-bus voltage to verify that it has reached a safe level. When DC-bus voltage is above 50V DC, the Charge status indicator is on. Failure to observe this precaution could result in severe bodily injury or loss of life.

**Table 46 - DC-bus Capacitor Discharge Time**

| **Kinetix 5100 (200V) Drives Cat. No.** | **Capacitor Discharge Time** Minutes |
|---|---|
| 2198-E1004-ERS | 5 |
| 2198-E1007-ERS | 15 |
| 2198-E1015-ERS | 15 |
| 2198-E1020-ERS | 20 |
| 2198-E2030-ERS | 20 |
| 2198-E2055-ERS | 35 |
| 2198-E2075-ERS | 45 |
| 2198-E2150-ERS | 110 |

| **Kinetix 5100 (400V) Drives Cat. No.** | **Capacitor Discharge Time** Minutes |
|---|---|
| 2198-E4004-ERS | 5 |
| 2198-E4007-ERS | 5 |
| 2198-E4015-ERS | 5 |
| 2198-E4020-ERS | 5 |
| 2198-E4030-ERS | 5 |
| 2198-E4055-ERS | 5 |
| 2198-E4075-ERS | 10 |
| 2198-E4150-ERS | 10 |

**IMPORTANT** For connector locations of the Kinetix 5100 drives, see Kinetix 5100 Connector Data on page 44.

When you remove insulation or tighten screws to secure the wiring, see the table on page 80 for torque values.

**IMPORTANT** To improve system performance, run wires and cables in the wireways as established in Establish Noise Zones on page 37.

Follow these steps when wiring the connectors on your Kinetix 5100 drive modules.

1. Prepare the wires by removing insulation as shown in Table 45.

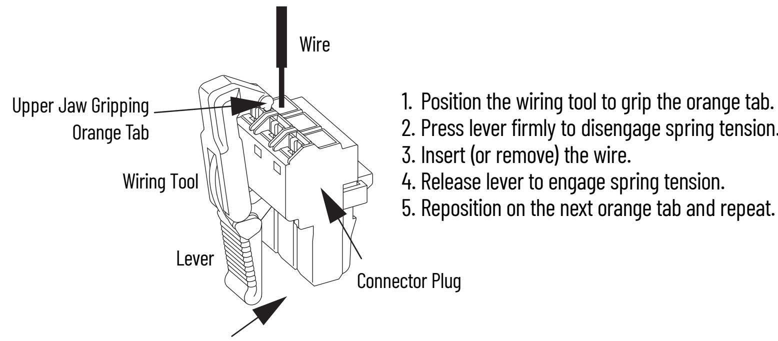
   **IMPORTANT** Use caution not to nick, cut, or otherwise damage strands as you remove the insulation.

2. Route the cable/wires as described in Chapter 2.
3. Insert wires into connector plugs or the I/O terminal block.

   See connector pinout tables in Chapter 3 and Appendix A beginning on page 447 for interconnect diagrams.

   - Tighten the terminal screws on 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS (200V) drives and 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS (400V) drives to the specified torque value.
   - Connectors on 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, 2198-E1020-ERS, and 2198-E2030-ERS (200V) drives and 2198-E4004-ERS, 2198-E4007-ERS, 2198-E4015-ERS (400V) drives use spring tension to hold wires in place.

- 2198-E1004-ERS, 2198-E1007-ERS, and 2198-E1015-ERS drives include connector plugs and a wiring tool.




4. Gently pull on each wire to make sure that it is secured in the terminal; reinsert and/or tighten any loose wires.
5. When the wiring is complete, plug the connector into the drive.

## Wire the Input Power Connectors

Input power connections are made at the input power connector on the bottom of the drive or the terminal blocks on the front of the drive. This section provides examples and guidelines to assist you in making connections to the input power connector or I/O terminal block.

**Figure 55 - 2198-E1004-ERS, 2198-E1007-ERS and 2198-E1015-ERS Servo Drives**

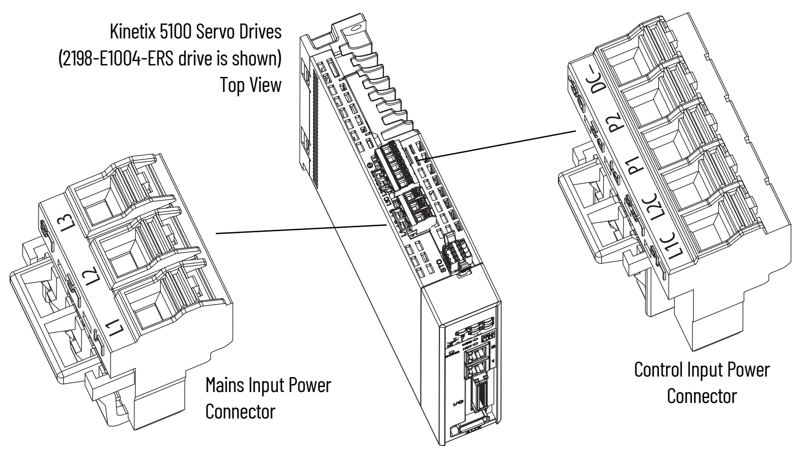



**Figure 56 - 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS Servo Drives**

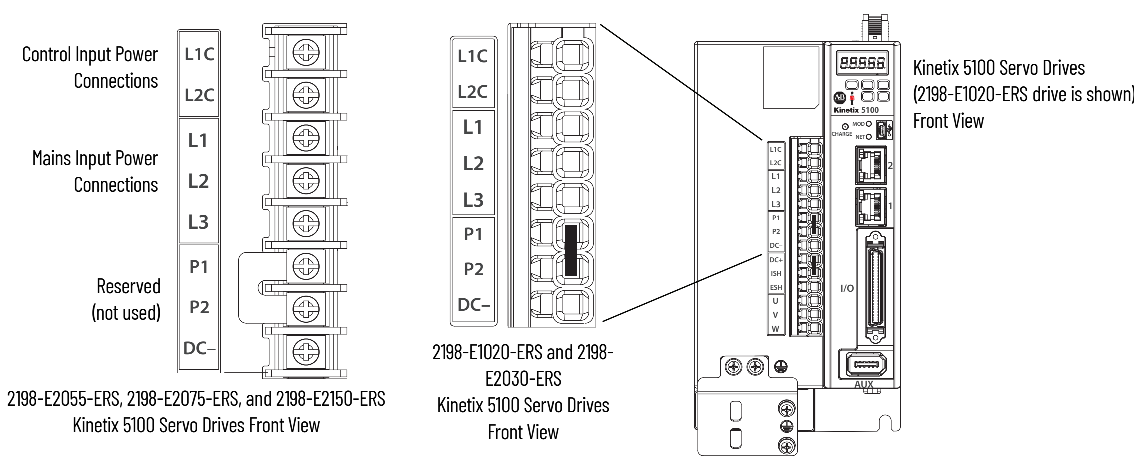
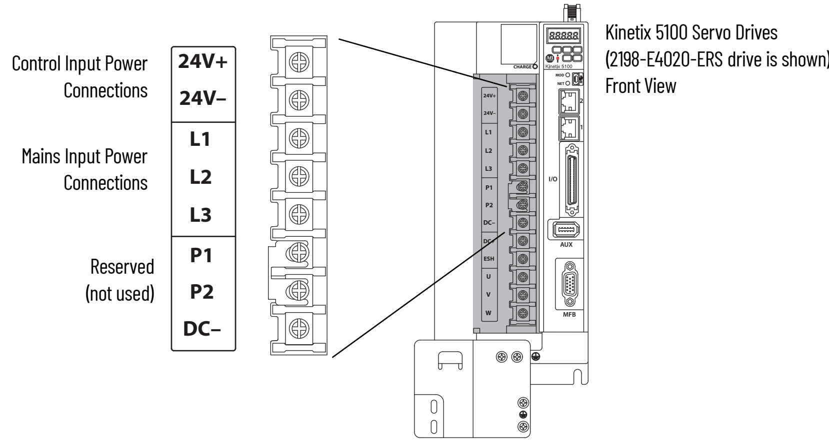


**Figure 57 - 2198-E4020-ERS, 2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS Servo Drives**




## Table 47 - Input Power Connector Specifications

<table>
<tr><th>Kinetix 5100 Drive Cat. No.</th><th>Connects to Terminals</th><th>Recommended Wire Size mm² (AWG)</th><th>Strip Length mm (in.)</th><th>Torque Value N•m (lb•in)</th></tr>
<tr><td>2198-E1004-ERS<br>2198-E1007-ERS</td><td rowspan="6">L1<br>L2<br>L3<br>L1C<br>L2C<br>P1<br>P2<br>DC-</td><td rowspan="2">0.20…3.31<br>(24…12)</td><td rowspan="2">11 (0.4)</td><td rowspan="2">N/A [1]</td></tr>
<tr><td>2198-E1015-ERS</td></tr>
<tr><td>2198-E1020-ERS<br>2198-E2030-ERS</td><td>0.20…5.26<br>(24…10)</td><td rowspan="2">13 (0.5)</td><td>N/A [1]</td></tr>
<tr><td>2198-E2055-ERS</td><td rowspan="2">0.82…8.36<br>(18…8)</td><td>1.8 [2]<br>(15.49)</td></tr>
<tr><td>2198-E2075-ERS</td><td>11 (0.4)</td><td>1.6 [2]<br>(13.90)</td></tr>
<tr><td>2198-E2150-ERS</td><td>2.08…21.1<br>(14…4)</td><td rowspan="3">13 (0.5)</td><td>3.1 [2]<br>(27.44)</td></tr>
<tr><td>2198-E4004-ERS<br>2198-E4007-ERS<br>2198-E4015-ERS</td><td rowspan="4">L1<br>L2<br>L3<br>24V+<br>24V-<br>P1<br>P2<br>DC-</td><td>0.20…5.26<br>(24…10)</td><td>N/A [1]</td></tr>
<tr><td>2198-E4020-ERS<br>2198-E4030-ERS<br>2198-E4055-ERS</td><td rowspan="2">0.82…8.36<br>(18…8)</td><td rowspan="2">1.6 [2]<br>(13.90)</td></tr>
<tr><td>2198-E4075-ERS</td><td>11 (0.4)</td></tr>
<tr><td>2198-E4150-ERS</td><td>2.08…21.1<br>(14…4)</td><td>13 (0.5)</td><td>3.1 [2]<br>(27.44)</td></tr>
</table>

(1) This connector uses spring tension to hold wires in place.
(2) Attach using a terminal crimp lug.

## Wire the I/O Connector

Connect your digital/analog inputs/outputs to the I/O connector by using the 2198-TBIO terminal expansion block. For the I/O terminal block pinout, see I/O Connector Pinout on page 49. See the Kinetix 5100 I/O Terminal Expansion Block Installation Instructions, publication 2198-IN020 for more information.

**Figure 58 - Kinetix 5100 Drive (I/O connector and terminal block)**

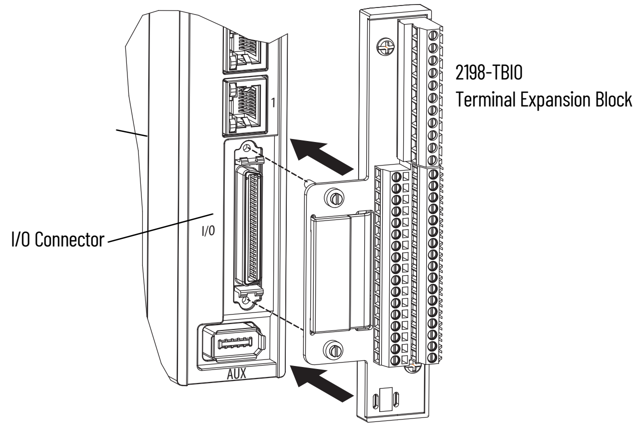



**Table 48 - I/O Terminal Expansion Block Specifications**

| I/O Terminal Expansion Block Cat. No. | Recommended Wire Size mm$^2$ (AWG) | Strip Length mm (in.) | Torque Value N•m (lb•in) |
|---|---|---|---|
| 2198-TBIO | 1.5…0.05<br>(16…30) | 6…7<br>(0.24…0.27) | 20<br>(1.77) |

## Wire the Safe Torque Off Connector

For the Safe Torque Off (STO) connector pinouts, feature descriptions, and wiring information, see Chapter 13 beginning on page 407.

## Wire the Motor Power Connector

Motor power connections are made at the motor power connector on the bottom of the drive or the terminal blocks on the front of the drive. This section provides examples and guidelines to assist you in making the motor power connections.

**Figure 59 - 2198-E1004-ERS, 2198-E1007-ERS and 2198-E1015-ERS Servo Drives**

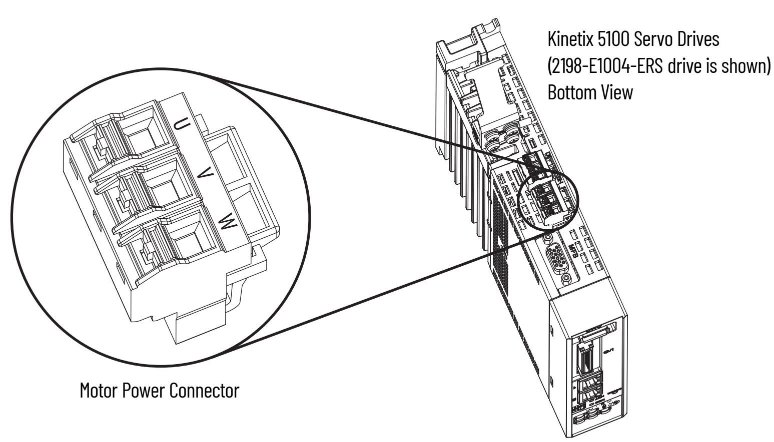
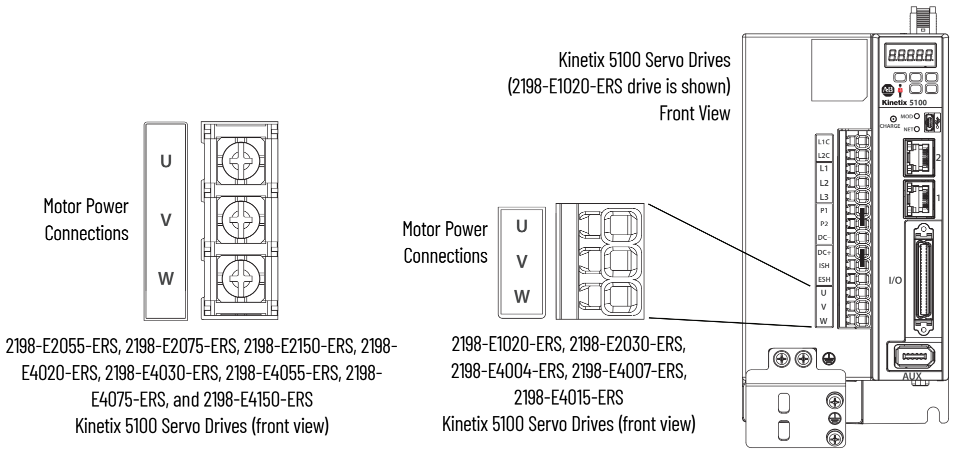


**Figure 60 - 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS and 2198-E4*xxx*-ERS Servo Drives**




## Table 49 - Motor Power Connector Specifications

| **Kinetix 5100 Drive Cat. No.** | **Connects to Terminals** | **Recommended Wire Size** mm² (AWG) | **Strip Length** mm (in.) | **Torque Value** N•m (lb•in) |
|---|---|---|---|---|
| 2198-E1004-ERS<br>2198-E1007-ERS<br>2198-E1015-ERS | U<br>V<br>W | 0.20…3.31 (1)<br>(24…12) | 11 (0.4) | N/A (2) |
| 2198-E1020-ERS<br>2198-E2030-ERS | | 0.20…5.26<br>(24…10) | 13 (0.5) | N/A (2) |
| 2198-E2055-ERS | | 2.08…21.1<br>(14…4) | | 3.1 (3)<br>(27.44) |
| 2198-E2075-ERS | | | | |
| 2198-E2150-ERS | | | | |
| 2198-E4004-ERS<br>2198-E4007-ERS<br>2198-E4015-ERS | U<br>V<br>W | 0.20…5.26<br>(24…10) | 13 (0.5) | N/A (2) |
| 2198-E4020-ERS<br>2198-E4030-ERS<br>2198-E4055-ERS | | 0.82…8.36<br>(18…8) | | 1.6 (3)<br>(13.90) |
| 2198-E4075-ERS<br>2198-E4150-ERS | | 2.08…21.1<br>(14…4) | | 3.1 (3)<br>(27.44) |

(1) Motor power cable depends on motor/drive combination.
(2) This connector uses spring tension to hold wires in place.
(3) Attach using a terminal crimp lug.

## Servo Motor and Motor Cable Compatibility

Kinetix 5100 drives are compatible with the following Allen-Bradley rotary and linear products:

- Kinetix TLP servo motors
- Kinetix MP motor family includes:
  - Kinetix MPL, MPM, MPF, and MPS servo motors
- Kinetix TL and TLY servo motors
- Kinetix MP linear actuator family includes:
  - Kinetix MPAS, MPMA, MPAR, and MPAI linear actuators
- Kinetix LDAT linear thrusters
- Kinetix LDC and Kinetix LDL linear motors

**IMPORTANT** To configure these motors with your Kinetix 5100 servo drive (see Table 51, Table 52, and Table 53), you must have drive firmware revision 1.*xxx* or 2.*xxx*. When using I/O mode with ControlLogix® or CompactLogix™ controllers, see Table 50 to determine if you need the revision of the Kinetix 5100 Add-on Profile.

**IMPORTANT** Class 1 and Class 3 EtherNet/IP Connections do not support induction motors and linear motors.

**Table 50 - AOP Installation Requirement**

| Drive Firmware Revision | Logix Designer Application Version | Kinetix 5100 AOP Needed? |
|---|---|---|
| 1.*xxx* or 2.*xxx* | 30, 31, or 32 | Yes |
| | 33.00 or later | No |

See Install the Kinetix 5100 Add-On Profile on page 184 for information on downloading the AOP.

## Motor Power and Brake Cables

Kinetix TLP motors use power cables that can combine the power and brake wiring (<4.5 kW with brake). The power/brake cable attaches to the ground plate on the drive and power/brake conductors attach to the motor power and I/O connectors respectively. Motors (with brake) and a power rating ≥5.5 kW have separate power and brake cables.

**Table 51 - Kinetix TLP Motor Power/Brake Cable Compatibility**

| Servo Motor Cat. No. | Motor Power Cat. No. (1) (with brake wires) | Motor Power Cat. No. (1) (without brake wires) | Brake Cat. No. (1) |
|---|---|---|---|
| TLP-A046-*xxx*, TLP-A070-*xxx*, TLP-A090-*xxx*, TLP-A100-*xxx* | 2090-CTPB-MADF-18A*xx* (standard) or 2090-CTPB-MADF-18F*xx* (continuous-flex) | 2090-CTPW-MADF-18A*xx* (standard) or 2090-CTPW-MADF-18F*xx* (continuous-flex) | Not applicable. Brake conductors are included in the power cable. |
| TLP-A115-100, TLP-A145-050, TLP-A145-100 | 2090-CTPB-MCDF-16A*xx* (standard) or 2090-CTPB-MCDF-16F*xx* (continuous-flex) | 2090-CTPW-MCDF-16A*xx* (standard) or 2090-CTPW-MCDF-16F*xx* (continuous-flex) | |
| TLP-A115-200, TLP-A145-090, TLP-A145-150, TLP-A145-250 | 2090-CTPB-MCDF-12A*xx* (standard) or 2090-CTPB-MCDF-12F*xx* (continuous-flex) | 2090-CTPW-MCDF-12A*xx* (standard) or 2090-CTPW-MCDF-12F*xx* (continuous-flex) | |
| TLP-A200-200, TLP-A200-300, TLP-A200-350 | 2090-CTPB-MDDF-12A*xx* (standard) or 2090-CTPB-MDDF-12F*xx* (continuous-flex) | 2090-CTPW-MDDF-12A*xx* (standard) or 2090-CTPW-MDDF-12F*xx* (continuous-flex) | |
| TLP-A200-450 | 2090-CTPB-MDDF-08A*xx* (standard) or 2090-CTPB-MDDF-08F*xx* (continuous-flex) | 2090-CTPW-MDDF-08A*xx* (standard) or 2090-CTPW-MDDF-08F*xx* (continuous-flex) | |
| TLP-A200-550, TLP-A200-750 (2) TLP-A235-11K | – | 2090-CTPW-MEDF-06A*xx* (standard) or 2090-CTPW-MEDF-06F*xx* (continuous-flex) | 2090-CTPB-MBDF-20A*xx* (standard) or 2090-CTPB-MBDF-20F*xx* (continuous-flex) |
| TLP-A235-15K (2) | – | 2090-CTPW-MEDF-04A*xx* (standard) or 2090-CTPW-MEDF-04F*xx* (continuous-flex) | |
| TLP-B070-040 TLP-B090-075 | 2090-CTPB-MADF-18A*xx* (standard) or 2090-CTPB-MADF-18F*xx* (continuous-flex) | 2090-CTPW-MADF-18A*xx* (standard) or 2090-CTPW-MADF-18F*xx* (continuous-flex) | Not applicable. Brake conductors are included in the power cable. |
| TLP-B115-100, TLP-B115-200 TLP-B145-050, TLP-B145-100 TLP-B145-150, TLP-B145-200 | 2090-CTPB-MCDF-16A*xx* (standard) or 2090-CTPB-MCDF-16F*xx* (continuous-flex) | 2090-CTPW-MCDF-16A*xx* (standard) or 2090-CTPW-MCDF-16F*xx* (continuous-flex) | |
| TLP-B200-300, TLP-B200-450 | 2090-CTPB-MDDF-12A*xx* (standard) or 2090-CTPB-MDDF-12F*xx* (continuous-flex) | 2090-CTPW-MDDF-12A*xx* (standard) or 2090-CTPW-MDDF-12F*xx* (continuous-flex) | |
| TLP-B145-250 | 2090-CTPB-MCDF-12A*xx* (standard) or 2090-CTPB-MCDF-12F*xx* (continuous-flex) | – | |
| TLP-B200-550, TLP-B200-750 | 2090-CTPB-MDDF-08A*xx* (standard) or 2090-CTPB-MDDF-08F*xx* (continuous-flex) | 2090-CTPW-MDDF-08A*xx* (standard) or 2090-CTPW-MDDF-08F*xx* (continuous-flex) | |
| TLP-B235-11K, TLP-B235-14K(2) | – | 2090-CTPW-MEDF-06A*xx* (standard) or 2090-CTPW-MEDF-06F*xx* (continuous-flex) | 2090-CTBK-MBDF-20A*xx* (standard) or 2090-CTBK-MBDF-20F*xx* (continuous-flex) |

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.
(2) Only these motors have separate brake connectors and brake cables. All other motors have brake wires included with the power connectors.

**Table 52 - Kinetix MP, LDAT, LDC/LDL Motor Power Cable Compatibility**

| Motor/Actuator Cat. No. | Motor Power Cat. No. (1) (with brake wires) | Motor Power Cat. No. (1) (without brake wires) |
|---|---|---|
| MPL-A/B15*xxx*-*xx*7*x*AA, MPL-A/B2*xxx*-*xx*7*x*AA, MPL-A/B3*xxx*-*xx*7*x*AA, MPL-A/B4*xxx*-*xx*7*x*AA, MPL-A/B45*xxx*-*xx*7*x*AA, MPL-A/B5*xxx*-*xx*7*x*AA, MPL-B6*xxx*-*xx*7*x*AA | 2090-CPBM7DF-*xx*AA*xx* (standard) or 2090-CPBM7DF-*xx*AF*xx* (continuous-flex) | 2090-CPWM7DF-*xx*AA*xx* (standard) or 2090-CPWM7DF-*xx*AF*xx* (continuous-flex) |
| MPM-A/B*xxxx*, MPF-A/B*xxxx*, MPS-A/B*xxxx* | | |
| MPAS-A/B*xxxx*1-V05S*x*A, MPAS-A/B*xxxx*2-V20S*x*A MPAI-A/B*xxxx*, MPAR-A/B3*xxx*, MPAR-A/B1*xxx* and MPAR-A/B2*xxx* (series B) | | |
| MPAS-B*xxxxx*-ALM*x*2C LDAT-S*xxxxxx*-*x*B*x* LDC-C*xxxxxx* LDL-*xxxxxxx* | N/A (these devices do not include a brake option) | |

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.

**Table 53 - Kinetix TL and TLY Motor Power/Brake Cable Compatibility**

| Motor/Actuator Cat. No. | Motor Power Cat. No. (1) (with brake wires) | Motor Power Cat. No. (1) (without brake wires) | Brake Cat. No. (1) |
|---|---|---|---|
| TLY-A*xxxx* | 2090-CPBM6DF-16AA*xx* (standard) | 2090-CPWM6DF-16AA*xx* (standard) | Not applicable. Brake conductors are included in the power cable. |
| TL-A*xxxx* | – | 2090-DANPT-16S*xx* | 2090-DANBT-18S*xx* |

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.

Refer to Table 49 on page 86 for the motor power connector specifications.

**Table 54 - Legacy Motor Power Cables for Kinetix MP Servo Motors**

| Motor Cable | Description | Motor Power Cat. No. |
|---|---|---|
| Standard | Power/brake, threaded | 2090-XXNPMF-*xx*S*xx* |
| | Power-only, bayonet | 2090-XXNPMP-*xx*S*xx* |
| Continuous-flex | Power/brake, threaded | 2090-CPBM4DF-*xx*AF*xx* |
| | Power-only, threaded | 2090-CPWM4DF-*xx*AF*xx* |
| | Power-only, bayonet | 2090-XXTPMP-*xx*S*xx* |

## Maximum Cable Length

Maximum cable length depends on the feedback type and input voltage that is used in the application.

**Table 55 - Maximum Cable Lengths (200V-class) Motors**

| Compatible Motor and Actuator Cat. No. | Feedback Type | Cable Length, max m (ft) |
|---|---|---|
| TLP-A*xxx*-*xxx*-D | Nikon (24-bit) absolute high-resolution, multi-turn and single-turn | 50 (164) |
| MPL-A15*xxx*-V/E*x*7*x*AA<br>MPL-A2*xxx*-V/E*x*7*x*AA | Hiperface, absolute high-resolution, multi-turn and single-turn | |
| MPL-A3*xxx*-S/M*x*7*x*AA, MPL-A4*xxx*-S/M*x*7*x*AA<br>MPL-A45*xxx*-S/M*x*7*x*AA, MPL-A5*xxx*-S/M*x*7*x*AA | | |
| MPM-A*xxxx*-S/M<br>MPF-A*xxxx*-S/M<br>MPS-A*xxxx*-S/M | | |
| MPAR-A3*xxxx*-M | | |
| MPAS-A*xxxx*1-V05S*x*A (ballscrew)<br>MPAS-A*xxxx*2-V20S*x*A (ballscrew)<br>MPAR-A1*xxxx*-V and MPAR-A/B2*xxxx*-V (series B)<br>MPAI-A*xxxxx*M3 | Absolute high-resolution, multi-turn | 50 (164) |
| MPL-A15*xxx*-H*x*7*x*AA<br>MPL-A2*xxx*-H*x*7*x*AA | Incremental | 30 (98.4) |
| MPL-A3*xxx*-H*x*7*x*AA<br>MPL-A4*xxx*-H*x*7*x*AA<br>MPL-A45*xxx*-H*x*7*x*AA | | |
| MPAS-A*xxxx*-ALM*x*2C (direct drive) | Incremental, magnetic linear | |
| TLY-A*xxxx*-B | Tamagawa (17-bit) absolute high-resolution, multi-turn | |
| TL-A*xxxx*-B | | |
| TLY-A*xxxx*-H | Incremental | |
| LDAT-S*xxxxxx*-*x*B*x* | Incremental, magnetic scale | 10 (33.1) |
| LDC-C*xxxxxx*-*x*H, LDL-*xxxxxxx*-*x*H | Sin/Cos or TTL encoder | |

**Table 56 - Maximum Cable Lengths (400V-class) Motors**

<table>
<tr><th rowspan="2">Compatible Motor and Actuator Cat. No.</th><th rowspan="2">Feedback Type</th><th colspan="2">Cable Length, max<br>m (ft)</th></tr>
<tr><th>≤ 400V AC Input</th><th>480V AC Input</th></tr>
<tr><td>TLP-B200-xxx-D</td><td rowspan="2">Nikon (24-bit) absolute high-resolution, multi-turn and single-turn</td><td rowspan="2">50 (164)</td><td>15 (49.2)</td></tr>
<tr><td>TLP-B070-xxx-D, TLP-B090-xxx-D, TLP-B115-xxx-D,<br>TLP-B145-xxx-D, TLP-B235-xxx-D</td><td>50 (164)</td></tr>
<tr><td>MPL-B15xxx-V/Ex7xAA<br>MPL-B2xxx-V/Ex7xAA</td><td rowspan="4">Hiperface, absolute high-resolution, multi-turn and single-turn</td><td>50 (164)</td><td>20 (65.6)</td></tr>
<tr><td>MPL-B3xxx-S/Mx7xAA, MPL-B4xxx-S/Mx7xAA<br>MPL-B45xxx-S/Mx7xAA, MPL-B5xxx-S/Mx7xAA<br>MPL-B6xxx-S/Mx7xAA, MPL-B8xxx-S/Mx7xAA<br>MPL-B9xxx-S/Mx7xAA</td><td rowspan="3" colspan="2">50 (164)</td></tr>
<tr><td>MPM-Bxxxx-S/M<br>MPF-Bxxxx-S/M<br>MPS-Bxxxx-S/M</td></tr>
<tr><td>MPAR-B3xxxx-M</td></tr>
<tr><td>MPAS-Bxxxx1-V05SxA (ballscrew)<br>MPAS-Bxxxx2-V20SxA (ballscrew)<br>MPAR-B1xxxx-V and MPAR-A/B2xxxx-V (series B)<br>MPAI-BxxxxxM3</td><td>Absolute high-resolution, multi-turn</td><td>50 (164)</td><td>20 (65.6)</td></tr>
<tr><td>MPL-B15xxx-Hx7xAA<br>MPL-B2xxx-Hx7xAA</td><td rowspan="2">Incremental</td><td>30 (98.4)</td><td>20 (65.6)</td></tr>
<tr><td>MPL-B3xxx-Hx7xAA<br>MPL-B4xxx-Hx7xAA<br>MPL-B45xxx-Hx7xAA</td><td colspan="2">30 (98.4)</td></tr>
<tr><td>MPAS-Bxxxx-ALMx2C (direct drive)</td><td>Incremental, magnetic linear</td><td colspan="2">20 (65.6)</td></tr>
<tr><td>LDAT-Sxxxxxx-xBx</td><td>Incremental, magnetic scale</td><td rowspan="2" colspan="2">10 (33.1)</td></tr>
<tr><td>LDC-Cxxxxxx-xH, LDL-xxxxxxx-xH</td><td>Sin/Cos or TTL encoder</td></tr>
</table>

**Table 57 - Maximum Cable Lengths, Third-Party Motors**

<table>
<tr><th rowspan="2">Motor Insulation Rating (1)</th><th colspan="2">Cable Length, max (2) m (ft)</th></tr>
<tr><th>≤ 400V AC Input</th><th>480V AC Input</th></tr>
<tr><td>1000V</td><td>10 (33.1)</td><td></td></tr>
<tr><td>1200V</td><td rowspan="3">50 (164)/30 (98.4) (3)</td><td>15 (49.2)</td></tr>
<tr><td>1488V</td><td rowspan="2">50 (164)/30 (98.4) (3)</td></tr>
<tr><td>1600V</td></tr>
</table>

(1) Motor Corona Inception Voltage (CIV) or Partial Discharge Inception Voltage (PDIV) ratings for motor.
(2) Cable lengths are estimated assuming nominal DC-bus voltage at nominal AC line input voltage.
(3) Limited to 30 m (98.4 ft) for incremental encoders.

## Cable Preparation for Kinetix TLP Servo Motors

Because the 2090-CT*xx*-M*x*D*x* motor cables are designed specifically for Kinetix TLP motors, there is no preparation required.

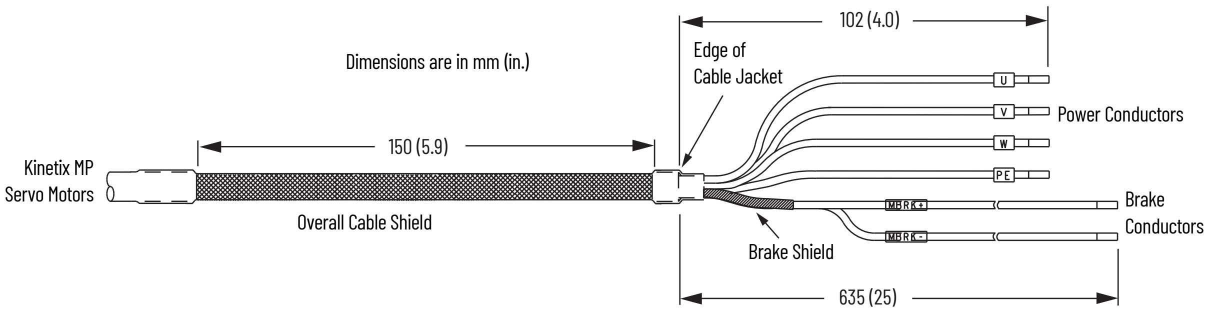
- 2090-CTPW-M*x*DF flying lead power cables are equipped with ring lugs where required, so no cable preparation is needed.
- 2090-CTFB-M*x*DD feedback cables are equipped with premolded connectors on the drive end, so no cable preparation is needed.

If you are building your own cables, see Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, to attach motor-side power and feedback connector kits to bulk cable. Also, see Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, to terminate the flying lead feedback cable connections.

## Cable Preparation for Kinetix MP Servo Motors

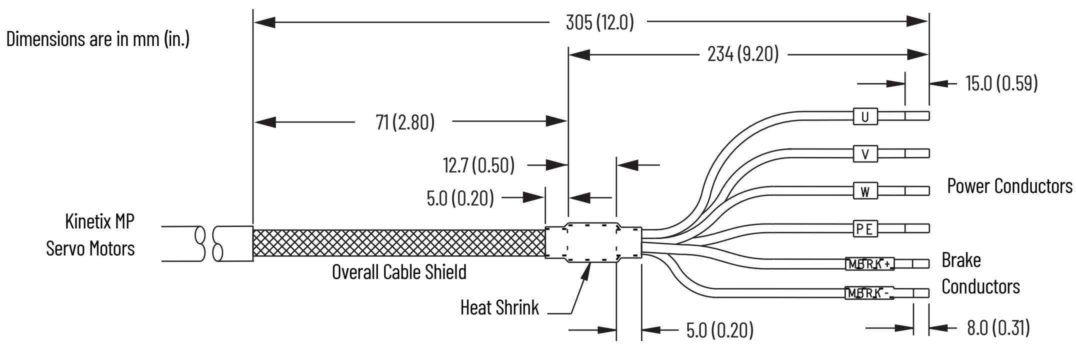
Motor power and brake conductors on 2090-CPBM7DF (series A) cables have the following dimensions from the factory. If your cable is reused from an existing application, the actual conductor lengths could be slightly different.

**Figure 61 - 2090-CPBM7DF (series A) Power/brake Cable Dimensions**




Motor power and brake conductors on 2090-CPBM7DF (series B) 12 and 10 AWG standard, non-flex cables provide (drive end) shield braid and conductor preparation designed for compatibility with multiple Kinetix servo-drive families, including Kinetix 5100 drives.

**Figure 62 - 2090-CPBM7DF (series B, 10 or 12 AWG) Power/brake Cable Dimensions**




See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, to attach the proper ring lugs to PE, U, V, and W conductors to 2090-CPBM7DF power cables when used with 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, and 2198-4*xxx*-ERS servo drives.

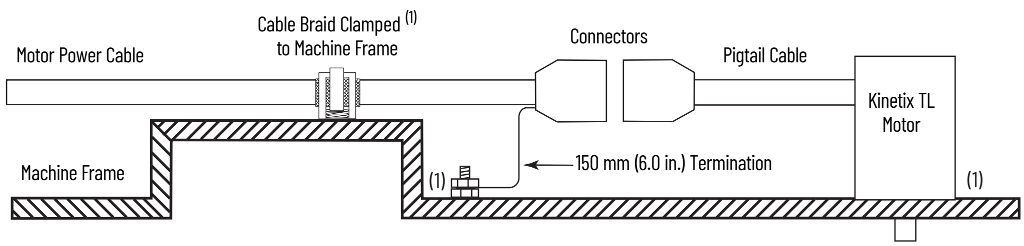
## Cable Preparation for Kinetix TL and TLY Motor Power Cables

2090-CPBM6DF motor power cables, used with Kinetix TLY motors, require no preparation. However, 2090-DANPT-16S*xx* power cables, used with Kinetix TL motors have a short pigtail cable that connects to the motor, but is not shielded. The preferred method for grounding the Kinetix TL power cable on the motor side is to expose a section of the cable shield and clamp it directly to the machine frame.

The motor power cable also has a 150 mm (6.0 in.) shield termination wire with a ring lug that connects to the closest earth ground. The termination wire can be extended to the full length of the motor pigtail if necessary, but it is best to connect the supplied wire directly to ground without lengthening.

| | |
|---|---|
| **IMPORTANT** | For Kinetix TL motors, connect the 150 mm (6.0 in.) termination wire to the closest earth ground. |

**Figure 63 - 2090-DANPT-16S*xx* Cable Preparation**




(1) Remove paint from machine frame to provide HF-bond between machine frame, motor case, shield clamp, and ground stud.

## Apply the Cable Shield Clamp

This procedure assumes that you have completed wiring your motor power connector and are ready to apply the cable shield ground plate. Factory-supplied motor power cables for Kinetix TLP and Kinetix MP motors are shielded. The braided cable shield must terminate at the drive during installation.

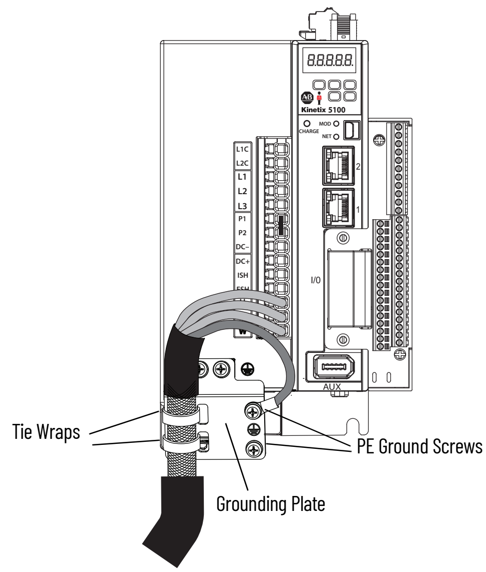
- 2090-CTP*x*-M*x*D*x* motor power cables are designed specifically for Kinetix TLP motors and require no preparation.
- For 2090-CP*x*M7DF cables, used with Kinetix MP motors, ring lugs need to be crimped to the PE, U, V, and W conductors when attaching to 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, and 2198-E4020-ERS, 2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, 2198-E4150-ERS servo drives.

See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, to attach the proper ring lugs to PE, U, V, and W conductors to 2090-CPBM7DF power cables.

**SHOCK HAZARD:** To avoid hazard of electrical shock, make sure shielded power cables are grounded according to recommendations.

Follow these steps to apply the cable shield clamp.

1. Route the conductors with service loops to provide stress relief to the motor power and brake conductors.




2. Apply tie wraps through the ground plate slots and around the exposed cable shield.

   Make sure the cable clamp tightens around the cable shield and provides a good bond between the cable shield and the drive chassis.

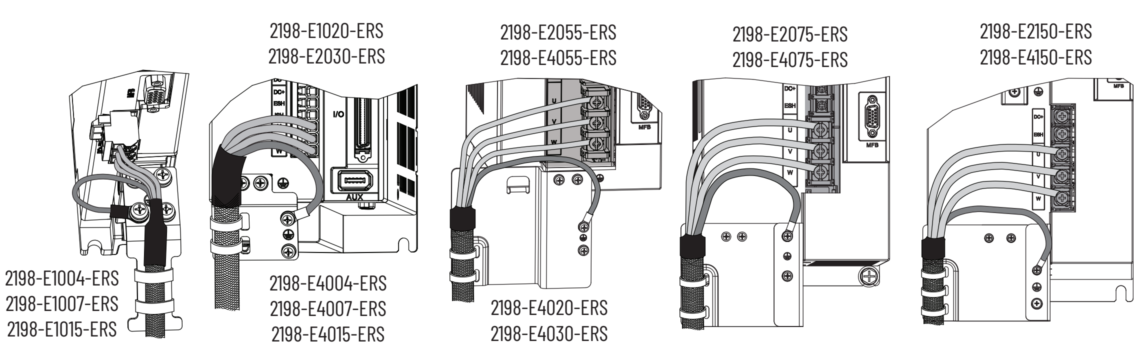
3. Attach the motor-power ground wire to one of the PE ground screws.

   Tighten the PE ground screw to a maximum torque value of 2.0 N•m (17.7 lb•in).

| | |
|---|---|
| **IMPORTANT** | If the power/brake cable shield has a loose fit between the ground plate and tie wraps, the cable shield ground is ineffective. When the tie wraps are pulled tight, the result must be a high-frequency bond between the cable shield and the drive chassis. |

Figure 64 displays examples of how the motor cable conductors and shield can be routed and attached for each of the servo drives.

**Figure 64 - Kinetix 5100 Drive Ground Plate Examples**



## Motor Brake Connections

For wiring the brake circuit, see Motor Brake Circuit on page 62 for wiring and configuration details. See Kinetix 5100 Drive/Rotary Motor Wiring Examples on page 454 for motor brake wiring examples.

- Kinetix TLP servo motors use 2090-CTPB-M*x*D*x* power/brake cables. Servo drives with a power rating ≥ 5.5 kW require a separate brake cable. See Kinetix TLP Motor Power/Brake Cable Compatibility on page 88 for the drive catalog numbers that require a separate brake cable.
- Kinetix MP motors and actuators use 2090-CPBM7DF power/brake cables.
- Kinetix TLY motors use 2090-CPBM6DF power/brake cables.
- Kinetix TL motors use 2090-DANBT-18S*xx* brake cables.

## Wire the Motor Feedback Connector

2090-CTFB-M*x*DD motor feedback cables are designed specifically for Kinetix TLP motors. The drive-end connector plugs directly into the 15-pin (MFB) feedback connector. The 2198-K51CK-DM15 feedback connector kit is also available when making your own cables. See Wire the 2198-K51CK-D15M Feedback Connector Kit on page 101 for pinouts and wiring.

2090-CFBM6DD and 2090-CFBM7DD motor feedback cables also provide a drive-end connector that plugs directly into the 15-pin (MFB) feedback connector. The 2198-K51CK-DM15 feedback connector kit can also be used with 2090-CFBM6DF and 2090-CFBM7DF flying-lead cables.

When using the 2198-K51CK-DM15 feedback connector kit, 2090-CFBM7DF flying-lead cables require preparation to make sure the ground plate attaches properly and conductors route smoothly to the connector terminals. All of the current and legacy feedback cables listed below are compatible with the 2198-K51CK-D15M connector kit.

**Table 58 - Kinetix TLP Motor Feedback Cable Compatibility**

| Servo Motor Cat. No. | Feedback Cable Cat. No. (1) |
|---|---|
| TLP-A046-*xxx*, TLP-A/B070-*xxx*, TLP-A/B090-*xxx*, TLP-A100-*xxx* | 2090-CTFB-MADD-CFA*xx* (standard) or<br>2090-CTFB-MADD-CFF*xx* (continuous-flex) |
| TLP-A/B115-*xxx*, TLP-A/B145-*xxx*, TLP-A/B200-*xxx*, TLP-A/B235-*xxx* | 2090-CTFB-MFDD-CFA*xx* (standard) or<br>2090-CTFB-MFDD-CFF*xx* (continuous-flex) |

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.

### Table 59 - Compatible Motors and Actuators

| Single-turn or Multi-turn Absolute Encoders | | Incremental Encoders | |
|---|---|---|---|
| **Servo Motor Cat. No.** | **Feedback Cable (1) Cat. No.** | **Servo Motor Cat. No.** | **Feedback Cable (1) Cat. No.** |
| MPL-A/B15*xxx*…MPL-A2*xxx*-V/E<br>MPL-A/B3*xxx*…MPL-A5*xxx*-M/S | 2090-CFBM7DF-CEAA*xx*<br>2090-CFBM7DD-CEAA*xx*<br>2090-CFBM7DF-CERA*xx* (standard) or<br>2090-CFBM7DF-CEAF*xx*<br>2090-CFBM7DD-CEAF*xx*<br>2090-CFBM7DF-CDAF*xx* (continuous-flex) | MPL-A/B15*xxx*…MPL-A/B2*xxx*-H<br>MPL-A/B3*xxx*…MPL-A/B45*xxx*-H | 2090-XXNFMF-S*xx*<br>(standard)<br>2090-CFBM7DF-CDAF*xx*<br>(continuous-flex) |
| MPM-A/B*xxxxx*-M/S | | – | |
| MPF-A/B*xxxx*-M/S | | – | |
| MPS-A/B*xxxx*-M/S | | – | |
| MPAR-A/B1*xxxx*-V and MPAR-A/B2*xxxx*-V (series B)<br>MPAR-A/B3*xxxx*-M<br>MPAI-A/B*xxxxx*M3 | | MPAS-A/B*xxxx*-ALM*x*2C (direct drive) | |
| MPAS-A/B*xxxx*1-V05S*x*A (ballscrew)<br>MPAS-A/B*xxxx*2-V20S*x*A (ballscrew) | | LDAT-S*xxxxxx*-*x*B*x* | |
| | | LDC-C*xxxxxx*-*x*H<br>LDL-*xxxxxxx*-*x*H | |
| TLY-A*xxxx*-B | 2090-CFBM6DF-CBAA*xx* (standard)<br>2090-CFBM6DD-CCAA*xx* (standard) | TLY-A*xxxx*-H | 2090-CFBM6DF-CBAA*xx* (standard)<br>2090-CFBM6DD-CCAA*xx* (standard) |
| TL-A*xxxx*-B | 2090-DANFCT-S*xx* (standard) | – | – |

(1) Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for cable specifications.

### Table 60 - Legacy Motor Feedback Cables

| Motor Cable | Description | Cable Cat. No. |
|---|---|---|
| Standard | Encoder feedback, threaded | 2090-XXNFMF-S*xx*<br>2090-UXNFBMF-S*xx* |
| | Encoder feedback, bayonet | 2090-UXNFBMP-S*xx*<br>2090-XXNFMP-S*xx* |
| Continuous-flex | Encoder feedback, bayonet | 2090-XXTFMP-S*xx* |
| | Encoder feedback, threaded | 2090-CFBM4DF-CDAF*xx* |

## Cable Preparation for Kinetix TLP Feedback Cables

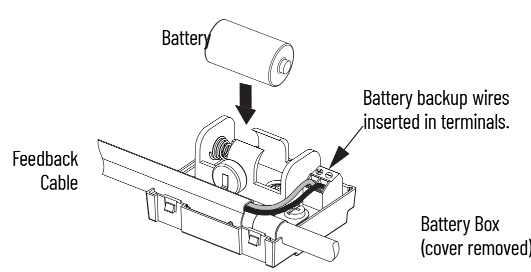
For Kinetix TLP motors, 2090-CTFB-M*x*DD feedback cables (with battery box) are available for applications with and without the need for battery backup.

- For multi-turn feedback, use 2090-CTFB-M*x*DD cables with drive-end connector plugs and wire the battery box (included with each Kinetix TLP feedback cable) and install a customer-supplied battery. Battery specifications are shown in Table 35 on page 67.

  See Feedback Battery Box Installation Instructions, publication 2198-IN022, for more information.

- For single-turn feedback, use 2090-CTFB-M*x*DD cables with drive-end connector plugs, however, the battery box option is not required.
- If you build your own cables, see Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, and make flying-lead feedback connections to the 2198-K51CK-D15M connector kit.

**Figure 65 - Battery Box Wired With Battery**



## Cable Preparation for 2090-CFBM7Dx Feedback Cables

2090-CFBM7DD motor feedback cables, used with Kinetix MP motors and actuators (with Hiperface encoders), also provide a drive-end connector that plugs directly into the 15-pin Kinetix 5100 (MFB) feedback connector. Use the 2198-K51CK-D15M feedback connector kit with 2090-CFBM7DF flying-lead cables.

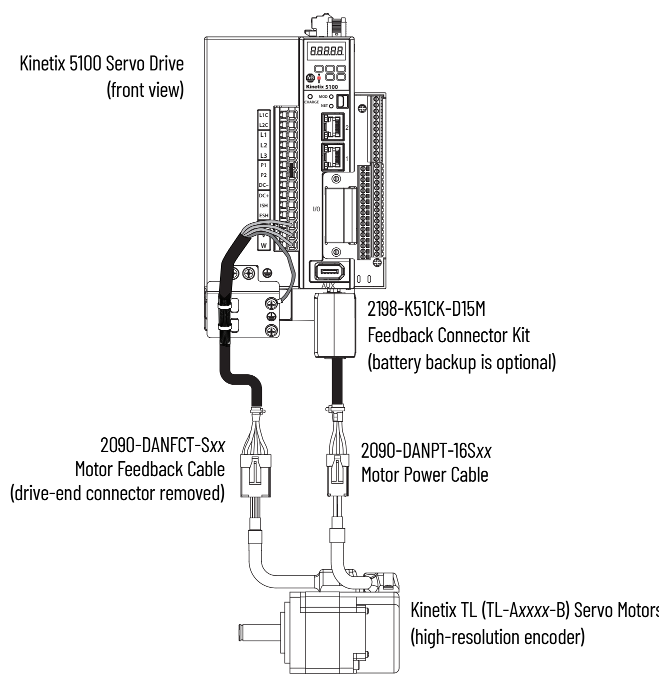
## Cable Preparation for Kinetix TL and TLY Feedback Cables

For Kinetix TLY motors, 2090-CFBM6D*x* feedback cables are available for applications with and without the need for battery backup.

- For multi-turn encoders (TLY-A*xxxx*-B motors), use the 2198-K51CK-D15M feedback connector kit (with customer-supplied battery) and 2090-CFBM6DF flying-lead cables.
- For incremental encoders (TLY-A*xxxx*-H motors), use 2090-CFBM6DD cables with drive-end connector and plug directly into the 15-pin (MFB) feedback connector.
  - If the 2090-CFBM6DF flying-lead cable is preferred, the 2198-K51CK-D15M connector kit (without battery) can also be used.

For Kinetix TL-A*xxxx*-B motors, use 2090-DANFCT-S*xx* feedback cables. You must remove the drive-end connector and prepare the leads for terminating at the 2198-K51CK-D15M connector kit. Install a (customer-supplied) battery for multi-turn encoder position backup.

**Figure 66 - Feedback Connection for Kinetix TL Motors**



## Motor Feedback Cable Preparation

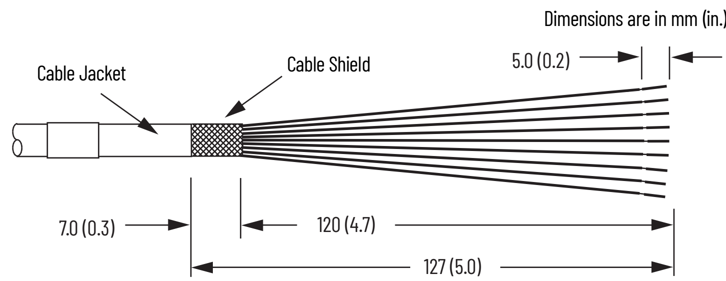
When using the 2198-K51CK-D15M feedback connector kit, you must prepare the Kinetix 2090 flying-lead conductors with the proper strip length. The cable shield requires a high-frequency bond with the ground pad.

Follow these steps to prepare feedback cables.

1. Remove 127 mm (5.0 in.) of cable jacket and 120 mm (4.7 in.) of cable shield.

| IMPORTANT | This length of wire is needed for the longest wires terminated at each 8-pin connector. However, most wires are trimmed shorter, depending on the terminal they are assigned to. |
|---|---|

2. Determine the length for each wire and trim as necessary.
3. Remove 5.0 mm (0.2 in.) of insulation from the end of each wire.



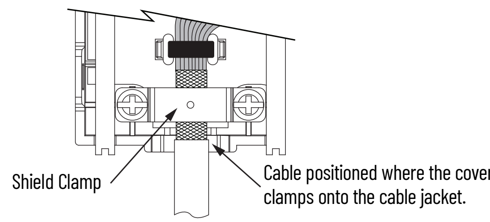
*Apply the Connector Kit Shield Clamp*

Follow these steps to apply the connector kit shield clamp.

1. Position the 12 mm (0.5 in.) of exposed cable shield over the ground pad to achieve a high-frequency bond.

| **IMPORTANT** | Cable preparation and positioning that provides a high-frequency bond between the shield braid and clamp is required to optimize system performance.<br>Also, make sure that the cable is positioned where the cover clamps onto the jacket for added stress relief. |
|---|---|

2. Place the shield clamp over the cable shield and install the clamp screws.
   Apply 0.34 N•m (3.0 lb•in) torque to each screw.




3. Route and insert each wire to its assigned terminal, apply 0.20 N•m (1.8 lb•in) maximum torque to each screw.
   Refer to the connector pinout as shown in Figure 67 on page 101.
4. Attach the tie-wrap (customer-supplied) through the slots and around the cable shield for stress relief and to create a high-frequency bond between shield and ground pad.

## Kinetix 2090 Feedback Cable Pinouts

The following tables provide motor connector pinouts and wire colors to the 2198-K51CK-D15M connector kit.

**Table 61 - 2090-CFBM7DF-CEA*xxx* Feedback Cables**

| **Absolute,<br>High-resolution<br>Feedback** | **MPL-B15*xxx* and MPL-B2*xxx*-V/Ex4/7xAA<br>MPL-B3*xxx*…MPL-B9*xxx*-M/Sx7xAA<br>MPL-A5*xxx*-M/Sx7xAA** | **MPL-A15*xxx* and MPL-A2*xxx*-V/Ex4/7xAA<br>MPL-A3*xxx*-M/Sx7xAA<br>MPL-A4*xxx*-M/Sx7xAA<br>MPL-A45*xxx*-M/Sx7xAA<br>MPM-A115*xxx*…MPM-A130*xxx*-M/S<br>MPF/MPS-A3*xx*-M/S<br>MPF/MPS-A4*xx*-M/S<br>MPF/MPS-A45*xx*-M/S** | **Wire Color** | **2198-K51CK-D15M<br>Connector Kit Pin** |
|---|---|---|---|---|
| **Motor/Actuator Pin** | **MPM-A165*xxx*…MPM-A215*xxx*-M/S<br>MPM-B*xxxxx*-M/S<br>MPF-B*xxx*-M/S<br>MPF-A5*xxx*-M/S<br>MPS-B*xxx*-M/S** | | | |
| | **MPAS-B*xxxxx*-VxxSxA<br>MPAR-B*xxxx*, MPAI-B*xxxx*** | **MPAS-A*xxxxx*-VxxSxA<br>MPAR-A*xxxx*, MPAI-A*xxxx*** | | |
| 1 | SIN+ | SIN+ | Black | 1 |
| 2 | SIN- | SIN- | White/Black | 2 |
| 3 | COS+ | COS+ | Red | 3 |
| 4 | COS- | COS- | White/Red | 4 |
| 5 | DATA+ | DATA+ | Green | 5 |
| 6 | DATA- | DATA- | White/Green | 10 |
| 9 | Reserved | EPWR_5V | Gray | 14 |
| 10 | ECOM | ECOM | White/Gray | 6 (1) |
| 11 | EPWR_9V | Reserved | Orange | 7 |
| 13 | TS+ | TS+ | White/Orange | 11 |

(1) The ECOM and TS- connections are tied together and connect to the cable shield.

**Table 62 - 2090-CTFB-MxDD-CF*xxx* Feedback Cables**

| **Motor Pin** | **TLP-A*xxx-xxx* and TLP-B*xxx-xxx*<br>24-bit Absolute, Multi-turn/Single-turn<br>High-resolution** | **Wire Color** | **2198-K51CK-D15M<br>Connector Kit Pin** |
|---|---|---|---|
| A | T+ | White | 5 |
| B | T– | White/Red | 10 |
| C | BAT+ | Red | Pin + |
| D | BAT– | Black | Pin – |
| L | Drain | – | ⏚ |
| R | ECOM | Blue | 6 |
| S | EPWR_5V | Brown | 14 |

### Table 63 - 2090-XXNFMF-S*xx* or 2090-CFBM7DF-CDA*xxx* Feedback Cables

| Incremental Feedback<br>Motor Pin | MPL-A/B15*xxx*...MPL-A/B2*xxx*-Hx4/7xAA | Wire Color | 2198-K51CK-D15M Connector Kit Pin |
|---|---|---|---|
| 1 | SIN+ | Black | 1 |
| 2 | SIN- | White/Black | 2 |
| 3 | COS+ | Red | 3 |
| 4 | COS- | White/Red | 4 |
| 5 | DATA+ | Green | 5 |
| 6 | DATA- | White/Green | 10 |
| 9 | EPWR_5V | Gray | 14 |
| 10 | ECOM | White/Gray | 6 (1) |
| 11 | EPWR_9V | Orange | 7 |
| 13 | TS+ | White/Orange | 11 |
| 15 | S1 | White/Blue | 12 |
| 16 | S2 | Yellow | 13 |
| 17 | S3 | White/Yellow | 8 |

(1) The ECOM and TS- connections are tied together and connect to the cable shield.

### Table 64 - 2090-CFBM6DF-CBAA*xx* Feedback Cables

| Motor Pin | TLY-A*xxxx*-H<br>Incremental Encoder Feedback | Wire Color | 2198-K51CK-D15M Connector Kit Pin |
|---|---|---|---|
| 9 | AM+ | Black | 1 |
| 10 | AM– | White/Black | 2 |
| 11 | BM+ | Red | 3 |
| 12 | BM– | White/Red | 4 |
| 13 | IM+ | Green | 5 |
| 14 | IM– | White/Green | 10 |
| 22 | EPWR_5V | Gray | 14 |
| 23 | ECOM | White/Gray | 6 (1) |
| 15 | S1 | White/Blue | 12 |
| 17 | S2 | Yellow | 13 |
| 19 | S3 | White/Yellow | 8 |
| 24 | Drain | – | ⏚ |

(1) The ECOM and TS- connections are tied together and connect to the cable shield.

### Table 65 - 2090-CFBM6DF-CBAA*xx* Feedback Cables

| Motor Pin | TLY-A*xxxx*-B<br>17-bit Absolute, Multi-turn, High-resolution Feedback | Wire Color | 2198-K51CK-D15M Connector Kit Pin |
|---|---|---|---|
| 13 | DATA+ | Green | 5 |
| 14 | DATA– | White/Green | 10 |
| 22 | EPWR_5V | Gray | 14 |
| 23 | ECOM and BAT- | White/Gray | 6 (1) |
| 6 | BAT+ | Orange | BAT+ |
| 24 | Drain | – | ⏚ |

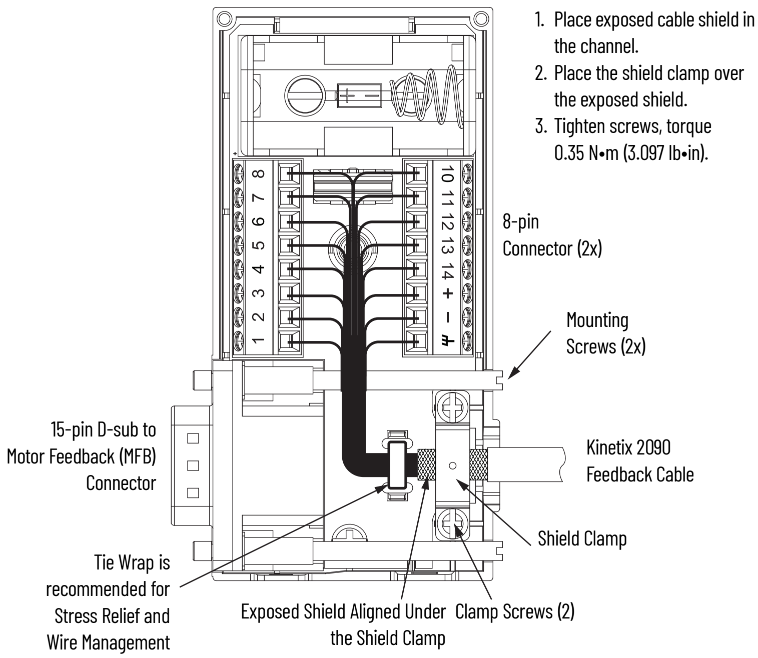
(1) BAT- is tied to ECOM (pin 23) in the cable.

**Table 66 - 2090-DANFCT-S*xx* Feedback Cables**

| Motor Pin | TL-A*xxxx*-B<br>17-bit Absolute, Multi-turn, High-resolution Feedback | Wire Color | 2198-K51CK-D15M Connector Kit Pin |
|---|---|---|---|
| 12 | SD+ | Brown | 5 |
| 13 | SD– | White/Brown | 10 |
| 7 | EPWR_5V | Gray | 14 |
| 8 | ECOM and BAT- | White/Gray | 6 (1) |
| 14 | BAT+ | Orange | BAT+ |
| 9 | Drain | – | ⏚ |

(1) BAT- is tied to ECOM (pin 8) in the cable.

**Figure 67 - Wire the 2198-K51CK-D15M Feedback Connector Kit**




| Terminal | Signal | | Wire Color |
|---|---|---|---|
| 1 | SIN+ | AM+ | Black |
| 2 | SIN– | AM– | White/Black |
| 3 | COS+ | BM+ | Red |
| 4 | COS– | BM– | White/Red |
| 5 | DATA+ | IM+ | Green |
| 6 | ECOM (1) | | White/Gray |
| 7 | EPWR_9V | | Orange |
| 8 | S3 | | White/Yellow |
| 10 | DATA– | IM– | White/Green |
| 11 | TS+ | | White/Orange |
| 12 | S1 | | White/Blue |
| 13 | S2 | | Yellow |
| 14 | EPWR_5V | | Gray |
| + | Battery + | | N/A (2) |
| – | Battery – | | N/A (2) |
| ⏚ | Drain | | Shield |

(1) The ECOM and TS- connections are tied together and connect to the cable shield.
(2) See cable pinouts for wire colors.

## External Passive-shunt Resistor Connections

Passive shunt connections are made at the shunt connector on the bottom of the drive or the terminal blocks on the front of the drive.

Follow these guidelines when wiring your 2198-R*xxx* or 2097-R*x* passive shunt:

- Refer to External Passive Shunt Modules on page 39 for noise zone considerations.
- Refer to Passive Shunt Wiring Examples on page 453.
- Refer to the installation instructions provided with your Bulletin 2198 shunt module, publication 2198-IN011.

| IMPORTANT | To improve system performance, run wires and cables in the wireways as established in Chapter 2. |
|---|---|

All Kinetix 5100 servo drives have internal shunt IGBT. However, only 2198-E1004-ERS…2198-E2030-ERS (200V) drives and 2198-E4004-ERS… 2198-E4015-ERS (400V) drives have an internal shunt resistor. The DC+ to ISH jumper connects the internal shunt resistor.

| IMPORTANT | You must remove the internal shunt jumper in the shunt connector (between DC+ and ISH) before connecting the Bulletin 2198 or 2097 passive shunt resistor wires. |
|---|---|

**Figure 68 - 2198-E1004-ERS, 2198-E1007-ERS and 2198-E1015-ERS Servo Drives**

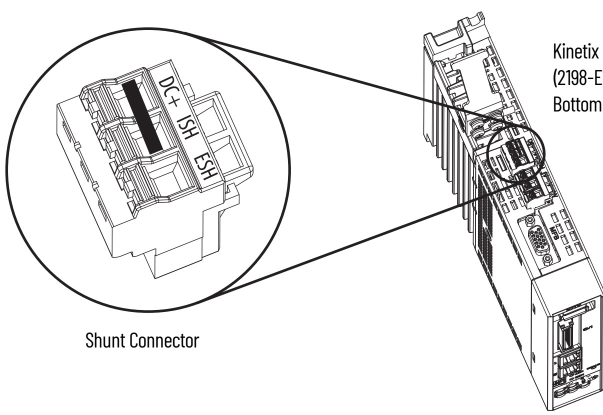
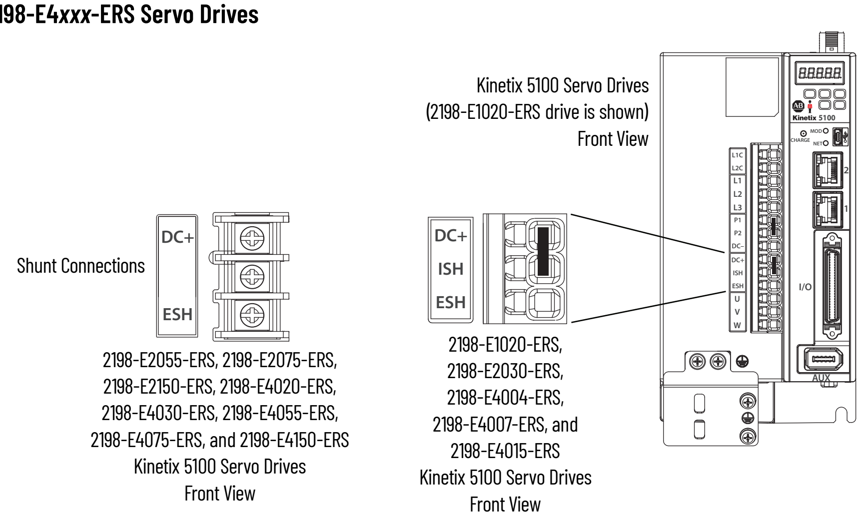



**Figure 69 - 2198-E1020-ERS, 2198-E2030-ERS, 2198-E2055-ERS, 2198-E2075-ERS, 2198-E2150-ERS, and 2198-E4*xxx*-ERS Servo Drives**



### Table 67 - Shunt Connector Specifications

| Kinetix 5100 Drive Cat. No. | Connects to Terminals | Recommended Wire Size<br>$mm^2$ (AWG) | Strip Length<br>mm (in.) | Torque Value<br>N•m (lb•in) |
|---|---|---|---|---|
| 2198-E1004-ERS<br>2198-E1007-ERS<br>2198-E1015-ERS | DC+<br>ISH<br>ESH | 0.20…3.31<br>(24…12) | 11 (0.4) | N/A [1] |
| 2198-E1020-ERS<br>2198-E2030-ERS | | 0.20…5.26<br>(24…10) | 13 (0.5) | N/A [1] |
| 2198-E2055-ERS | DC+<br>ESH | 0.82…8.36<br>(18…8) | | 1.8 [2]<br>(15.49) |
| 2198-E2075-ERS | | | 11 (0.4) | 1.6 [2]<br>(13.90) |
| 2198-E2150-ERS | | 2.08…21.1<br>(14…4) | 13 (0.5) | 3.1 [2]<br>(27.44) |
| 2198-E4004-ERS<br>2198-E4007-ERS<br>2198-E4015-ERS | DC+<br>ESH | 0.20…5.26<br>(24…10) | 13 (0.5) | N/A [1] |
| 2198-E4020-ERS<br>2198-E4030-ERS<br>2198-E4055-ERS | | 0.82…8.36<br>(18…8) | | 1.6 [2]<br>(13.90) |
| 2198-E4075-ERS | | | 11 (0.4) | |
| 2198-E4150-ERS | | 2.08…21.1<br>(14…4) | 13 (0.5) | 3.1 [2]<br>(27.44) |

(1) This connector uses spring tension to hold wires in place.
(2) Attach using a terminal crimp lug.

See Passive Shunt Considerations on page 29 for shunts compatible with your Kinetix 5100 servo drive.

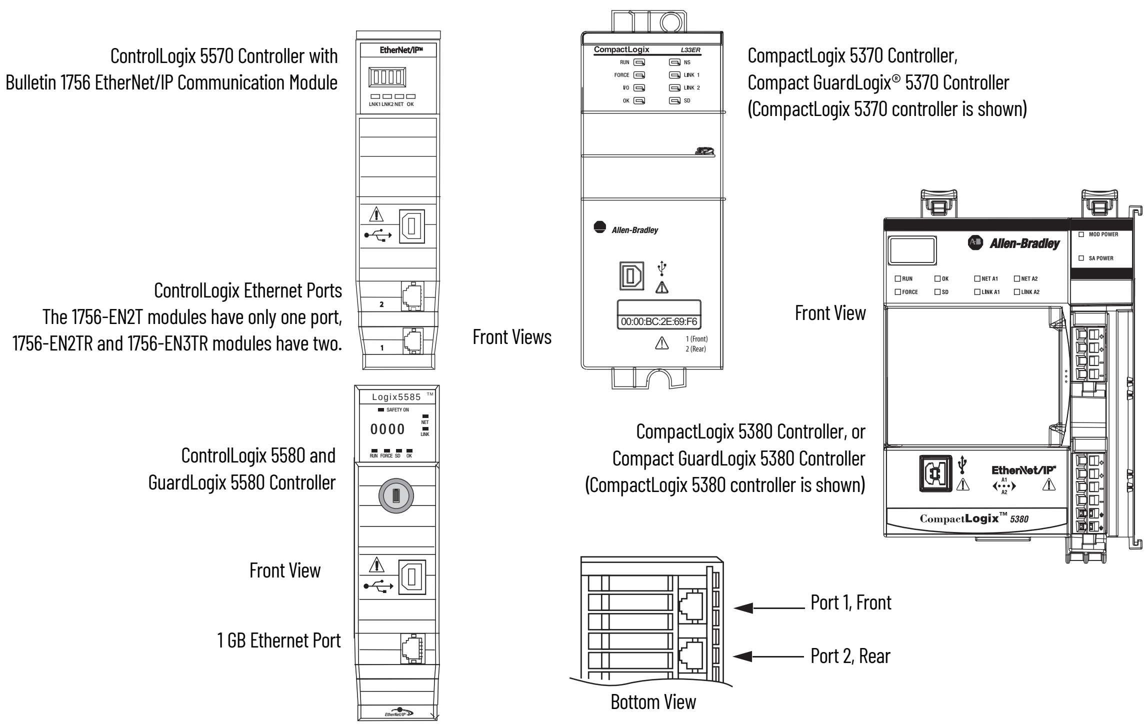
## Ethernet Cable Connections

This procedure assumes that you have your Logix 5000™ controller and Kinetix 5100 drives mounted and are ready to connect the network cables.

The EtherNet/IP™ network is connected by using the PORT 1 and PORT 2 connectors of the drive. Refer to page 44 to locate the Ethernet connectors on your drive module. Refer to Figure 70 to locate the connectors on your Logix 5000 controller.

Shielded Ethernet cable is required for EMC compliance and is available in several standard lengths. Ethernet cable lengths that connect drive-to-drive, drive-to-controller, or drive-to-switch must not exceed 100 m (328 ft). Refer to the Kinetix Motion Accessories Specifications Technical Data, publication KNX-TD004, for more information.

**Figure 70 - ControlLogix and CompactLogix Ethernet Port Locations**




The Logix 5000 controllers accept linear, ring (DLR), and star network configurations. Refer to Typical Communication Configurations on page 15 for linear, ring, and star configuration examples.

# Set Up EtherNet/IP Communication



You can add the drive to your Studio 5000 Logix Designer® application by adding it to a configured EtherNet/IP™ module or controller under the I/O configuration folder. After setting network parameters, you can view the drive status information in Studio 5000® environment and use it in your Logix Designer application.

Settings are stored in nonvolatile memory. You can change the IP address through the keypad interface, Module Configuration dialog box in RSLinx® software, by using KNX5100C software, or through the drive Internet Protocol page of Module Properties in your Logix Designer application. Changes to the IP address take effect after drive power is cycled.

If configure DHCP is turned ON in the Network Parameters, you must configure the IP address of drive by using BOOTP-DHCP tool.

Use one of the following three methods to set the network parameters:

- Panel display
- KNX5100C software on page 108
- BOOTP-DHCP tool on page 109

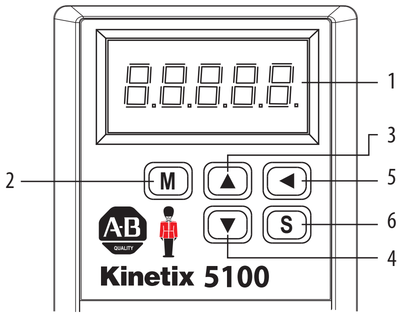
The drive is factory programmed to static IP address of 192.168.1.1 and Gateway address of 192.168.1.254.

| | |
|---|---|
| **IMPORTANT** | Only standalone mode is supported for linear motors and induction motors. |

## Set Network Parameters by Using the Keypad Interface

Follow these steps to set network parameters.

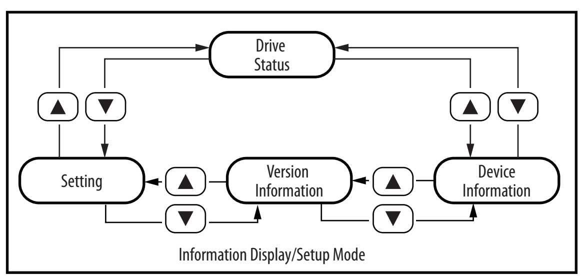
**Figure 71 - Keypad and Display**




| Item | Key | Name | Description |
|---|---|---|---|
| 1 | – | Display | A 5-digit, 7-segment status indicator that displays the monitoring values, parameters, and setting values. |
| 2 | M | Mode key | Use this key to return to the parent menu or, if there is one, to return to the previous menu. |
| 3 | ▲ | Up key | Use this key to return to the previous menu. It is also increases the values that you edit while in the configuration and parameter edit screens. |
| 4 | ▼ | Down key | Use this key to advance to the next menu. It also decreases the values that you edit while in the configuration and parameter edit screens. |
| 5 | ◄ | Shift key | Use this key to toggle between the digits or menus in the same level. |
| 6 | S | Set key | Use this key to enter a sub-menu, if one exists, or to confirm a value that you have edited. |

1. Apply power to your drive.

   BOOT*x* appears on the display as the drive boots up. After a successful boot process, the drive display scrolls 5100 192.168.1.1, then STOP 192.168.1.1.




2. In the Device Information screen or Drive Status screen, the current IP address is shown.
3. Press ▼ key.

   SETTING appears on the display.
4. Press S key.

   NET SETTING scrolls across the display.
5. Press S key.

   STATIC IP scrolls across the display.

To enter the IP ADDR, press [S] key, and use the [▲] [▼] keys to enter the IP Address octets.

To enter the SUBNET, press [▼] key, and use the [▲] [▼] keys to enter the subnet address octets.

To enter the GATE, press [▼] key, and use the [▲] [▼] keys to enter the Gateway octets.

Press [M] to return to the Static IP display.

6. Press [▼] key.

   DHCP appears on the display.

   To show the current DHCP setting (OFF or ON), press [S] key.

   To change the DHCP setting, and press [▲] or [▼] key.

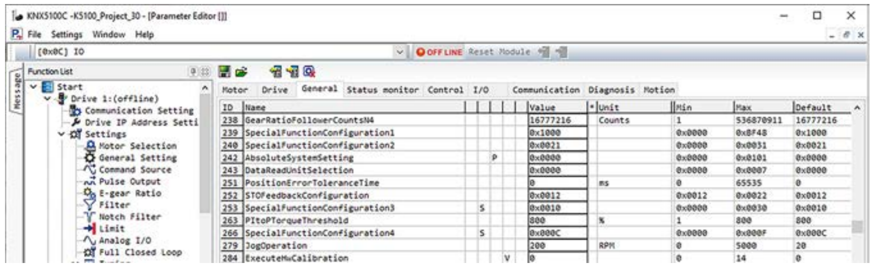
   The display toggles between OFF and ON.

   To apply the setting, press [S] key or to exit the setting press [M] keypad.

See Chapter 6, Use the Keypad Interface for help with setting the network parameters

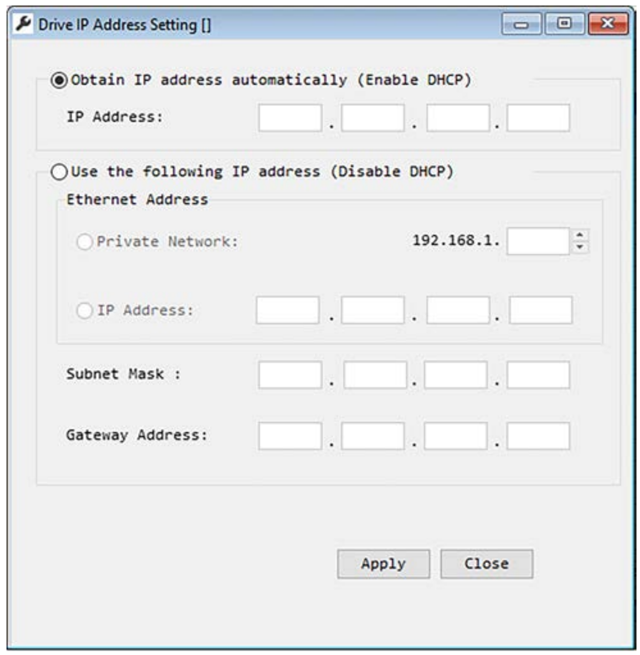
## Set Network Parameters by Using KNX5100C Software

The KNX5100C software reads the parameters from your drive. Follow these steps to configure network parameters.



1. From the Function List, click Drive IP Address Setting.

   The Drive IP Address Setting dialog box appears, and the current IP Settings are displayed.




2. Choose between STATIC IP and DHCP.

   The default setting is STATIC IP.
3. If STATIC IP, then configure the following parameters:
   - IP address
   - Gateway
   - Subnet mask
4. Click Apply.
5. To have the IP Settings take effect, click Reset Module from the tool bar.

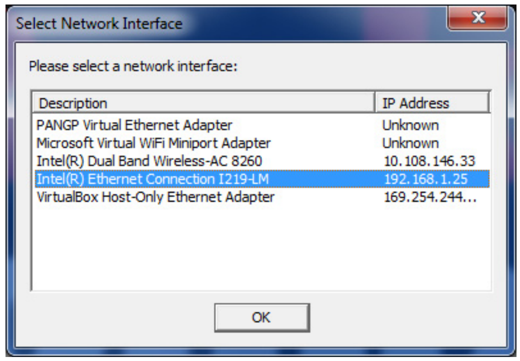
## Configure IP Address by Using BOOTP-DHCP Tool

Follow these steps to configure the IP address.

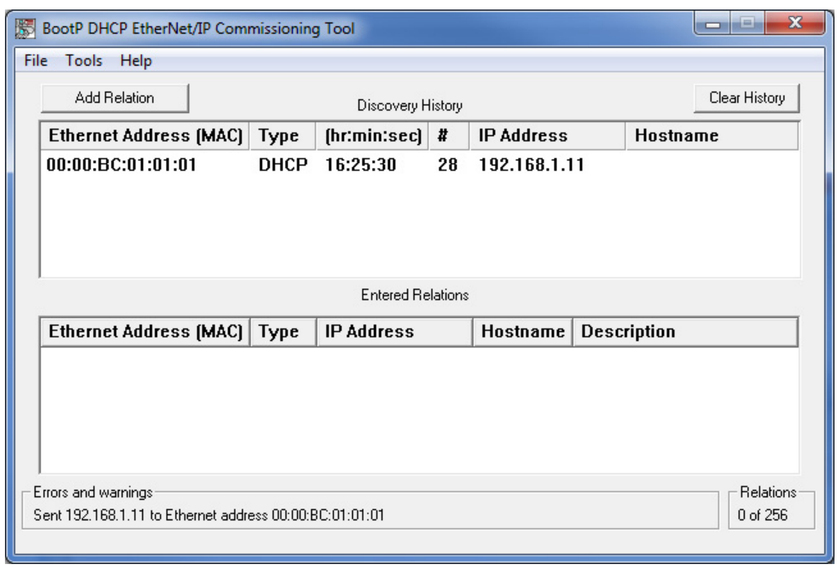
The Kinetix 5100 drive supports DHCP only, not BootP. You can use other DHCP server software to configure the IP address of the Kinetix 5100 drive. This example shows a software tool called BootP-DHCP Tool, which is installed together with the Studio 5000 application.

1. Connect your PC with a Kinetix 5100 drive via Ethernet cable, and then apply the power to the drive.
2. Open BOOTP-DHCP tool in your workstation, and select network interface according to your environment as shown.

   In this example, the IP address of workstation is 192.168.1.25.



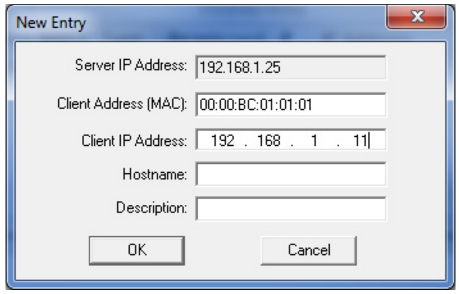

   The BOOTP-DHCP tool automatically scans the devices that are configured to DHCP on the network, and displays the device MAC addresses as shown.




   You can find the MAC address of your drive on the drive label. In this example, the MAC address 00:00:BC:01:01:01 is used.

3. From the dialog box, double-click the MAC address of your drive.

   The New Entry dialog appears.




4. Type your specified IP address in the New Entry dialog, and then click OK.

Chapter 6

# Use the Keypad Interface

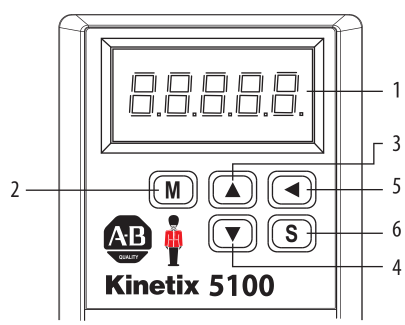


## Keypad Input and Panel Display

The Kinetix® 5100 drive is equipped with a diagnostic status indicator and five push buttons that are used to display information and to edit a limited set of parameter values.

The drive has three status indicators: Charge, MOD, and NET. For an explanation of their functions, see Status Indicators on page 439. For more information on how the keypad and status indicator can be used to do tuning, see Autotuning via the Drive Panel on page 198.

**Figure 72 - Keypad and Display**




| Item | Key | Name | Description |
|---|---|---|---|
| 1 | – | Display | A 5-digit, 7-segment status indicator that displays the monitoring values, parameters, and setting values. |
| 2 | M | Mode key | Use this key to return to the parent menu or, if there is one, to return to the previous menu. |
| 3 | ▲ | Up key | Use this key to return to the previous menu. It is also increases the values that you edit while in the configuration and parameter edit screens. |
| 4 | ▼ | Down key | Use this key to advance to the next menu. It also decreases the values that you edit while in the configuration and parameter edit screens. |
| 5 | ◄ | Shift key | Use this key to toggle between the digits or menus in the same level. |
| 6 | S | Set key | Use this key to enter a sub-menu, if one exists, or to confirm a value that you have edited. |

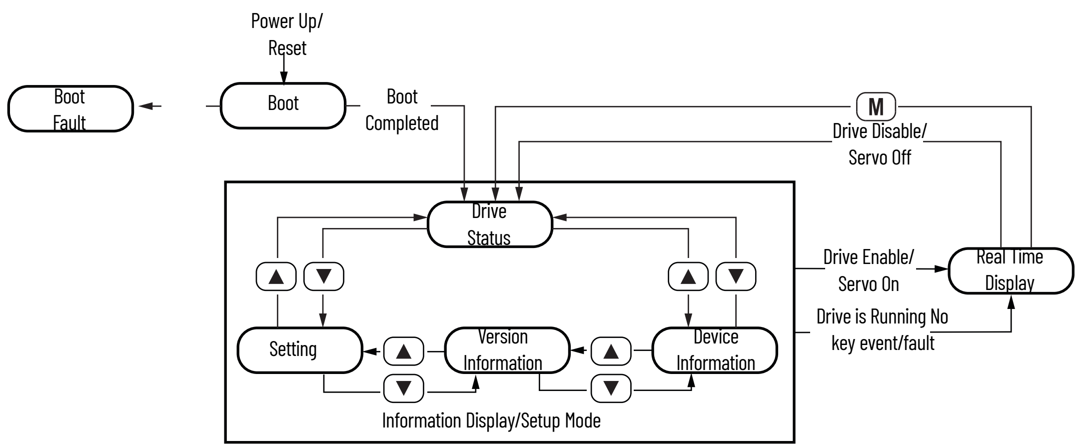
# Drive Displays

After the drive boots up successfully, it displays 'Kinetix 5100' briefly and then transitions to the Drive Status display, assuming the drive is disabled/servo off. If the drive is enabled/servo on with no faults, then the Real Time display is shown. If a fault occurs, then the fault screen displays an E, followed by the fault code. If a warning occurs, then the fault screen displays an A, followed by the warning code.

For more information on fault codes, see Chapter 16, Troubleshoot the Kinetix 5100 Drive System.

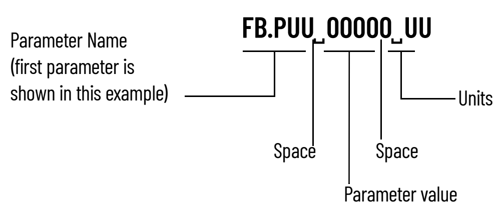
Main displays are as follows.

- Real time data
- Drive status
- Setting




## Real Time Data

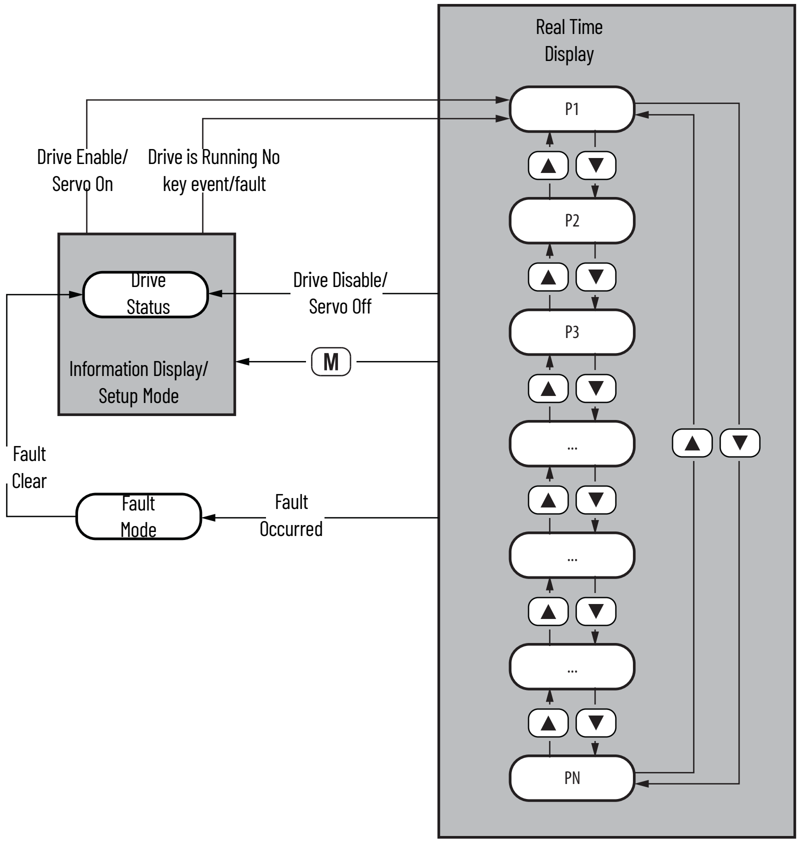
Real Time Data screen shows the real-time value of the selected parameter. The Real Time Data display format is as follows.




Use the ▲ ▼ keys to move between parameters.

When the drive is enabled/servo on, you can use the M key to access the Drive Status screen to view information. If no button is pressed and no fault or alarm occurs within one minute, then the display reverts back to Real Time Data.

**Figure 73 - Real Time Data Display**




*For example:*
On the Real Time Display, the drive displays FB.PUU. When you press (▲), the drive displays C-PUU, which is the input pulse number. See Table 68 for the description of the Real Time Display symbols.

**Table 68 - Real Time Display Symbols**

| Code | Real Time Displayed Symbol | Description | Unit |
|---|---|---|---|
| 0 | Fb.PUU | Motor feedback pulse number after the scaling of electronic gear ratio. | User unit |
| 1 | c-PUU | Input pulse number of pulse command after the scaling of electronic gear ratio. | User unit |
| 2 | Er.PUU | The deviation between control command pulse and feedback pulse number. | User unit |
| 3 | Fb.cnt | Motor feedback pulse number (encoder unit) (1.28 million count/rev) | Count |
| 4 | c-cnt | Input pulse number of pulse command before the scaling of electronic gear ratio. (encoder unit) | Count |
| 5 | Er.cnt | Error pulse number after the scaling of electronic gear ratio. (encoder unit) | Count |
| 6 | cP-Fr | Input frequency of pulse command. | kHz |
| 7 | SPEEd | Motor speed. | rpm |
| 8 | cSPd 1 | Speed command. | Volt |

## Table 68 - Real Time Display Symbols (Continued)

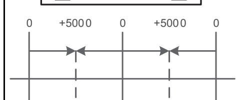
| Code | Real Time Displayed Symbol | Description | Unit |
|---|---|---|---|
| 9 | cSPd2 | Speed command. | rpm |
| 10 | c-tq1 | Torque command. | Volt |
| 11 | c-tq2 | Torque command. | % |
| 12 | AVG-L | Average torque. | % |
| 13 | PE-L | Peak torque. | % |
| 14 | U bUS | Main circuit voltage. | Volt |
| 15 | J-L | Load/motor inertia ratio.<br>If 13.0 is displayed, the actual inertia is 13. | 1 time |
| 16 | iGbt.t | IGBT temperature. | °C |
| 17 | rSnFr | Resonance frequency. Low byte is the first resonance and high byte is the second resonance. | Hz |
| 18 | d iFF2   | The absolute pulse number of encoder Z phase equals the homing value, 0. The absolute pulse number can be +5000 or -5000 pulses depending on whether the motor rotates in a forward or reverse direction. | – |
| 19 | nnAP 1 | Map parameter number 1 displays the content of parameter ID55 (P0.025). Specify the map target by using ID60 (P0.035). | – |
| 20 | nnAP2 | Map parameter number 2 displays the content of parameter ID56 (P0.026). Specify the map target by using ID61 (P0.036). | – |
| 21 | nnAP3 | Map parameter number 3 displays the content of parameter ID57 (P0.027). Specify the map target by using ID62 (P0.037). | – |
| 22 | nnAP4 | Map parameter number 4 displays the content of parameter ID58 (P0.028). Specify the map target by using ID62 (P0.038). | – |
| 23 | VAr-- 1 | Monitor variable number 1 displays the content of parameter ID663 (P0.009). Specify the monitor variable code by using ID668 (P0.017). | – |
| 24 | VAr--2 | Monitor variable number 2 displays the content of parameter ID664 (P0.010). Specify the monitor variable code by using ID669 (P0.018). | – |
| 25 | VAr--3 | Monitor variable number 3 displays the content of parameter ID665 (P0.011). Specify the monitoring variable code by using ID670 (P0.019). | – |
| 26 | VAr--4 | Monitor variable number 4 displays the content of parameter ID666 (P0.012). Specify the monitoring variable code by using ID667 (P0.020). | – |
| 27 | 2-d iF | Offset value between motor position and Z phase in PUU unit. The value is 0 when the position overlaps with Z phase. The greater the value, the greater the offset. | User Unit |
| 28 | FLt-c | Current drive fault. | – |

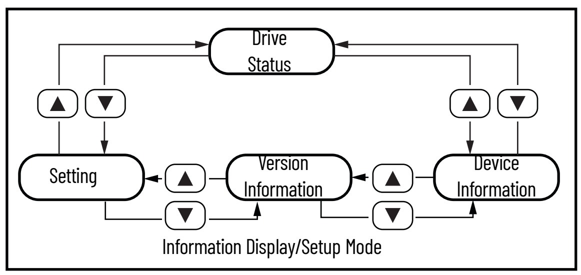
**Table 68 - Real Time Display Symbols (Continued)**

| Code | Real Time Displayed Symbol | Description | Unit |
|---|---|---|---|
| 29 | AFbUU | Position feedback from the auxiliary encoder. | User Unit |
| 30 | AErUU | Position deviation between the position feedback and the command from the auxiliary encoder. | User Unit |
| 31 | NAEUU | Feedback position deviation between main encoder and auxiliary encoder. | User Unit |

## Drive Status Display

This display provides drive information and access to the Setting display, which shows network and parameter information. When the drive is enabled/servo on, the information can only be viewed.

Use the ▲▼ keys to move between status information displays.




### *Device Information Screen*

| Drive Status Name | Display String | Description |
|---|---|---|
| Standby | Stdby | If the drive has passed boot steps and self-testing, but the drive has not been configured.<br>• DHCP off: Stdby_192.168.1.180<br>• DHCP on (before IP address is assigned): Stdby_DHCP_0.0.0.0<br>• DHCP on (after IP address is assigned): Stdby_DHCP_192.168.1.180 |
| Stopped | StoP | If the drive has been configured, but it is still not enabled/servo on. |
| Running | RUN | The drive is enabled/servo on. |
| Fault | | A fault or warning occurred during operation. |

### *Version Information Screen*

This screen displays hardware and firmware versions of the drive. The display string is h␣01.002␣␣F␣01.102. h represents the hardware version, and F represents the firmware version.

### *Setting Screen*

When the drive is disabled/servo off, the Setting screen lets you edit the network address or drive parameters, or reset the drive.

For more information, see Edit Settings From the Display on page 116.

## Edit Settings From the Display

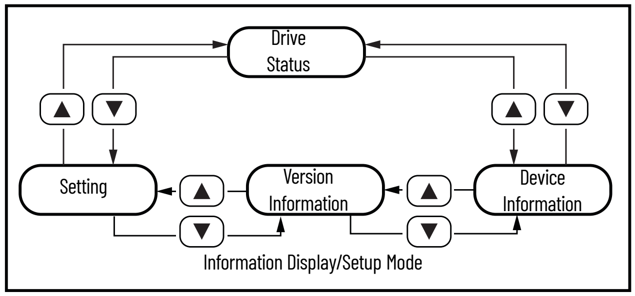
Access the Setting display from the Drive Status display by pressing the ▼ key.

When the drive is disabled/servo off, perform the following steps.

1. Press the S key to enter the editing mode.

   Use the ▲▼ keys to scroll through the Network setting, reset, and parameter setting displays.
2. Press the M key to return to the previous display.

**Figure 74 - State Switch Machine of Information Display and Setup**




### Edit Network Settings

From the Setting display, perform the following steps.

1. Press S to go to Network Setting display.
2. Press S again to enter the Static IP display.

   From that display, there are two choices:

   - Press S again to set a static IP address. See Set Static IP Address.
   - Press ▼ to turn DHCP on or off. See Turn DCHP On or Off on page 117.

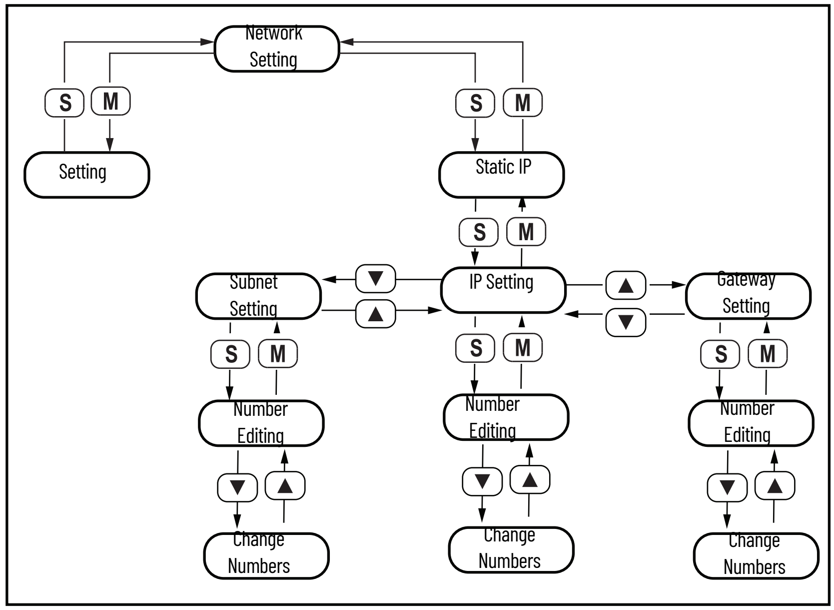
*Set Static IP Address*

On the Static IP Address display, perform the following steps.

1. Press the S key to enter the IP Setting display.
2. Press the S key to enter the edit display.
3. Use the ▲▼ keys to move between the IP Address, Gateway, and Subnet setting screens.

   See Figure 75.
4. Press S in any one of those settings displays and use the ▲▼ keys to edit the values.
5. Press the M key to set the values and return to the setting display.
6. Press the M key to return to the IP Address display.

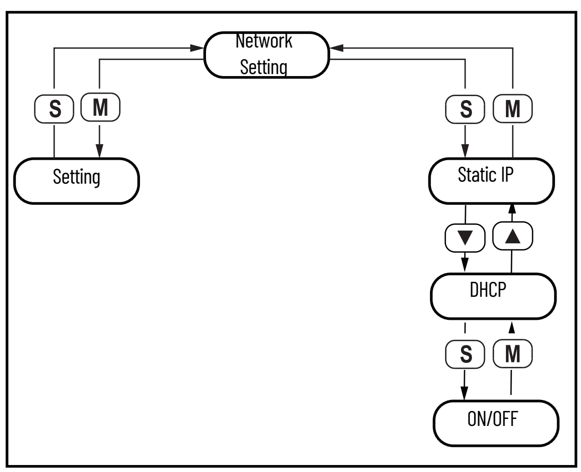
**Figure 75 - State Switch Machine of Setting**




### *Turn DCHP On or Off*

On the DHCP display, perform the following steps.

1. Press the S key to enter the DHCP editing display.
2. Press the S key to turn the switch OFF or ON.
3. Press the M key to return to the DHCP editing display.
4. Press the ▲ key to return to the IP Setting display.



## Edit Parameter Settings

From Settings display, perform the following steps.

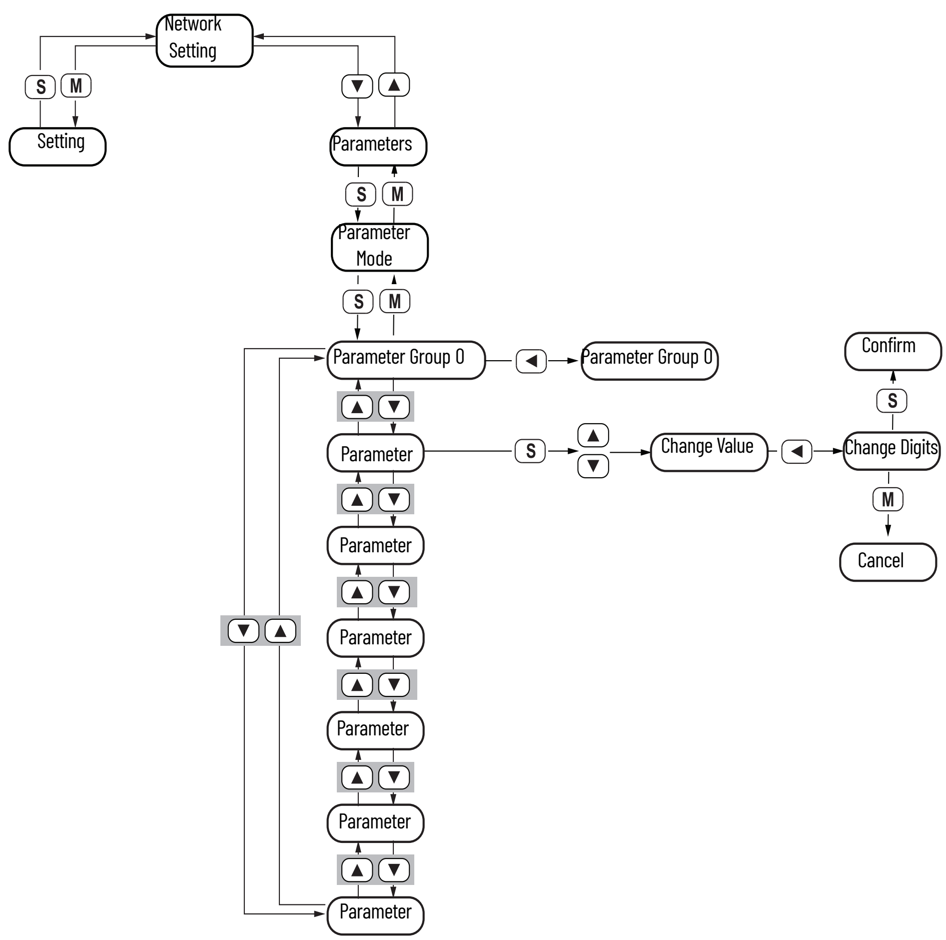
1. Press the (S) key to get to Network Settings.
2. Press the (▼) key for Parameters.
3. Press the (S) key for the parameter editing mode.

   Starting with group 0, use (▲)(▼) to move between parameter numbers within the group.
4. Use (◄) to move to the next parameter group.

   Use the (▲)(▼) keys to move between parameter numbers within a group.
5. Once you have navigated to the parameter you want to edit, press the (S) key to select it.

   Use the (▲)(▼) keys to change the value of the selected digit (flashing). Use the (◄) key to move between digits.
6. Press the (S) key to confirm the edit or the (M) key to cancel the change and to return to the Parameter display.

When you press the (S) key, the drive saves the value and displays Saved or another status message on the display. See Table 69 on page 119.



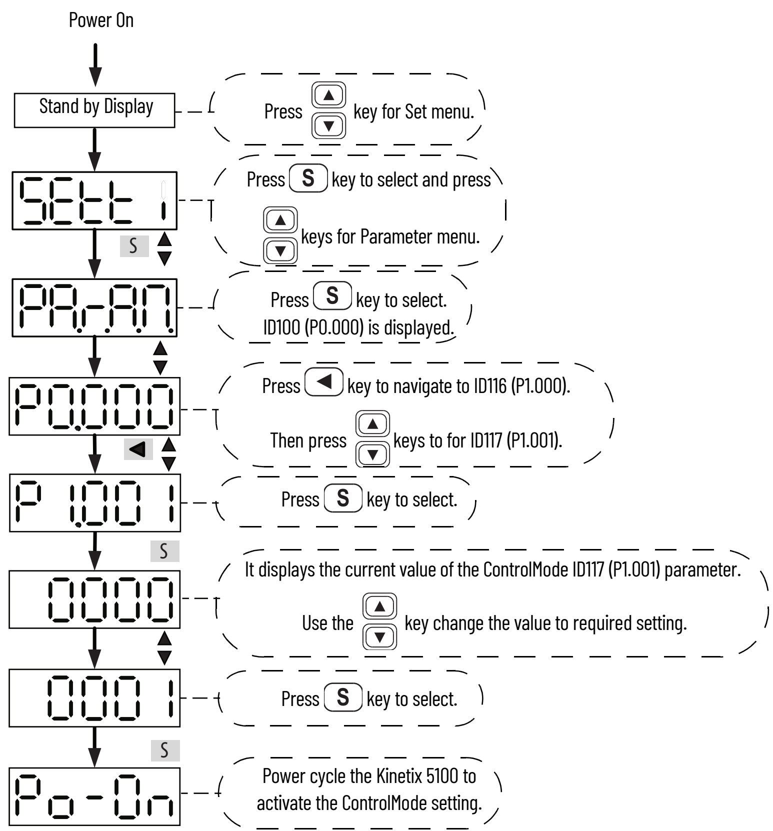
### *Save Display*

When you have set the parameter, press the S key to save. The display shows one of the following symbols for one second.

**Table 69 - Parameter Status Display**

| Displayed Symbol | Meaning | Description |
|---|---|---|
| SAVEd | Saved | Correctly saved the setting value. |
| Out-r | Out of Range | Incorrect value or the input is reserved for this value. |
| Po-On | Power On | The parameter will be effective after the servo drive is re-powered. |

### *Example*




## Reset the Drive via Keypad

To reset the drive, perform the following steps.

1. From the Parameter display, press the ▼ key to get to the Reset display.
2. On the Reset display, press the S key.

   The reset string blinks.
3. Press the S key again.

The drive resets.

4. Press the (▲) key to return to the Parameters display.

## Display Low Byte, High Byte, and Negative Values

In the real-time data display, all values are scrolled and displayed as decimal or hexadecimal. On the parameter editor screen, the value range can be shown in one of two ways:

- The real-time value is 'short' or 16 bits (can be shown in one screen).
- The real-time value is 'long' or 32 bits (must be shown in two screens). The first screen is the high byte and the second screen is the low byte. In these instances, use the (◄) key to move between screens.

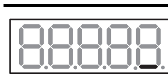
How the panel displays 16-bit and 32-bit values is shown in Table 70.

**Table 70 - 16-Bit and 32-Bit Display Formats**

| Example of the displayed value | Description | |
|---|---|---|
| 12345 (Dec) | 16 bits | If the value is positive 12345, the display shows 12345 in decimal format. |
| 0 1 1F (Hex) | | If the value is 0x011F, the display shows 0x011F in hexadecimal format; the highest digit is not shown. |
| 12304 (Dec high)<br>78900 (Dec low) | 32 bits | If the value is (positive) 1230478900, the display for the high byte shows 12304, and display for the low byte shows 78900, both in decimal format. |
| h001F (Hex high)<br>L0000 (Hex low) | | If the value is 0x001F0000, the display for the high byte shows h001F, and display for the low byte shows L0000 in hexadecimal format. |

Figure 76 shows the panel display of positive and negative signs.

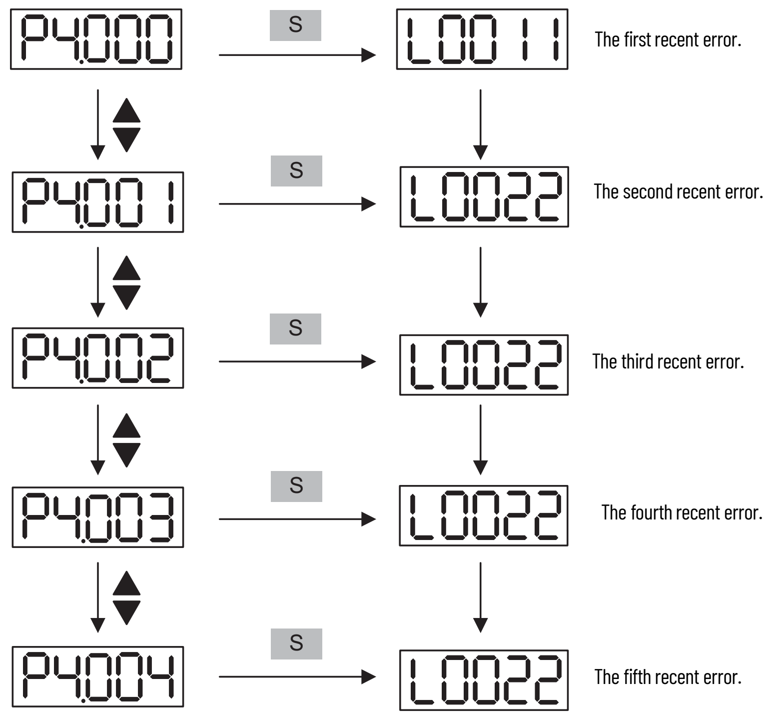
**Figure 76 - Panel Display**

| Positive Sign | Negative Sign |
|---|---|
|  |  |

## Display Fault Record

From the Diagnosis display, use the ◄ key to move between high and low byte. Parameter ID274 (P4.000) FaultRecordN displays the most recent fault. It is not read-only and can be set to 0 to reset all fault records.

Parameters ID275…ID278 (P4.001 …P4.004) are read-only.



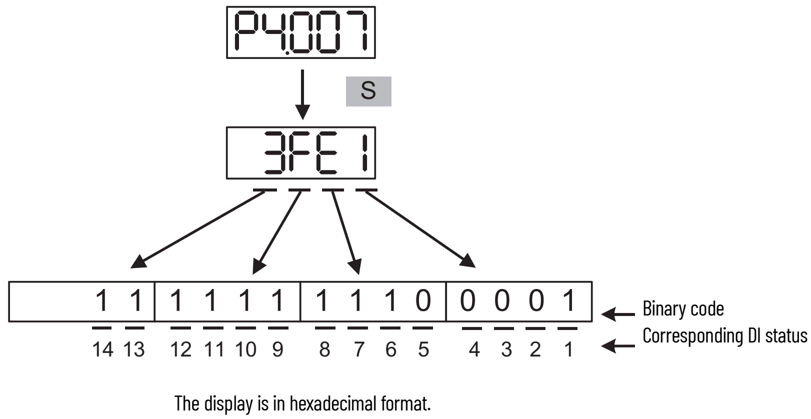

## Diagnosis Parameters via Keypad

You can use the keypad to display the status of digital inputs and outputs.

### *Digital Input Diagnosis Operation*

When external output signal triggers DI1…DI10, the display shows the corresponding signal by bit. When the bit is equal to 1, the DI is on.

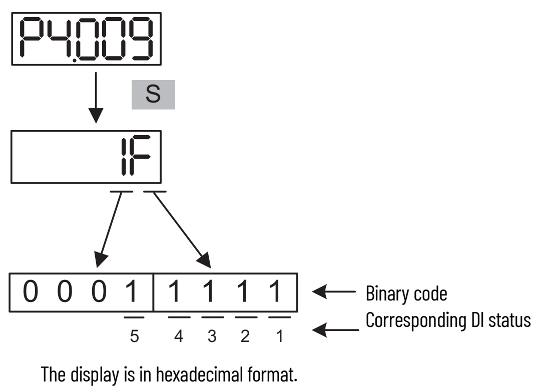
For example, if hexadecimal number 3FE1 is displayed, the binary equivalent for E is 1110, then DI6…DI8 are on.




*Digital Output Diagnosis Operation*

The output signal DO1…DO5 are triggered and the corresponding signals are shown on the display by bit. When 1 is displayed, the DO is on.

For example, if hexadecimal number 1F, is displayed, the binary equivalent for F is 1111, then DO1…DO4 are on.




## Display Firmware Upgrade Information

See Upgrade Kinetix 5100 Drive Firmware on page 467.

# Configure the Drive with KNX5100C Software



## Before You Begin

This section provides instructions to download and install KNX5100C configuration software. It also provides procedures to launch KNX5100C and configure your Kinetix® 5100 drive system with a Micro800™ controller by using the Connected Components Workbench™ software.

For help using the Connected Components Workbench as it applies to configuring the Micro800 controllers, see Additional Resources on page 8.

The Connected Components Workbench application, version 11.00 or later, makes it possible to launch KNX5100C Configuration Tool and to configure a Kinetix 5100 drive.

These procedures assume that you have wired your Kinetix 5100 drive system.

KNX5100C software is required for all applications. It is used to commission, configure, and possibly program the Kinetix 5100 drive.

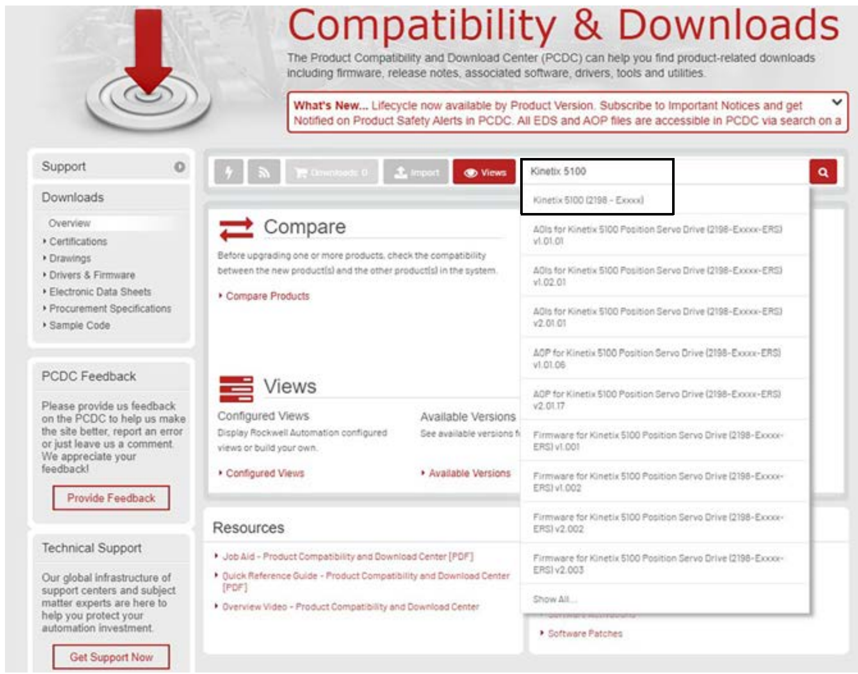
## Download KNX5100C Software

KNX5100C configuration software is available for download at the Product Compatibility Download Center (PCDC) website:
https://compatibility.rockwellautomation.com/Pages/home.aspx
and search Kinetix 5100.

To download the KNX5100C configuration software, perform the following steps.

1. Go to the Product Compatibility Download Center website.

   The Compatibility and Downloads webpage appears.
2. In the Search PCDC window, enter Kinetix 5100.



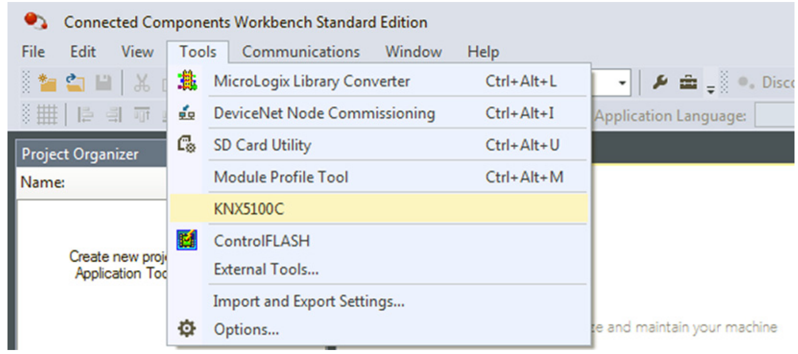

3. Click the appropriate software version and follow prompts to download.
4. Extract the zip file and run Setup.

### Launch KNX5100C Configuration Tool

To launch the KNX5100C configuration tool, perform the following steps.

1. Use one of two methods to launch the KNX5100C software:
   a. On your personal computer desktop, double-click the KNX5100C shortcut icon.

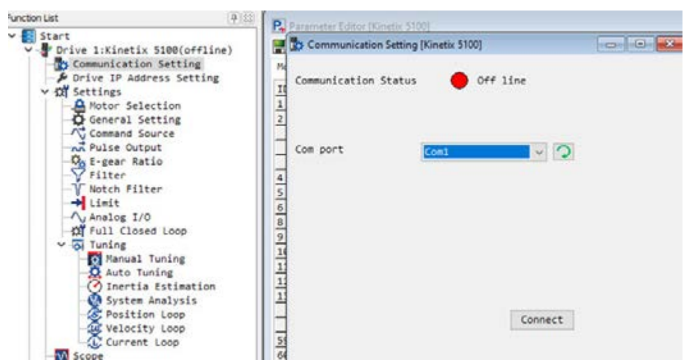
b. If you have Connected Components Workbench software installed, open it and select Tools > KNX5100C.




When the KNX5100C software is launched, it starts with a new project. If you create a New Project, you can choose to add a New Device. When you click Add, the drive is automatically created. If you cancel the New Project prompt, you can open an existing file.

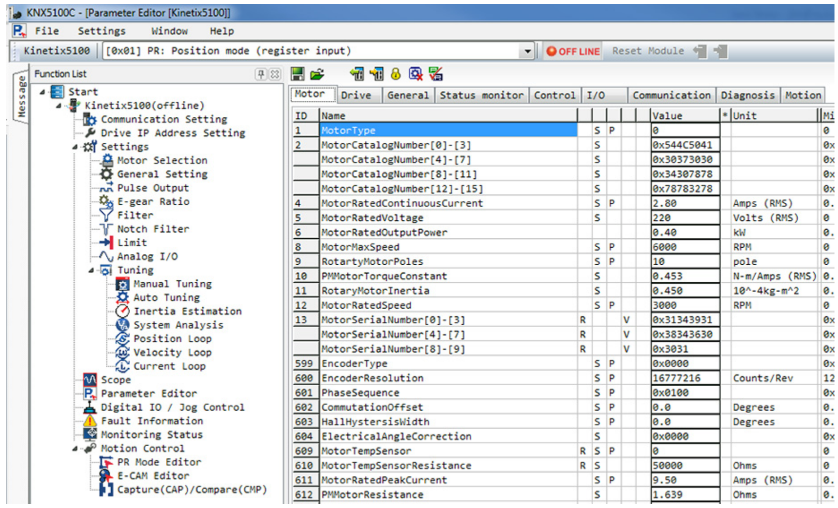

2. Choose the COM port associated with your drive.

If you are connected to your drive, click the Com port pull-down menu and select a COM port. In some cases, the mini-USB cable has to be removed and reinserted to refresh the COM port state.



3. Click Add to add your drive to the Function List.

   By default, Kinetix 5100 is used as the device name.



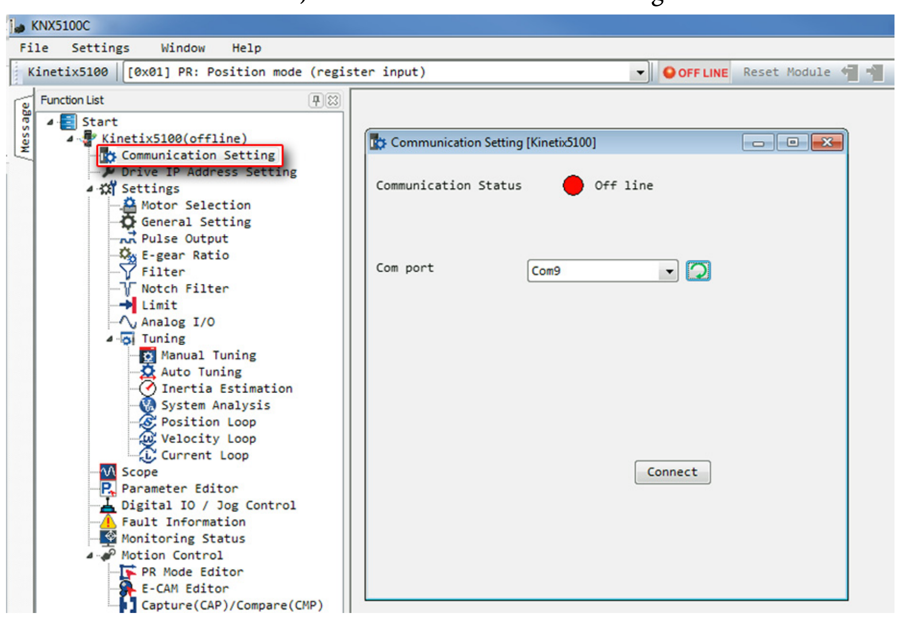

To add more drives that are connected your computer, from the File menu, choose Add New Drive or right-click Start/Add Device in the Function List.

## Connect to the Drive/Set Your COM Port

You can change the COM port associated with your drive if it has changed after initial configuration. In some cases, the mini-USB cable has to be removed and re-inserted to refresh the COM port state.

To change the COM port, perform the following steps.

1. From the Function List, click Communication Setting.

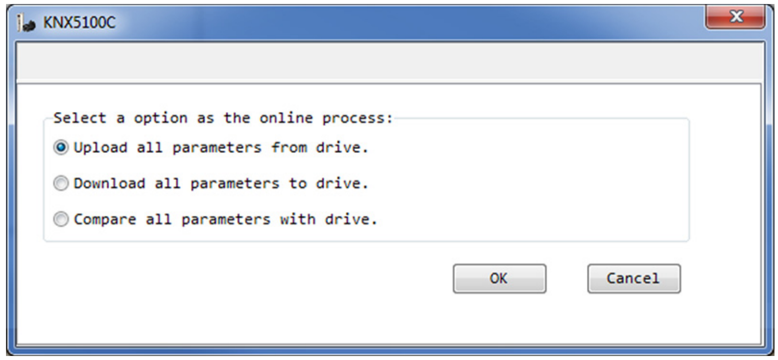



2. Choose the COM port associated with your drive.

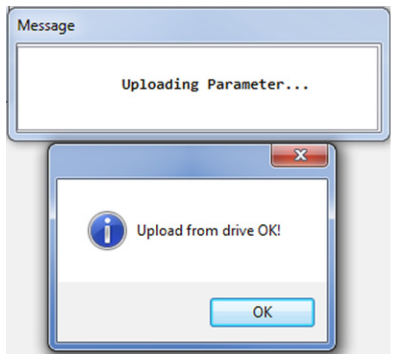
You can choose the COM port from the pull-down menu, or click [refresh icon] to refresh the COM port.

3. Click Connect to connect your drive.

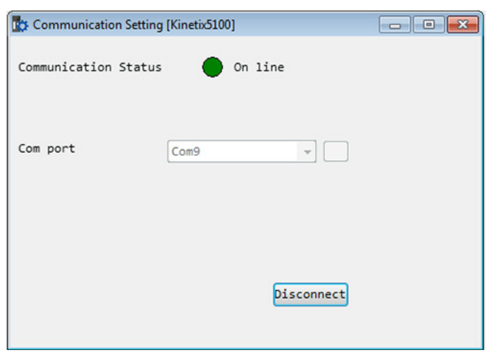
   The online process options dialog appears.




4. From the three options, choose the one that is best suited as your online process, and then click OK.
5. If you select the first option, an uploading message box appears until the process is completed.

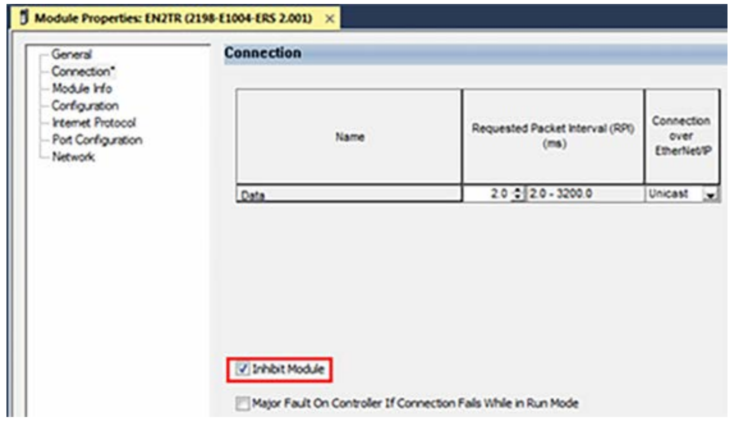



6. In the Communication Setting dialog, communication status is shown as online.



## Configure Drive Settings

If an I/O connection is established with a controller, the KNX5100C software is then set in 'read-only' mode and configuration changes are not permitted. In this situation, you can exit the I/O connection by checking 'Inhibit Module' on the AOP 'Connection' page or when you disconnect the network cable from the drive.

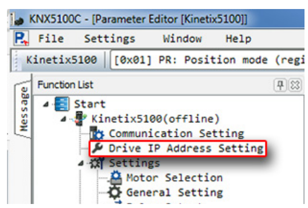



## Set the IP Address

You can change the IP address (network) setting through the Function List.

To change the IP address, perform the following steps.

1. Under the Function List, click Drive IP Address Setting.




2. Choose between STATIC IP and DHCP.

   See Configure IP Address by Using BOOTP-DHCP Tool on page 109

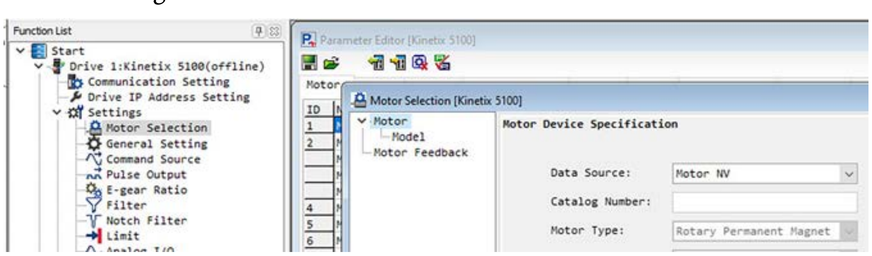
   If Static IP, then configure the IP address, Gateway, and Subnet mask.

| | |
|---|---|
| **IMPORTANT** | Settings are stored in nonvolatile memory, and changes to the IP address take effect after power is cycled. |

For more information on setting the network parameters, refer to Chapter 5, Set Up EtherNet/IP Communication.

## Configure the Motor Selection in KNX5100C Software

In the KNX5100C software, navigate to Function List > Settings > Motor Selection. There are three data sources available to configure the motor/actuator through the Function List.



The parameters displayed in the Motor Selection dialog box depend on the data source and the type of motor selected.

You can specify the motor data source and configure the related parameter value via the motor pages according to data source and motor type.

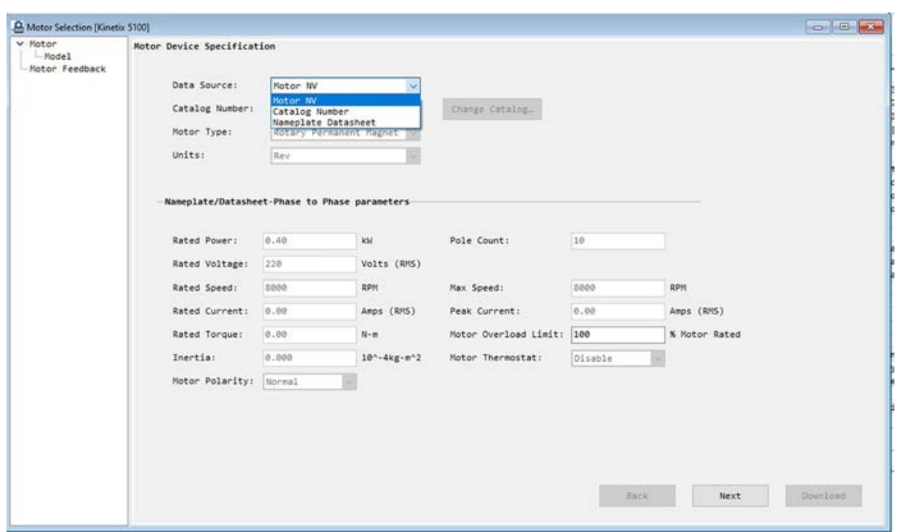
## Data Source

You can specify the data source where the motor feedback values originate.

The available data sources are:

- Motor NV: Motor parameter values come from the nonvolatile memory of a motor. When the motor has an intelligent feedback device, the drive is able to identify the motor when using NV parameters from the feedback device.
- Catalog number: Motor parameter values come from the selected catalog number. Select the motor from a pull-down menu where the motor database is embedded into the KNX5100C software.
- Nameplate datasheet: Motor parameter values come from a motor nameplate and datasheet. You must input the motor nameplate data manually.

| | |
|---|---|
| **IMPORTANT** | When the nameplate datasheet is selected, the parameter field of nameplate/datasheet parameter section of the Motor, Model, and Motor Feedback pages are visible, and you can enter these values.<br>If a data source other than Nameplate datasheet is selected, the parameter field of nameplate/datasheet parameter section of the Motor, Model, and Motor Feedback pages are dimmed and the motor parameters values are read either from the intelligent encoder or the KNX5100C software motor database.<br>The Motor Overload Limit parameter is not dimmed and can be modified, see Motor NV on page 130.<br>When the data source is Catalog Number and a Kinetix LDC or Kinetix LDL motor is selected, you must manually enter the parameters in the Motor Feedback dialog box. |



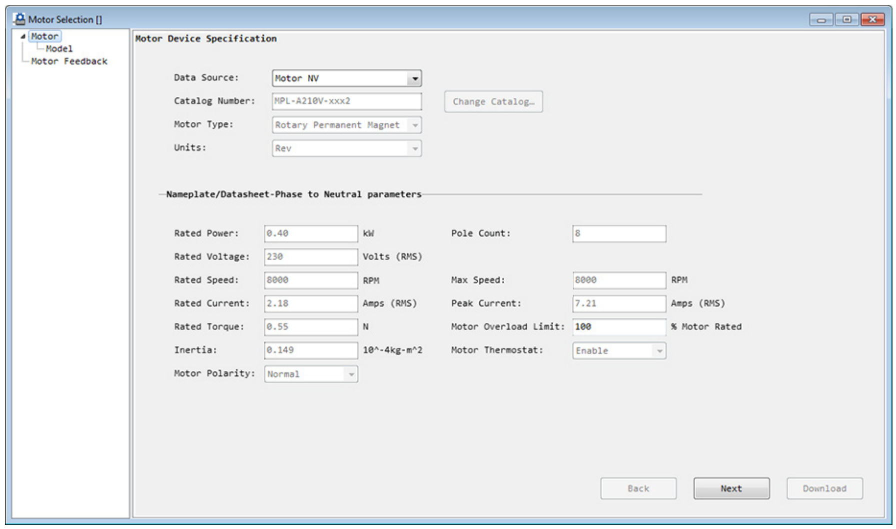
*Motor NV*

When Motor NV is selected as the data source and the attached motor has a intelligent encoder with internal memory, the drive can identify the motor automatically and read all motor parameter values.

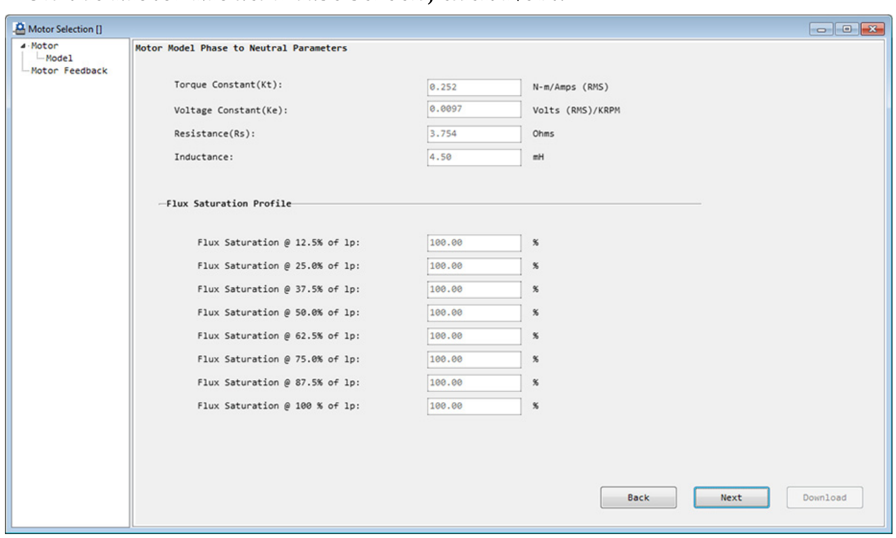
If the attached motor does not have a intelligent encoder when Motor NV is selected, then fault E 60B, Motor Selection Error, occurs. If the attached motor has a Nikon encoder that is not a intelligent encoder and no motor parameters are stored, then fault E 004, Motor Combination Error, occurs.

When Motor NV is selected as the data source, then all parameter data is dimmed on the Motor Device Specification dialog box except for the Motor Overload Limit field and the Next button.

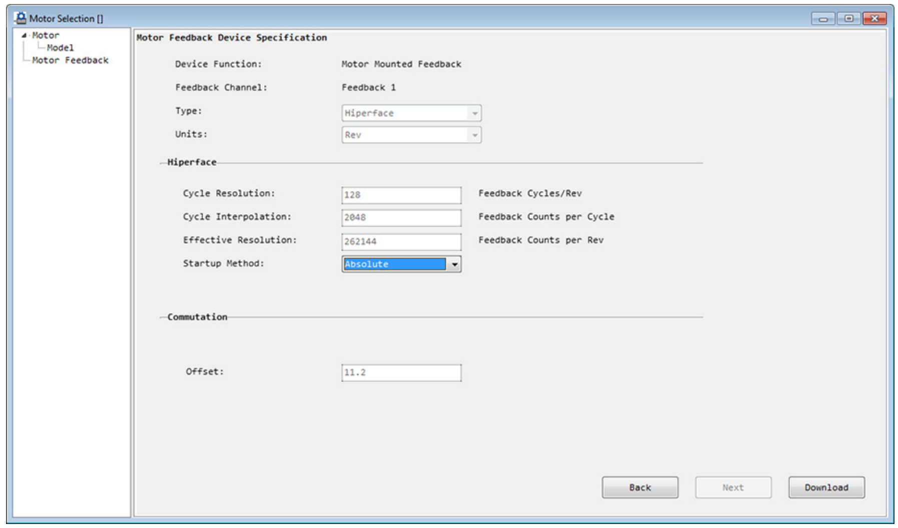
1. Type an appropriate Motor Overload Limit and click Next.



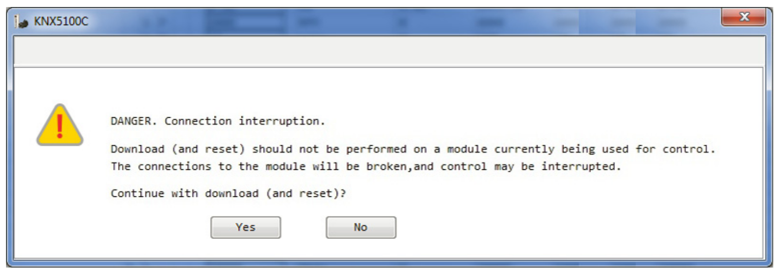

2. On the Motor Model Phase screen, click Next.



3. On the Motor Feedback Device screen, click Download to download all parameters to the drive.




The following screen notifies you that the drive requires a reset and power cycle.



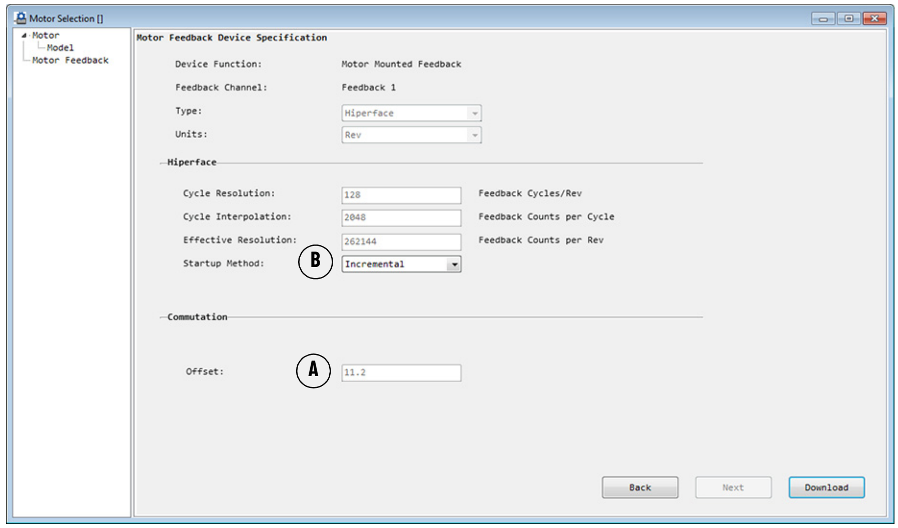

After you click Yes, the drive performs the following sequence:

- Sets ID628 (PN.000) MotorDataSource to 0 (Motor NV selection)
- Sets the value of ID629 (PN.001) MotorOverloadLimit
- Automatically triggers a drive reset and power cycle

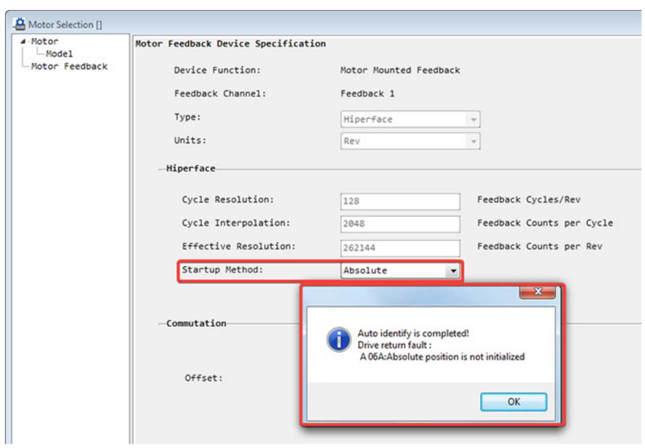
After the reset and power cycle, the identified motor catalog number is shown in the motor page, and the motor related parameters are updated according to encoder internal memory.

With Motor NV selected and the drive is power cycled, these other changes are made:

- Commutation alignment is fixed as Motor offset (A in the next figure)
- The default Startup Method is set as Incremental (B in the next figure)
- The position feedback is zero




If your application requires absolute positioning, you can change the startup method to Absolute from the pull-down menu. If you do, click Download to initiate the change. Then AbsoluteSystemSetting parameter ID242 (P2.069) is set to 1 and the drive automatically triggers a power cycle. Warning A 06A (Absolute position is not initialized) occurs after the power cycle, so you must initialize the absolute position (using a Homing Command) to clear this fault to let the absolute operation start.




| | |
|---|---|
| **IMPORTANT** | If the startup method is Absolute and the TLP motor is configured, a battery must be used to establish absolute positioning; regardless of single or multi-turn operation. See Table 36 on page 67 for battery specifications. |

**IMPORTANT** If the startup method is set to Absolute but the attached motor is not equipped with an appropriate encoder or is not configured correctly, then the following faults are posted:

| | Kinetix MP Motor-related Faults | | |
|---|---|---|---|
| | Single Turn (-E, -S) | Multi-turn (-V, -M) | Incremental (-H) |
| Change startup method to Absolute | E 069 | A 06A | E 069 |

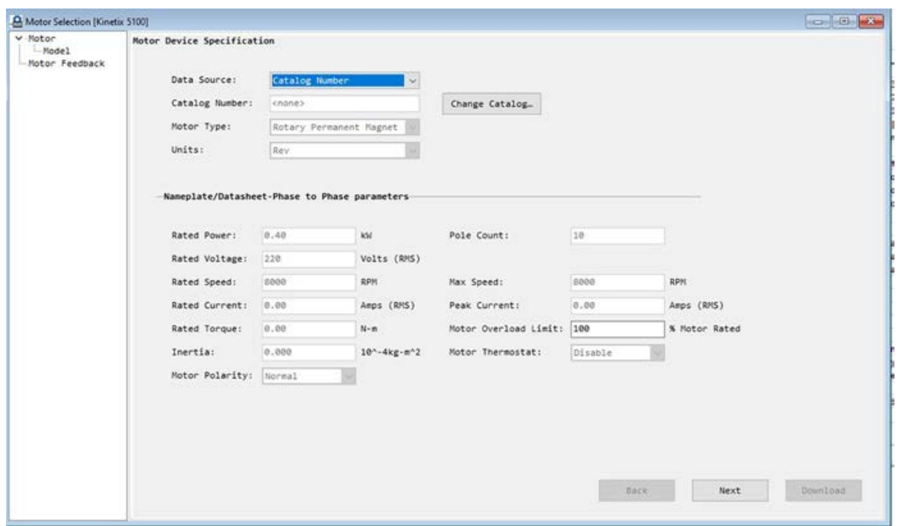
| | Kinetix TLP and TL/TLY (-B) Motor-related Faults | |
|---|---|---|
| | Without Battery | With Battery |
| Change startup method to Absolute | A 060 | A 06A |

*Catalog Number*

When the catalog number is selected as the data source, you must select the appropriate motor from the Change Catalog Number dialog box.

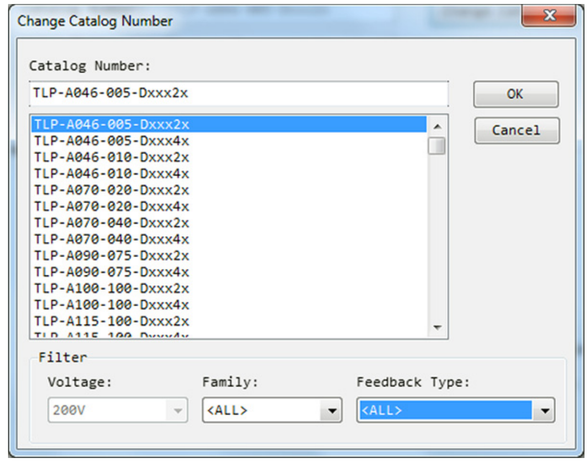
To change the catalog number, perform the following steps.

1. Choose Function List > Settings > Motor Selection, and select Catalog Number from the Data Source pull-down menu.




2. Click Change Catalog...

3. In the Change Catalog Number dialog box, find and select the motor for your application.




Catalog number availability is from the motor database embedded into the KNX5100C software. By using the catalog number, the drive can validate that the correct motor is connected.

Use the Family and Feedback Type pull-down menus to further filter the related motors.

4. Click OK to select that catalog number and to close the Change Catalog Number dialog box.

   When you click OK, all motor parameter values for that catalog number are retrieved from the KNX5100C software motor database.

5. From the Motor Device Specification dialog box, click Download.
6. Drive power is automatically cycled.

   When power is restored to the drive, all motor parameter values for the selected catalog number are downloaded to the drive and take effect.

| | |
|---|---|
| **IMPORTANT** | If your motor has an intelligent encoder and you select the wrong catalog number, an E 60A (Catalog Number Match Error) fault occurs at the drive. |

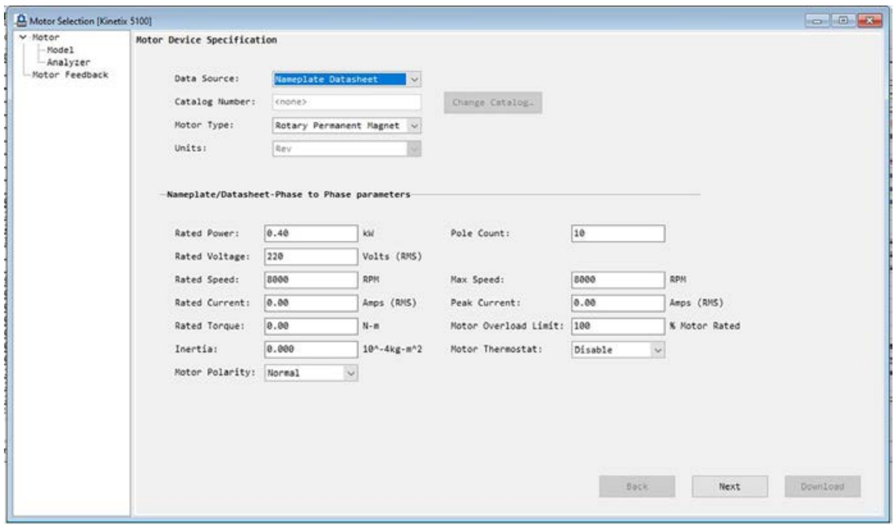
### *Nameplate Datasheet*

Motor parameter values are from a motor nameplate and datasheet. You must input this data manually on the Motor and Model pages.

To select Nameplate datasheet as your data source, perform the following steps.

1. Choose Function List>Settings>Motor Selection>Motor Device Specification, and select Nameplate Datasheet from the Data Source pull-down menu.

   Motor types available for selection are the following: Rotary permanent magnet, linear permanent magnet, and induction motors.




2. After you add data manually to the fields under the Nameplate/ Datasheet-Phase to Phase Parameters section, click Next.
3. From the Motor Model Phase to Neutral Parameters dialog box, add data manually.

   When you are done, click Next.

4. From the Motor Feedback Device Specification dialog box, select applicable feedback type from the Type pull-down menu.

| Motor Type | Feedback Type |
|---|---|
| Rotary Permanent Magnet and Linear Permanent Magnet | Digital AqB<br>Digital AqB with UVW<br>Hiperface<br>Sine/Cosine |
| Induction Motor | Digital AqB |

5. Click Download.

   After the motor parameters are downloaded, you can use the motor analyzer feature, where the drive analyzes the motor and provides suggested parameter values.

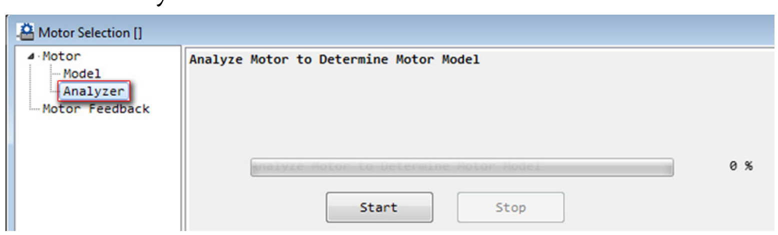
   - Motor Analyzer - Rotary Motors and Linear Motors on page 136
   - Dynamic Motor Analyzer - Induction Motors on page 137
   - Static Motor Analyzer - Induction Motors on page 138
   - Inertia Estimation Motor Analyzer - Induction Motors on page 139

If you click Accept, drive power is automatically cycled. When power is restored to the drive, all motor parameter values that you added manually are downloaded to the drive and take effect.

### *Motor Analyzer - Rotary Motors and Linear Motors*

Depending on the motor type you choose, the motor analyzer test is visible. To use the motor analyzer feature for rotary and linear motors, perform the following steps.

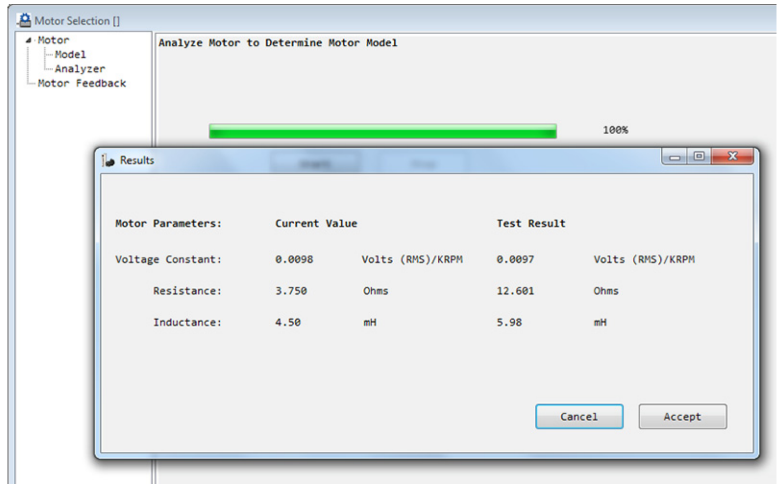
1. Select Motor > Analyzer.




2. Click Start to initiate the analyze process.
3. After each step of the analyzing process is completed, a confirmation window appears; click OK.

   A results window appears with suggested parameter values.

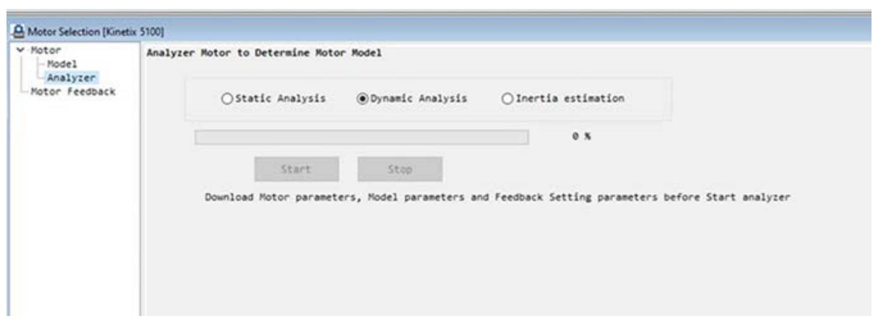
4. Click Accept if you want to use those values, or click Cancel if you want to stay with the parameters that you added manually.




### *Dynamic Motor Analyzer - Induction Motors*

The dynamic motor test generates motion, be sure your motor is un-coupled to perform this test. To use the motor analyzer feature for induction motors, perform the following steps.

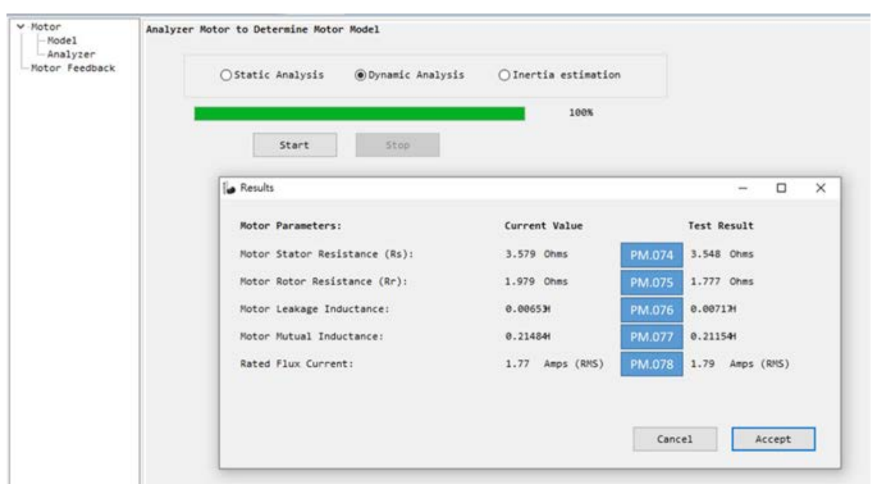
1. Select Motor > Analyzer.
2. Select Dynamic Analysis and click Start to initiate the analysis.




3. After each step of the analyzing process is completed, a confirmation window appears; click OK.

   A results window appears with suggested parameter values.

4. Click Accept if you want to use those values, or click Cancel if you want to stay with the parameters that you added manually.



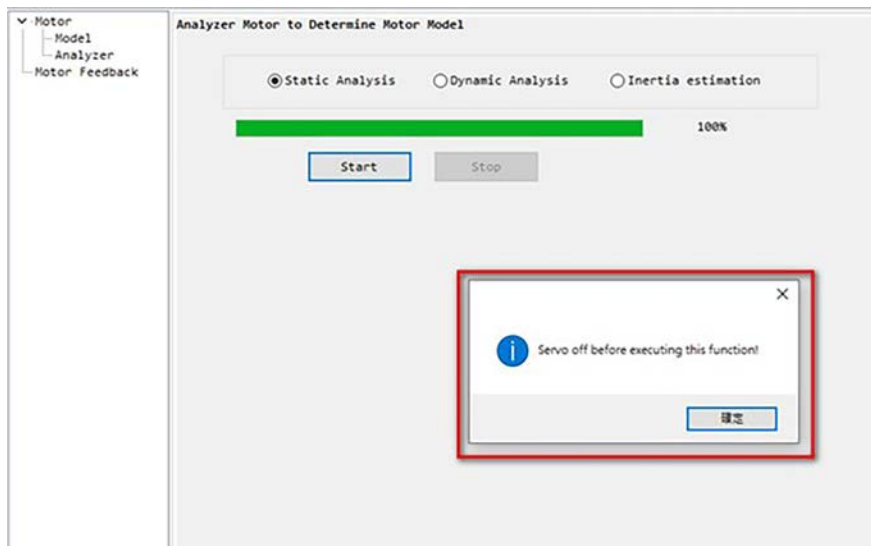
*Static Motor Analyzer - Induction Motors*

The static motor test does not generate motion. If Dynamic Analysis is not possible for your system, select Static Analysis. To use the motor analyzer feature for induction motors, perform the following steps.

1. Select Motor > Analyzer.
2. Select Static Analysis and click Start to initiate the analysis.

| | |
|---|---|
| **IMPORTANT** | For Static Analysis, the test results (using an induction motor) are affected by the value of the flux current parameter. If you cannot use Dynamic Analysis to analyze (for example, due to mechanical restrictions), we recommend that you set the value of rated flux current to 40% of motor rated current to execute Static Analysis analysis. The allowable setting range for rated flux current is 10…100% of rated motor current. |

| | |
|---|---|
| **IMPORTANT** | If the drive is in the servo-on status before executing the Static Analysis function, after you click Start, the KNX5100C software displays a notification 'Servo off before executing this function' message. |




3. After each step of the analyzing process is completed, a confirmation window appears; click OK.

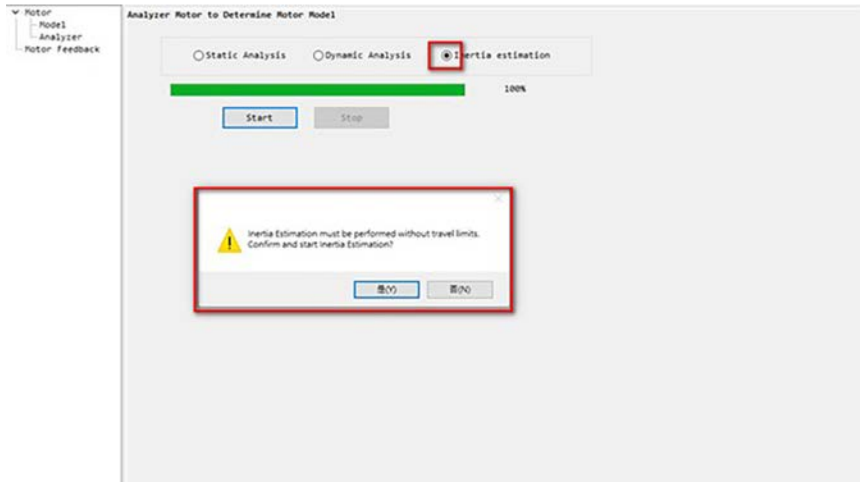
   A results window appears with suggested parameter values.
4. Click Accept if you want to use those values, or click Cancel if you want to stay with the parameters that you added manually.

### *Inertia Estimation Motor Analyzer - Induction Motors*

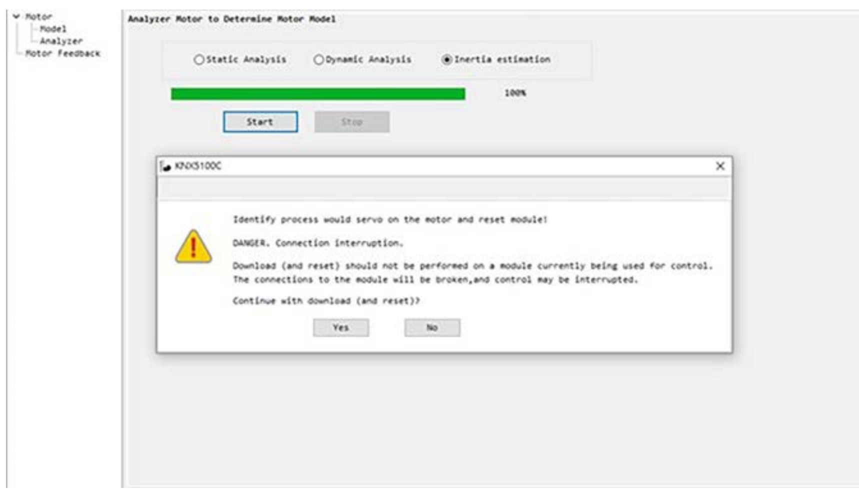
To use the Inertia Estimation feature for induction motors, perform the following steps.

1. Select Motor > Analyzer.
2. Select Inertia Estimation and click Start to initiate the analysis.

   A confirmation dialog box displays.

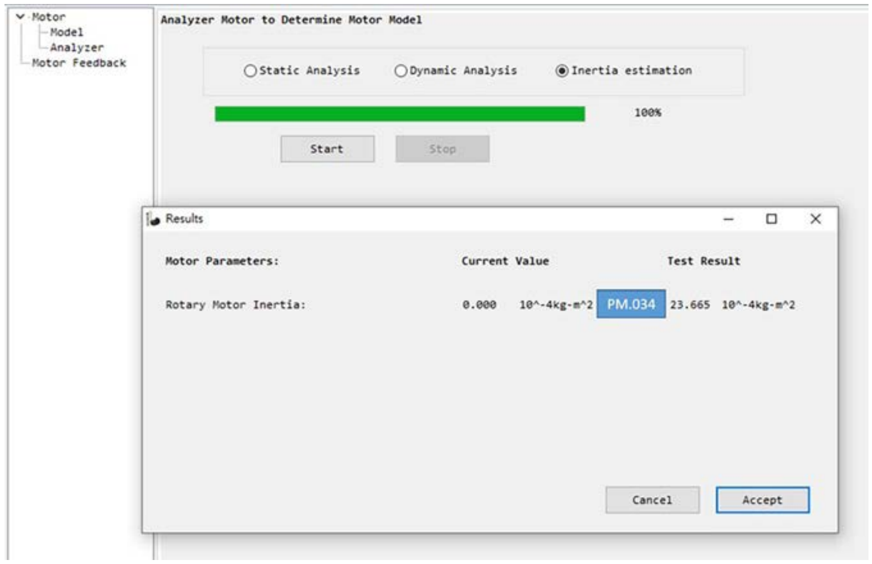



3. Click Yes and a dialog box appears indicating that the drive will perform servo-on to execute dynamic analysis.




   A results window appears with suggested parameter values.

4. Click Accept if you want to use those values, or click Cancel if you want to stay with the parameters that you added manually.



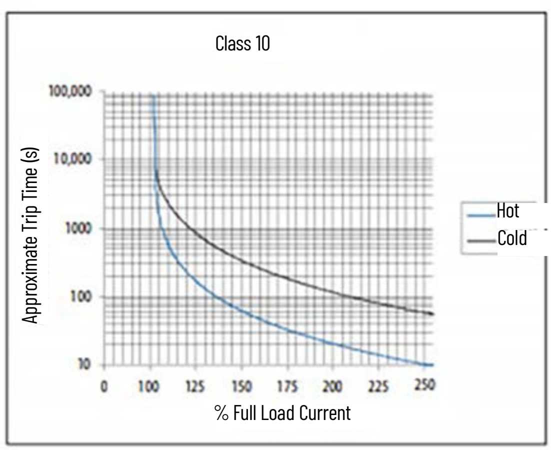

## Selection of Motor Thermal Models

The Kinetix 5100 drives contain two motor thermal-overload protection algorithms that are used to prevent the motor from overheating.

*Generic Motors*

The default thermal model is a generic I2 T Class 10 overload protection algorithm. This model is active if the MotorWindingToAmbientResistance ID635 (PN.007) or the MotorWindingToAmbientCapacitance ID636 (PN.008) values are 0.0. The purpose of this algorithm is to limit the time a motor is operating with excessive levels of current.

**Figure 77 - Motor Overload Curve**




The relationship between Motor Overload Factory Limit trip-time and motor output current is shown in Figure 77. Hot vs cold is determined by applying a 1st order filter, with a 20 minute time constant, to the output current. The hot curve corresponds to a filtered output current of 100% or greater rated current. The cold curve corresponds to a filter output current of 0%.

You can use the MotorOverloadLimit ID629 (PN.001) attribute (default of 100%, max of 200%) to increase the motor overload trip-time by artificially increasing the motor rated current (for thermal protection only). Increase MotorOverloadLimit above 100% only if cooling options are applied. Increasing MotorOverloadLimit causes MotorCapacity ID656 (PN.038) to increase more slowly. The generic motor thermal model also derates the motor rated current (for thermal protection only) when operating at low speeds. The derating factor is 30% at 0 Hz and 0% at 20 Hz, with linear interpolation between. Operating at output frequencies less than 20 Hz causes MotorCapacity to increase more quickly. When the generic motor thermal-model is active, the MotorCapacity attribute increases only if the motor output current is greater than the effective motor rated current (taking into account the MotorOverloadLimit and low speed derating factor). The default MotorThermalOverloadFactoryLimit and MotorThermalOverloadUserLimit values for this thermal model are both 100%.

| | |
|---|---|
| **IMPORTANT** | The generic motor-thermal model does not support Current Foldback as a Motor Overload Action. |

*Thermally Characterized Motors*

If the ID635 (PN.007) MotorWindingToAmbientResistance and MotorWindingToAmbientCapacitance ID636 (PN.008) attribute values are both non-zero, the motor is considered thermally characterized and an alternate motor thermal model is run. The purpose of this algorithm is to limit the time a motor is operating with excessive levels of current. This thermal model uses the firstorder time constant determined from the MotorWindingToAmbientResistance and MotorWindingToAmbientCapacitance values to estimate the motor thermal capacity based on the motor output current. The MotorOverloadLimit ID629 (PN.001) attribute (default of 100%, max of 200%) can be used to increase the motor overload trip-time by increasing the MotorThermalOverloadFactoryLimit value. The MotorOverloadLimit should be increased above 100% only if cooling options are applied. Increasing MotorOverloadLimit does not change the behavior of MotorCapacity ID656 (PN.038). This thermal model supports setting the MotorOverloadAction attribute as Current Foldback. Selecting the Current Foldback action results in a reduction in the current reference via the MotorThermalCurrentLimit attribute value that is reduced in proportion the percentage difference between the MotorCapacity and the MotorOverloadLimit values. When this thermal model is active, the MotorCapacity attribute is non-zero if the motor output current is non-zero. The default MotorThermalOverloadFactoryLimit and MotorThermalOverloadUserLimit values for this thermal model are both 110%.

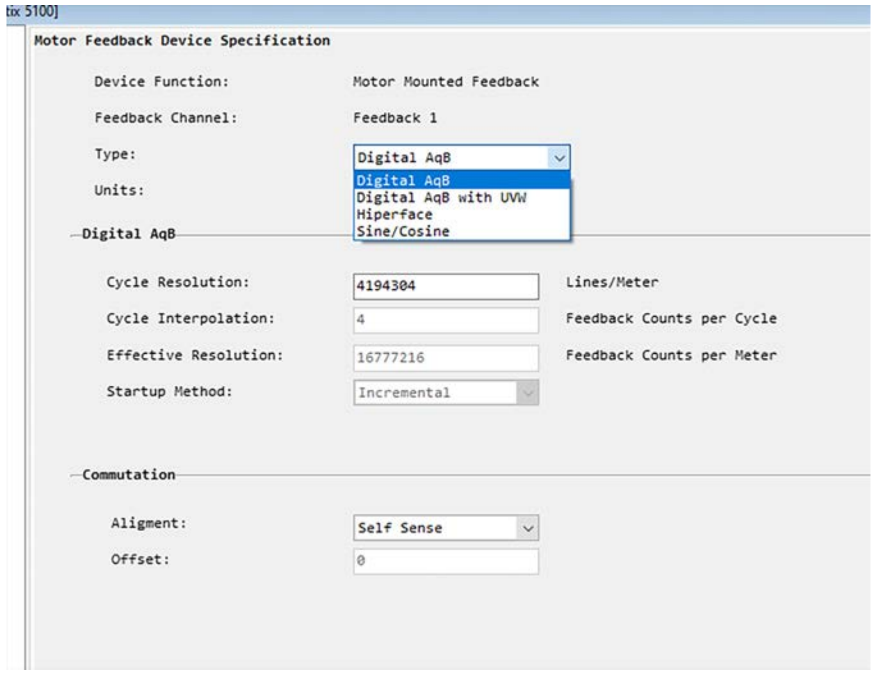
| | |
|---|---|
| **IMPORTANT** | This thermal model does not derate the motor-rated current when operating at low speeds. Operating at low output frequencies does not cause the MotorCapacity behavior to change. |

## Motor Feedback

With some motor type selections, the feedback type is automatically selected for the corresponding motor. For others, the selection can be changed.

| | |
|---|---|
| **IMPORTANT** | If you select Digital AqB when the attached motor has a Hall sensor, the drive ignores the Hall sensor. |

**Figure 78 - Supported Motor Feedback**

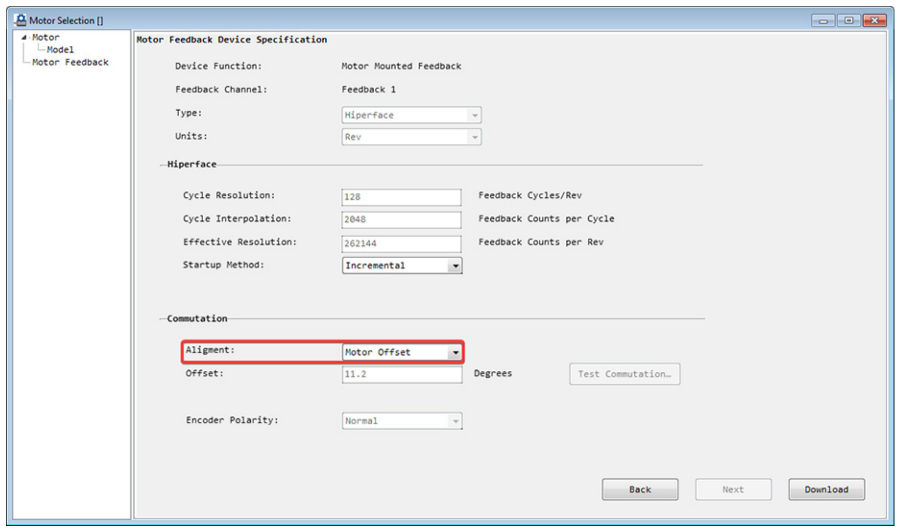


To choose a motor feedback type, perform the following steps.

1. Under Motor, select Motor Feedback.
2. On Motor Feedback Device Specification, choose either Incremental or Absolute as the startup method.

> The chosen startup method determines how the device applies the feedback count value during drive startup.
>
> For Incremental, the drive uses zero for the feedback count accumulator at drive startup.
>
> For Absolute, the drive uses the absolute feedback position value from the encoder at startup.

**IMPORTANT** Kinetix 5100 drives support only incremental feedback on Kinetix LDAT motors.




3. Under Commutation, choose one of the following from the Alignment pull-down menu.
   - Motor Offset: This setting is the default if the selected catalog number has an intelligent encoder. The drive reads the internal commutation offset saved in the intelligent encoder.
   - Self-sense: This setting enables automatic magnetic field detection, where the commutation offset is detected automatically from the drive whenever the drive is powered up.

> Any commutation offset that is detected by self-sense alignment is not shown in the Offset field on Motor Feedback Device Specification.
>
> Self-sense alignment cannot read commutation offset from CommutationOffset parameter ID602 (PM.007).

   - Drive Offset: You must input the commutation offset and encoder polarity manually.

### *Considerations for Drive Offset Alignment*

If you select Drive Offset as the Commutation Alignment type, the valid range of the Commutation Offset is calculated based on the Commutation Offset from the encoder's internal value (x):

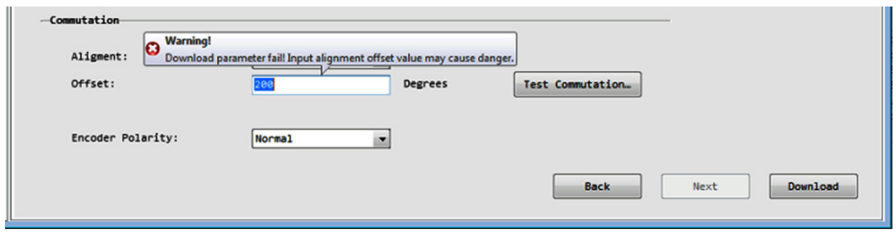
x-85 < Commutation Offset setting < x+85 (unit: degree)

*For example:*
By using the KNX5100C software, choose Start>Parameter Editor>Motor>CommutationOffset (ID 602, (PM.007)).

With Motor Offset selected as the commutation alignment, the parameter ID602 (PM.007) CommutationOffset is 11.2°.

Therefore, the Commutation Offset setting for the Drive Offset type must be in the range of 0…96.2° and 286.2…360°.

If you click Download and the input value of 200 exceeds the range, the following warning appears.




You must change the input value before you can click Download again and have the input value accepted.

## Run a Commutation Test

The commutation test determines an unknown commutation offset and can also be used to determine (or verify) the polarity of the start-up commutation wiring.

You can choose to keep or discard the test results.

| | |
|---|---|
| **IMPORTANT** | This test mainly applies to third-party or custom permanent-magnet motors equipped with (TTL with Hall) incremental encoders that are not available as a catalog number in the Motion Database.<br>This test also applies to Kinetix MP and Kinetix TLP motors that are available as a catalog number in the Motion Database, and use to verify a known commutation offset or use the test result other than the commutation offset specified in the motion Database. |

The following parameters are updated after commutation test:

- Phase Sequence ID601 (PM.006)
- Commutation Offset ID602 (PM.007)
- Hall Hysteresis Width ID603 (PM.008)

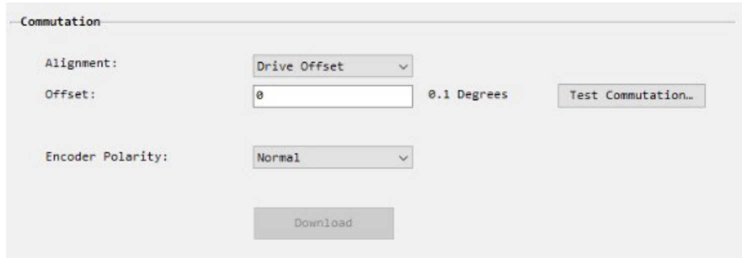
To test commutation, perform the following steps.

1. Uncouple the motor from the load.

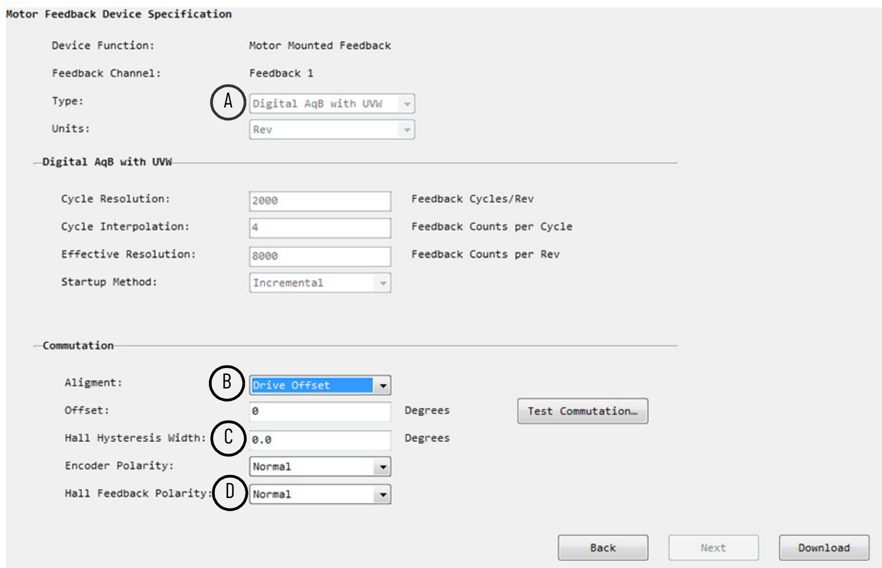
**ATTENTION:** To avoid personal injury or damage to equipment, you must uncouple the motor from each load you test as uncontrolled motion can occur if an axis with an integral motor brake is released during the test.

2. In the Alignment field, select Drive Offset.

   Different encoder types result in different configuration fields.

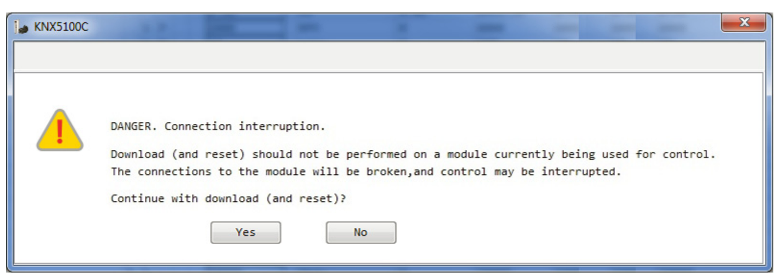



3. Type an offset.
4. If the attached motor feedback type is Digital AqB with UVW (A in the following figure) and the Commutation Alignment is Drive Offset (B), then you must add additional data to the Hall Hysteresis Width (C) and Hall Feedback Polarity (D) fields.




5. Click Test Commutation.

   After you click Test Commutation, the following message appears to alert you that this operation resets the drive.

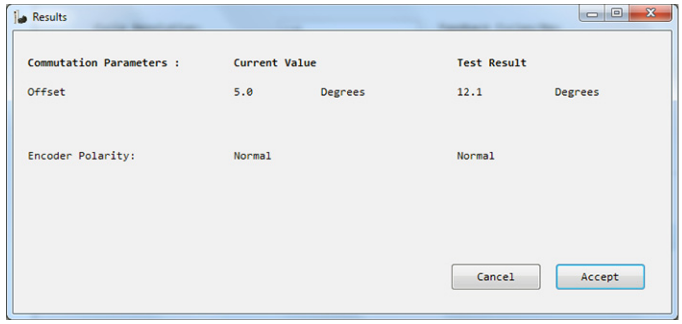



6. Click Yes.

   A message window alerts you that the process might take some time to complete.

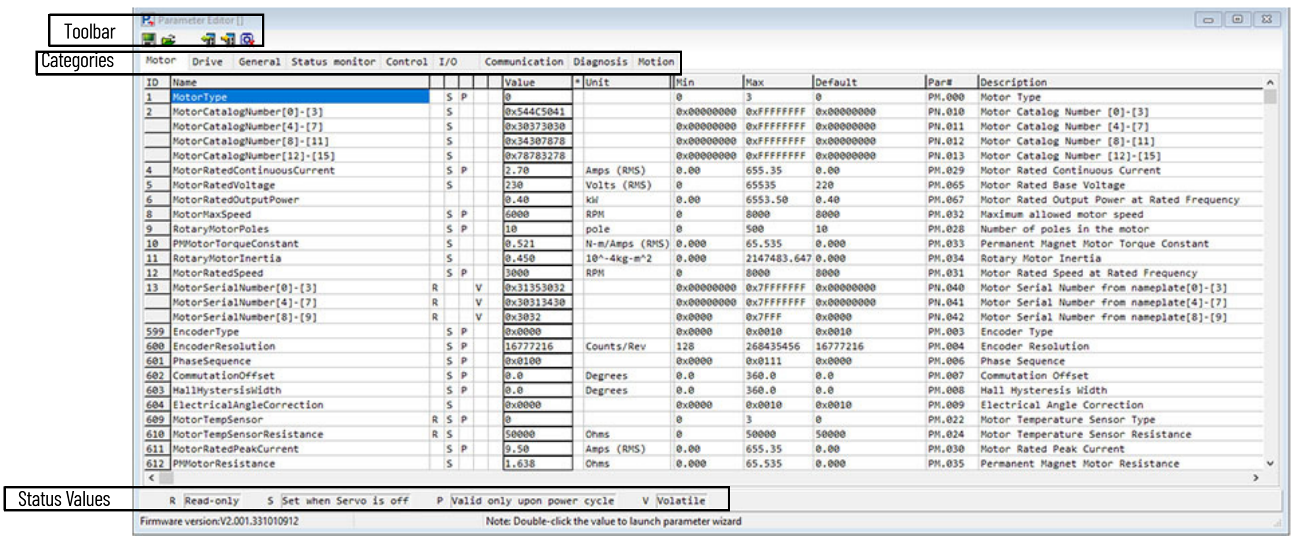
   When the process is complete, a results window appears with suggested parameter values.

7. Click Accept to use the test result values, or click Cancel to stay with the original parameter values.



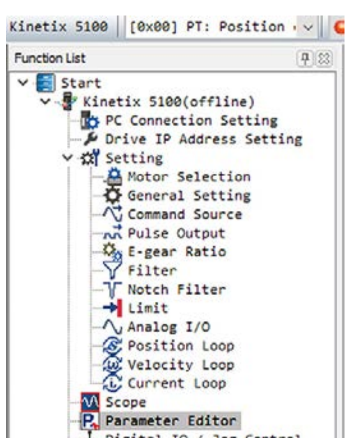

## Parameter Editor

You can read all Kinetix 5100 drive parameters of the servo drive and upload them to your personal computer by using KNX5100C software, choose Function List>Kinetix Drive>Parameter Editor. You can also use the Parameter Editor to view or modify all Kinetix 5100 drive parameters then download them to the servo drive.




The Parameter Editor consists of parameter categories (page 147), a toolbar (page 148), and a status indicator that includes the firmware version and other information.

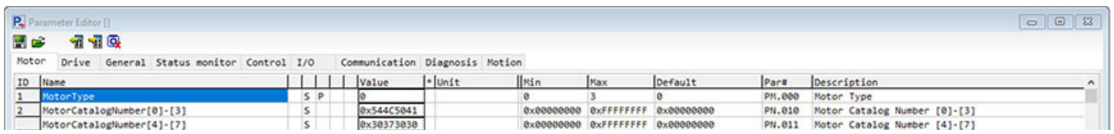
To access the Parameter Editor, select Start > Kinetix 5100 > Setting > Parameter Editor in the Function List.



All Kinetix 5100 drive parameters are divided into the following categories:

- Motor
- Drive
- General
- Status monitor
- Control
- I/O
- Communication
- Diagnosis
- Motion

Click each parameter group tab to toggle between tabs.




The following information is displayed for each parameter:

- ID
- Name - for example, MotorType
- Status - R (read only), S (set when servo disabled), P (requires a power cycle, V (volatile; reset on power cycle)
- Value - Click the box to the left of the parameter value to poll the drive for the latest value
- * - Indicates that a setting has changed
- Unit
- Min (value)
- Max (value)
- Default (value)
- Parameter Number
- Description

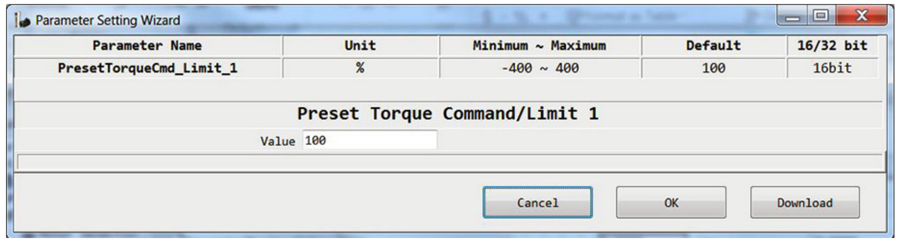
The Parameter Editor provides the status of the parameter:

- (R) Read-only
- (S) Value is set when servo power is off
- (P) Value is applied after a Power Cycle
- (V) Value is volatile (cleared once power is cycled)

The firmware version is also shown in this window.

## Parameter Wizard

Double-click a parameter value to open the parameter wizard, which provides a simple method to change parameter values.




## Parameter Toolbar

The toolbar at the top of Parameter Editor contains six icons.

The function of each icon is as follows.

### *Save Parameters File* 

All Kinetix 5100 parameters that are shown on the screen (which are those also saved to your personal computer) are saved as a *.par file.

### *Open Parameter File* 

All Kinetix 5100 parameter files (.par) on your personal computer can be opened and displayed.

### *Read Parameters* 

All Kinetix 5100 parameters are read.

### *Download Parameters* 

When online with the Kinetix 5100 drive, a dialog box lets you choose to download all the parameters or just the parameters that have been modified.

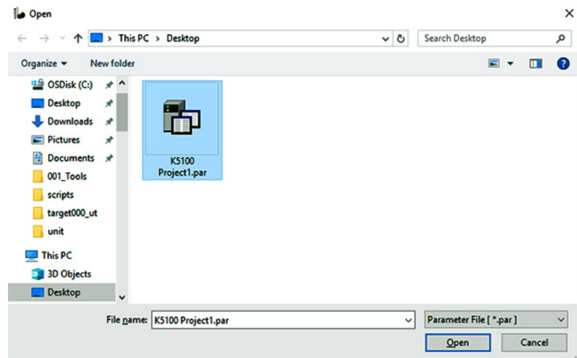
### *Stop Operation* 

This stops any operation in progress.

### *Compare Parameters*

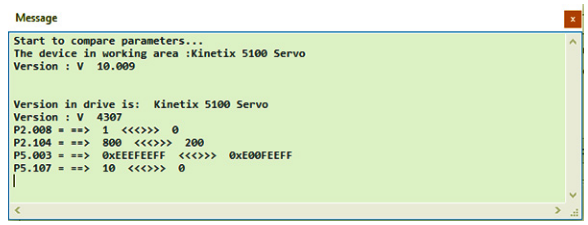
Use this function to compare the file you open with existing parameters.

1. On your personal computer, navigate to your target saved *.par file.




2. Select the file and click Open.

   A message appears that the comparison process has started.



## Choose an Operation Mode

There are three ways to change the operation mode in the KNX5100C software:

- By using the Operation Mode Selection List
- By using the Setting dialog box
- By using the Parameter Editor

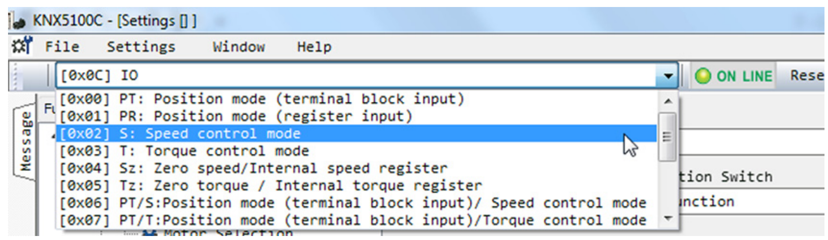
For detailed information on how the drive operates in each mode, see Chapter 10, Modes of Operation.

### Using the Operation Mode Selection List

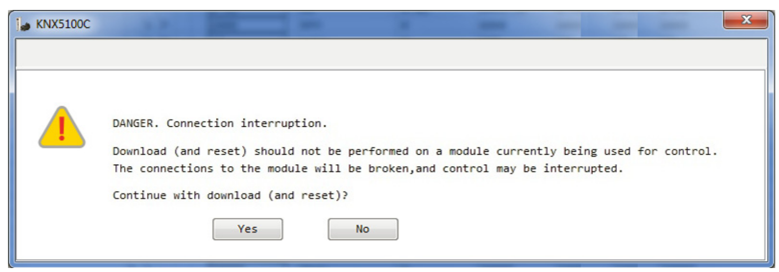
To select an operation mode, perform the following steps.

1. Use the pull-down menu to select an operating mode setting.

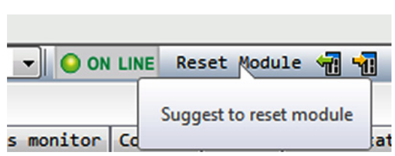
   The operating modes are critical to the usability of different features in the drive, to see which Operating Modes are available and their use, see Chapter 10.




   When you choose a new operation mode setting, the following message appears.




If you click Yes, the drive is reset. We recommend this choice.
If you click No, you are returned to the Settings view without a power cycle. However, a reminder appears until you initiate a power cycle.

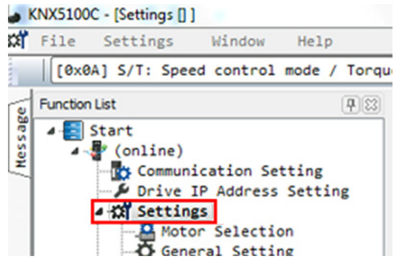



| | |
|---|---|
| **IMPORTANT** | ControlMode Parameter ID117 (P1.001) is valid only after power cycle. |

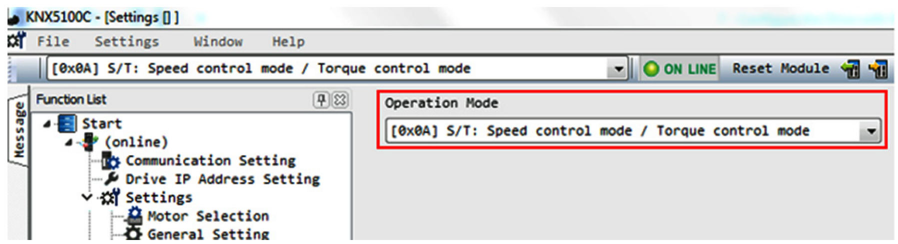
## Using the Setting Page

To change the operation mode setting, perform the following steps.

1. From the Function List, select Start > Kinetix 5100 > Settings.

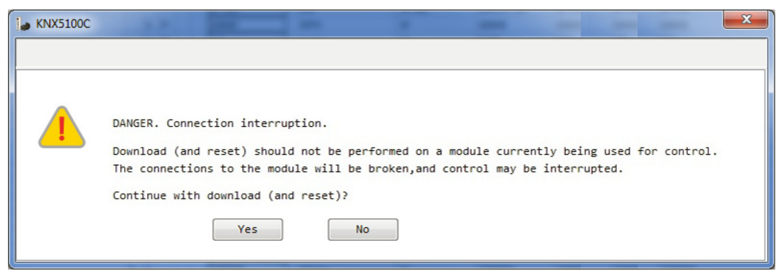



2. From the Operation Mode pull-down menu, select an operation mode.




3. Click .

   When you choose a new operation mode setting, the following message appears.



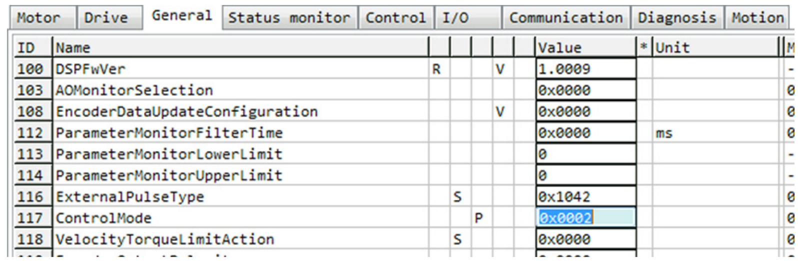

If you click Yes, the drive is reset.
If you click No, the original operation mode is used.

## Using the Parameter Editor

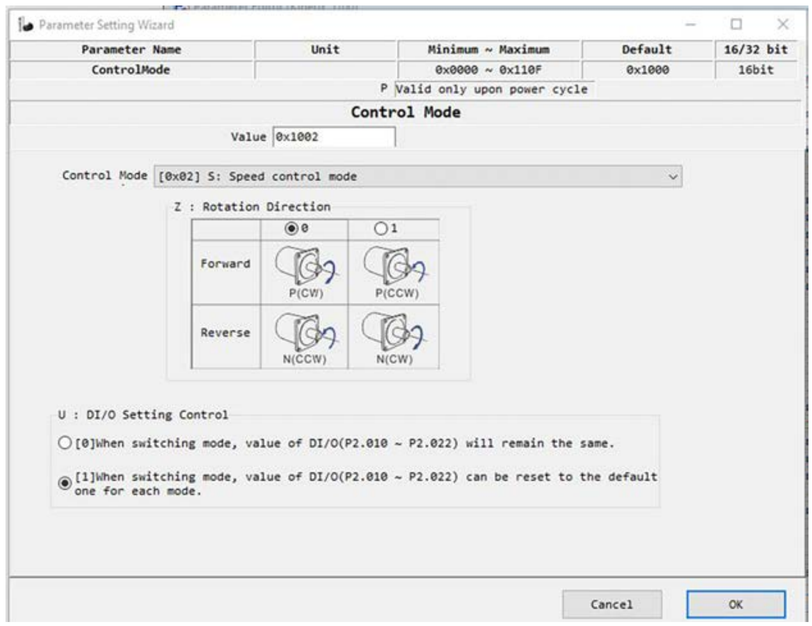
To change the control mode in the Parameter Editor, perform the following steps.

1. From Function List, select Start > Kinetix 5100 > Setting > Parameter Editor.

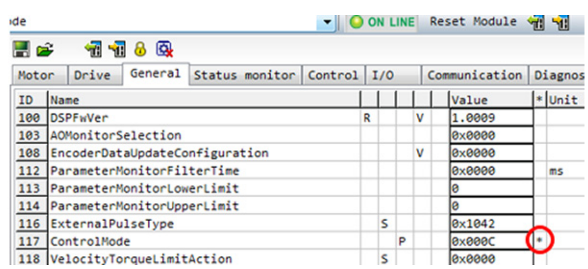
2. Change the ControlMode value by clicking directly in its value field and typing a new value.




- Another way to change the parameter is to double-click the value, which opens the ControlMode dialog box.



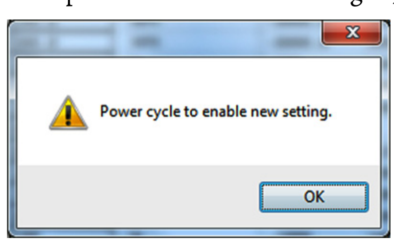

When the parameter value is changed and has not been downloaded to the drive, there will be a '*' mark next to the value field.




Click the box immediately to the left of the parameter to see the present value of the parameter in the drive. The drive is polled immediately and updates the Value field.

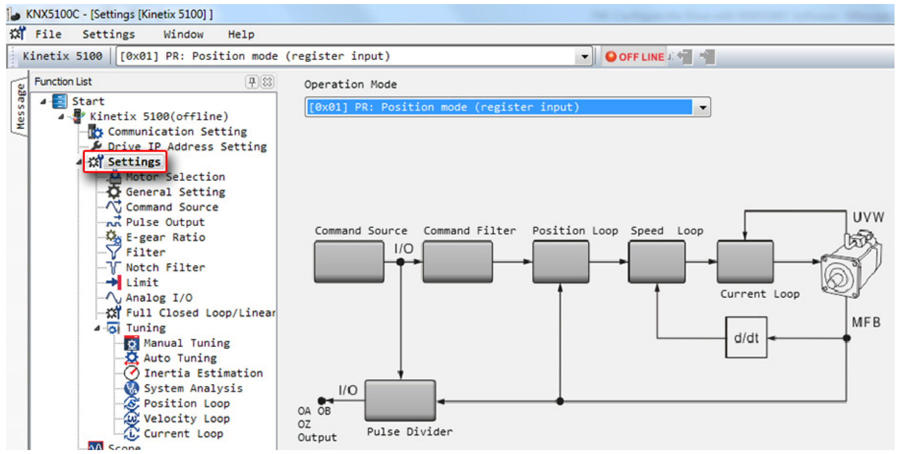
3. In KNX5100C software, choose the Operation Mode from the main screen pull-down menu.

After the parameter value is changed, the following reminder appears.

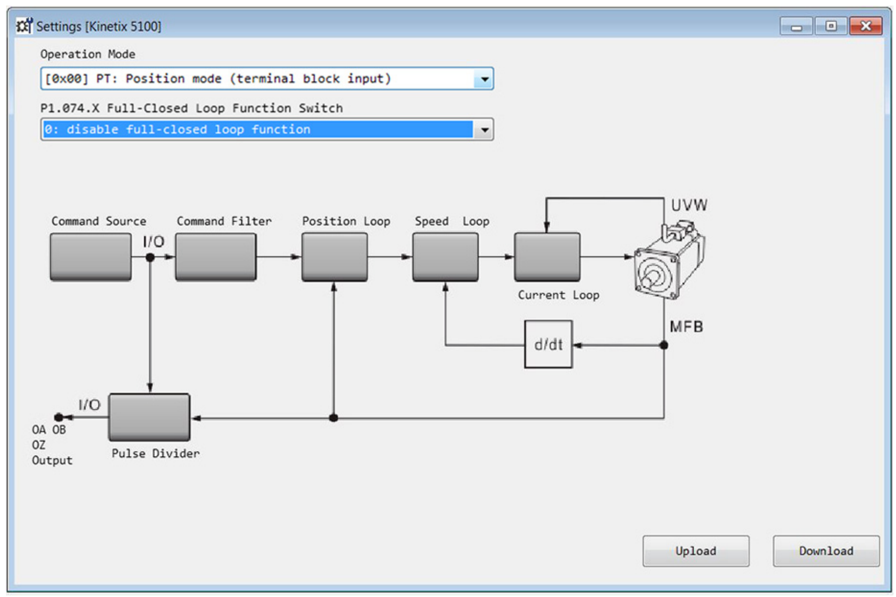


## Configure Settings

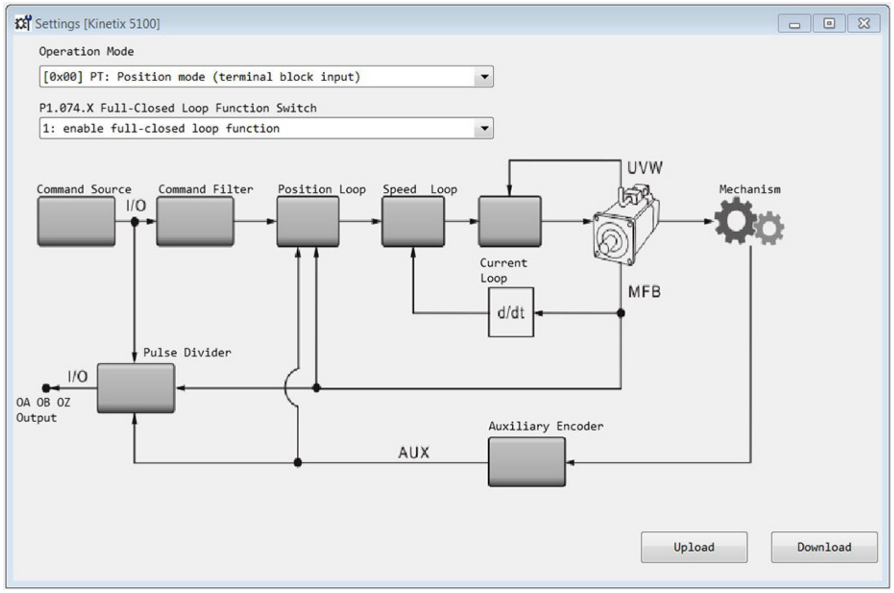
From the Settings selection, you can view and change the operation mode. The Operation Mode control loop diagram is updated based on the mode.




When the Operation Mode value is changed from the pull-down menu, subsequent pull-down menus can appear.



The Operation Mode block control loops change as values are selected from both pull-down menus.




The gray boxes show the functions included in the each operation mode.
You can double-click a box to open a dialog box and to configure the related functions.

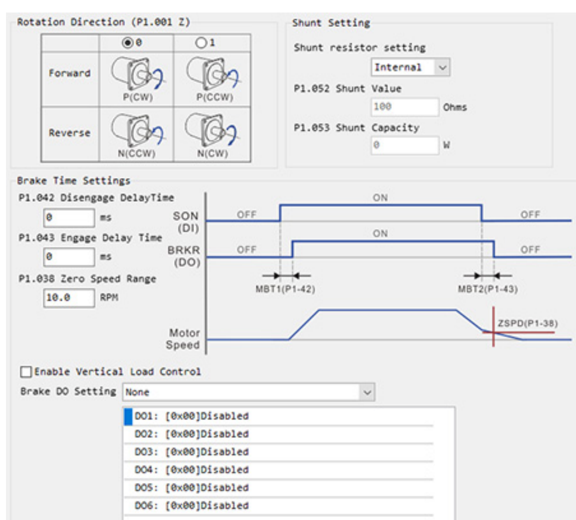
## Configure General Settings

The General Setting page lets you configure parameters related to the motor, shunt, and brake operation.

To access the General Setting page, perform the following steps.

1. From the Function List, select Start > Kinetix 5100 > Settings > General Setting.
2. In General Settings, change the fields manually as needed.

   Any changes to these settings require the motor to be disabled.




3. Click Download to send any changed parameters to the servo drive.

*Enable Vertical Load Control (Motor Holding Brake)*

A common requirement for a load is to be held using a holding brake. A holding brake can be used with a vertical or horizontal load. A vertical load is classified as a load that stores potential energy either by gravity or spring effect. In this type of load, the Kinetix servo motor must hold part or all the load, even when the motor is not moving, but is still powered by the drive. A horizontal load does not store potential energy (either by spring or gravity effect) when the motor is disabled. Vertical or horizontal loads can use a motor holding brake to keep the load stationary while the motor is disabled. Holding brakes are not designed to stop a motor, but rather to hold a motor when it is stationary and disabled.

While this feature is named 'Vertical Load Control' it can be used to setup any load type used with a holding brake. This feature is enabled in the KNX5100C software Function List>Settings>General Setting and enables the automatic control of the motor holding brake.

Once the checkbox is selected:

- The Brake DO setting is chosen and a DO is assigned as [0x08] Brake Control
- The Brake Engage / Disengage times are set to non-zero values (these must be changed to match your motor holding brake engage/disengage times, that data is obtained in the Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001)
- The Zero Speed Range is set to a non-zero value; this value is used as one of the conditions to engage the holding brake
- MotorStopMode ID675 (P1.032).Y is set to use Enable Vertical Load Control

There must be a DI that is user assigned to provide the enable/disable function for the motor with the associated timing that is used with the Brake control DO.

There are three DIs that can be used, the characteristics of each DI is shown in Table 71.

**Table 71 - Holding Brake Digital Inputs**

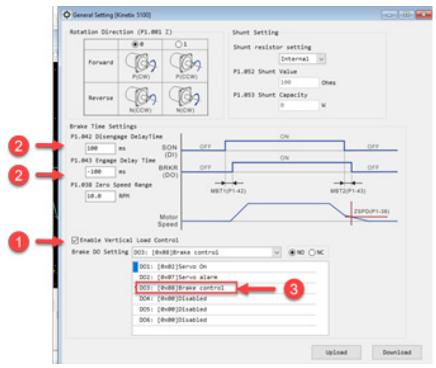
| DI Signal | Characteristic |
|---|---|
| [0x01] Servo On | • Uses brake timing. |
| | • Provides one signal for enable/disable operation of motor. |
| | • Can be used with explicit read/write operation. |
| | • By default uses dynamic braking when deceleration is active (similar to a current deceleration operation), which can be aggressive. |
| | • Can use disable and coast MotorStopMode ID675 (P1.032). |
| [0x47] Profile Quick Stop | • Uses brake timing. |
| | • This input is solely used to decelerate and disable the motor. |
| | • Requires an enabling signal (second input is used to enable the motor). |
| | • Uses a programmable deceleration profile AutoProtectionDecelTime ID296 (P5.003). |
| | • Alarm is issued at the end of the disable operation. |
| [0x48] Servo on with Holding Brake | • Uses brake timing. |
| | • Uses a programmable deceleration profile AutoProtectionDecelTime ID296 (P5.003). |
| | • In IO mode, this input is not required to be assigned, these operations occur with raC_*xxx*_K5100_MSO and raC_*xxx*_K5100_MSF commands. |

Servo on with Holding Brake is available starting from firmware revision 2 and is the preferred input when using a motor holding brake.

The holding brake timing is shown in the KNX5100C software. Configure the vertical load control feature using these steps:

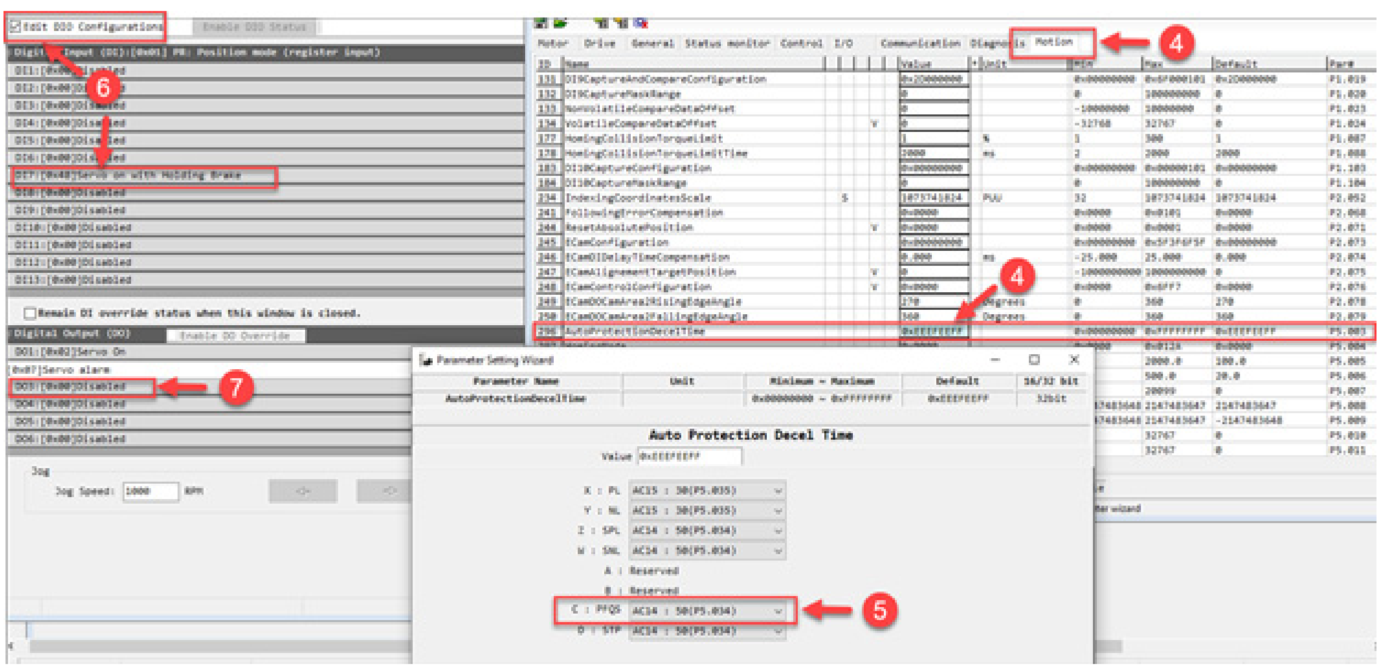
1. Select Enable Vertical Load Control checkbox.
2. Verify the Enagage Delay Time for your motor (this is negative indicating that the motor remains enabled while the holding brake is engaging).

   Verify the Disengage Delay Time for your motor.



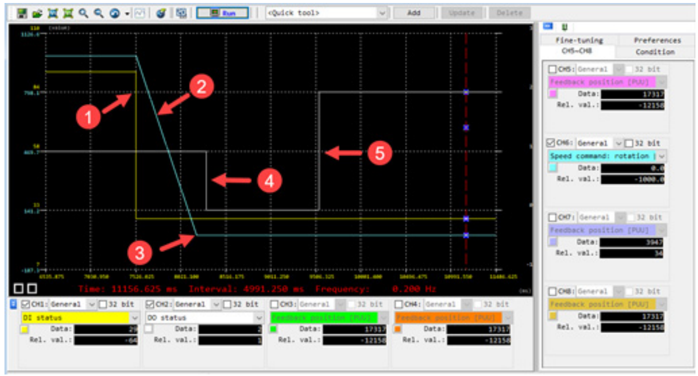

3. Navigate to Function List > Settings > Parameter Editor > Motion, and find ID296 (P5.003); double-click the Value.
4. Use the pull-down menu for C: PFQS (Profile Quick Stop) and select the deceleration time to use before the motor is disabled. (AutoProtectionDecelTime ID296 (P5.003))

   This value is programmable by using the PR Mode Editor > Speed and Time Setting > Accel/Decel Time.
5. Navigate to Function List > Digital IO/Jog Control and check 'Edit DIO Configuration', then using an available DI, use the pull-down menu to select Servo on with Holding Brake and make this a NO type of input.
6. Verify that the motor holding brake has been selected; if it is not selected, use the pull-down menu and associate a DO as Brake Control.



The scope trace below shows the holding brake timing:

1. DI is on and transitions off.
2. Motor is decelerated (blue pen is motor speed).
3. Motor reaches zero speed
4. DO Brake Control is off and Brake EngageTime begins timing
5. Once the BrakeEngageTime expires, the motor is disabled



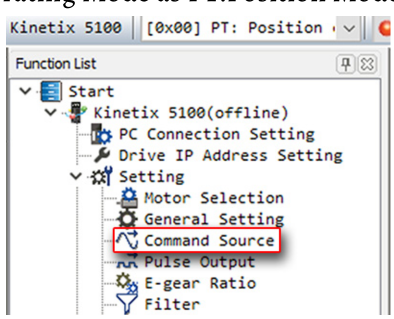
## Configure the Command Source

The selected operation mode allows the modification of different parameters. The configuration of the Command Source is available with: I/O Terminal Block input, Speed Mode, and Torque Mode. Command Source is not available for Position Register (PR) or IO Modes.

*Configure the Command Source for Position mode (I/O Terminal block input -PT Mode)*

To configure the Command Source for Position mode, perform the following steps.

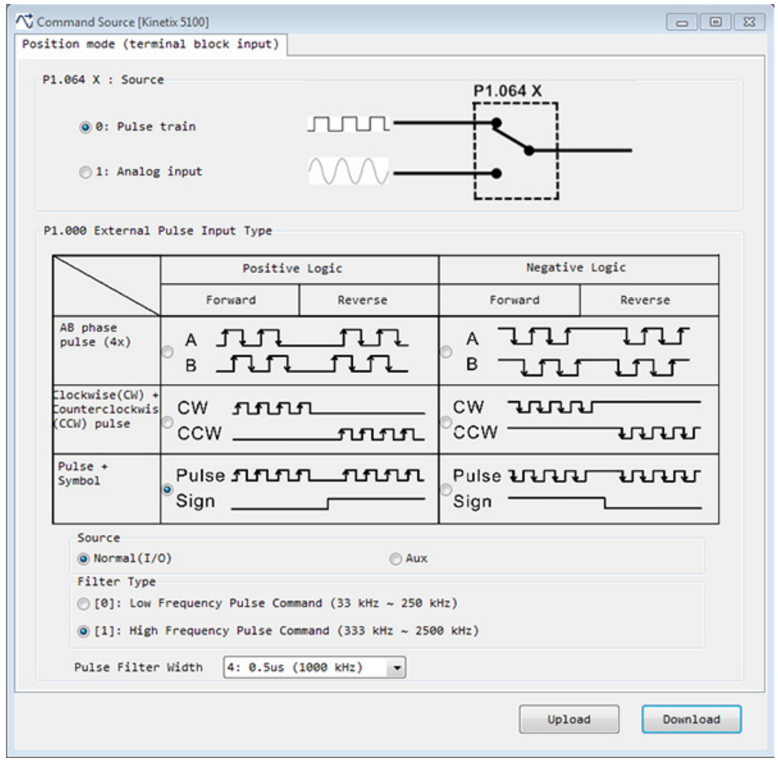
1. From the Function List, choose Start>Kinetix 5100>Setting and select the Operating Mode as PT:Position Mode (I/O terminal block input).




In Command Source, the Position Mode (I/O terminal block input) tab is used.

| | |
|---|---|
| **IMPORTANT** | If you have configured a dual or multiple operation mode, more than one tab is visible. For example, if you have PT/S mode, you get a Position mode (I/O terminal block input) tab and a Speed mode tab. |

2. On the Position Mode tab, select either Pulse Train or Analog Input as the position command source.
3. If you select Pulse train, you can specify the External Pulse Input Type, Source (the drive port from where the command originates), Filter Type, and Pulse Filter Width.




4. Select the Source to be used.

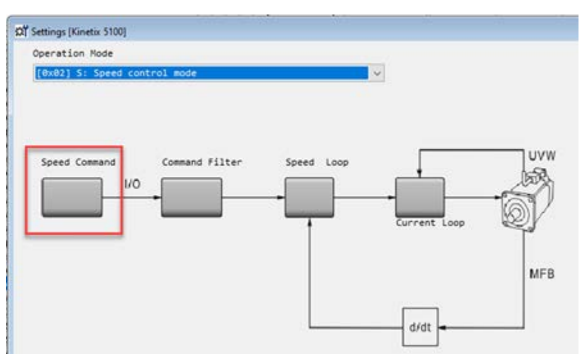
   When the Control Mode is PT (Position Terminal), the source indicates which port the Master Pulses originate.
5. Click Download to download any changed parameters to the servo drive.

   For more information, see PT Mode (Position Command with I/O Terminal Block Input) on page 231.

### *Configure the Command Source for Speed Mode (-S mode)*

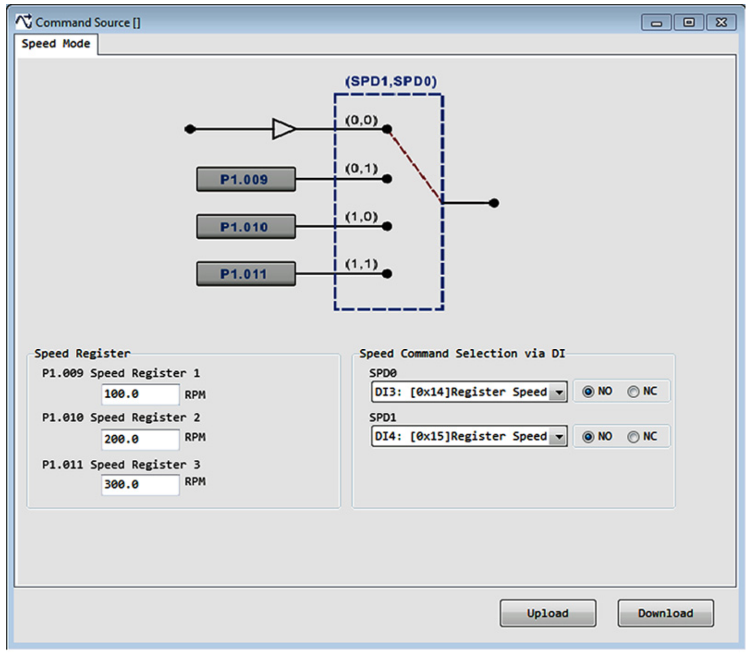
| | |
|---|---|
| **IMPORTANT** | The Speed Mode tab is visible if you have configured a dual or multiple operation mode, such as PT/S mode. |

1. From the Function List, choose Start>Kinetix 5100> Setting and select the Operating Mode as S:Speed Control Mode.
2. Click the Speed Command box.



3. On the Speed Mode tab, select the speed command source from either an analog input or preset speed registers that is triggered by using binary weighted digital inputs signals DI.SPD0 and DI.SPD1.

   You can change the values of the Speed registers 1…3 by using ID125…ID127 (P1.009…P1.011).



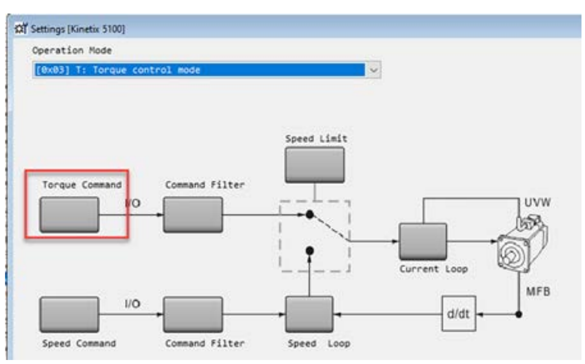

4. Click Download to send any changes to the servo drive.

   For more information, see Configure and Select the Preset Speeds on page 240.

### *Configure the Command Source for Torque Mode (-T Mode)*

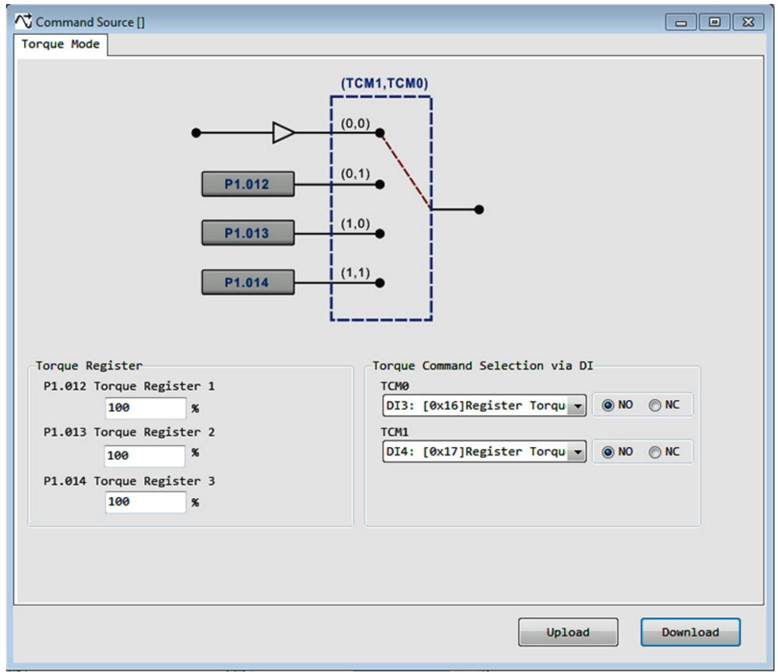
| **IMPORTANT** | The Torque Mode tab is visible if you have configured a dual or multiple operating mode. |
|---|---|

1. From the Function List, choose Start>Kinetix 5100>Setting and select the Operating Mode as T:Torque Control Mode.
2. Click the Torque Command box.



3. In the Torque Mode tab, select the torque command source from either an analog input or preset torque registers that can be triggered by using binary weighted digital inputs signals DI.TCM0 and DI.TCM1.

   You can change the values of the torque registers 1…3 by using ID128…ID130 (P1.012…P1.014).



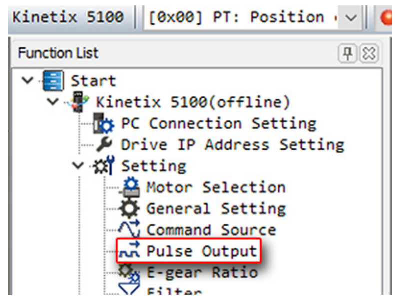

   For more information, see Selection of Torque Command on page 246.

## Configure the Pulse Outputs

Use the Pulse Output as a form of buffered encoder outputs. Use these pulses to provide master feedback signal to another drive, to provide feedback for closed loop operation, or pulse train control is used with an external controller.

To access and use the Pulse Outputs, perform the following steps.

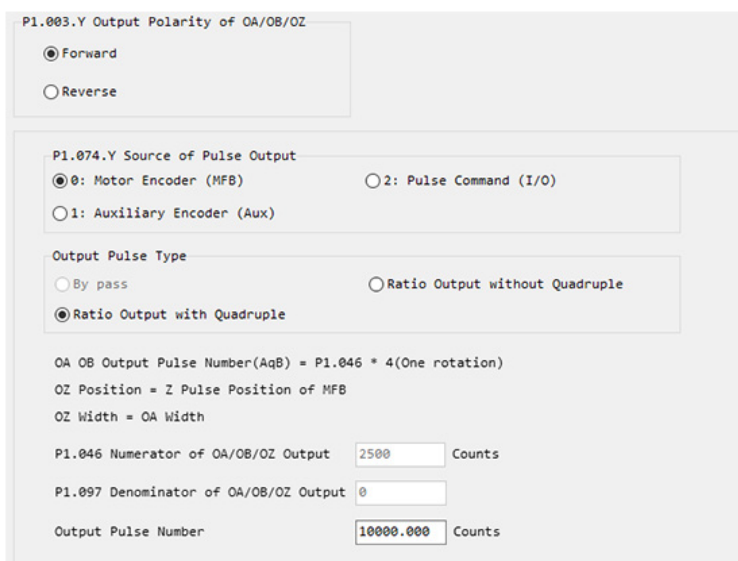
1. From the Function List, select Start > Kinetix 5100 > Setting > Pulse Output.




2. In the Pulse Output dialog box, you can configure the following:
   - The output polarity of OA/OB/OZ to either forward or reverse
   - The source of pulse output from Motor Encoder (MFB), Auxiliary Encoder (Aux), or Pulse Command (I/O)
   - The Output Pulse Type to by-pass, Ratio Output without Quadruple, or Ratio Output with Quadruple

| IMPORTANT | Output Pulse Type selection depends on the source of the pulse output. For example, by-pass is only available when Pulse Command (I/O) is chosen as the source. |
|---|---|

   - The Output Pulse Number is the output pulse count that you can change to match your application requirements. The Output Pulse Number is visible when Ratio Output with Quadruple is selected. This value is set as a default that you can change to match your application. When Ratio Output without Quadruple is selected, you can change the numerator and denominator to match your application.




3. You can also use the Settings>Parameter Editor>General to manually change the Encoder Output Resolution ID153 (P1.046), which is counts.
4. Click Download to send any changes to the servo drive.

## Configure Electronic Gear (E-Gear) Ratio

The E-Gear ratio configuration is important and serves two purposes depending on the Operation Mode:

- PT Operation mode/IO mode - (raC_*xxx*_K5100_MAG Add-On Instruction only). The E-Gear ratio represents a pulse-pulse relationship between a master and slave source (Pulse-Pulse follower). In this mode, the drive internally has no conversion constant (counts/mm or inch), any user position conversions must be considered as pulses.
- PR Operation Mode/IO mode. When in this mode, the E-Gear ratio represents Position Scaling (PUU). This mode allows you to define the number of feedback counts/motor rotation.

Regardless of the Operation Mode, the E-Gear ratio is always used to provide either a representation of Position Scaling (PUU) or a Pulse Following relationship.

**Table 72 - Relevant Parameters(1)**

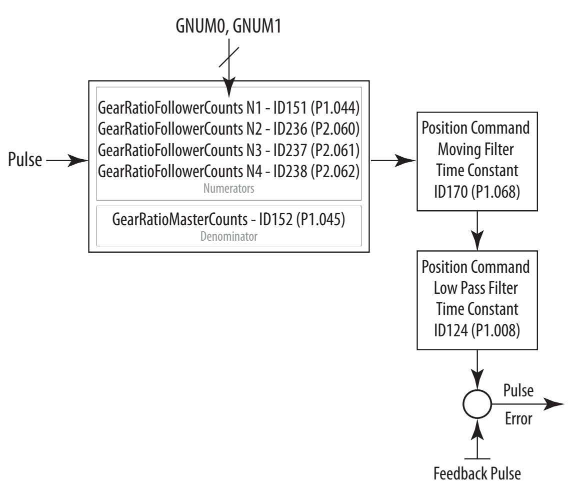
| Parameter | Name |
|---|---|
| ID151 (P1.044) | GearRatioslaveCountsN1 |
| ID236 (P2.060) | GearRatioslaveCountsN2 |
| ID237 (P2.061) | GearRatioslaveCountsN3 |
| ID238 (P2.062) | GearRatioslaveCountsN4 |
| ID152 (P1.045) | GearRatioMasterCounts (denominator) |
| ID170 (P1.068) | PositionCmdMovingFilterTime |

(1) Do not change the setting value in servo on state.

If you change the gear ratio in your application, when servo is off, you can define multiple numerators but only one denominator. The numerator of the E-Gear ratio can be selected via the DI.GNUM0 and DI.GNUM1 signals. If the DI.GNUM0 and DI.GNUM1 signals are not defined, ID151 (P1.044) is the default numerator. To avoid mechanical vibration, switch the DI.GNUM0 and DI.GNUM1 signals during servo off status.

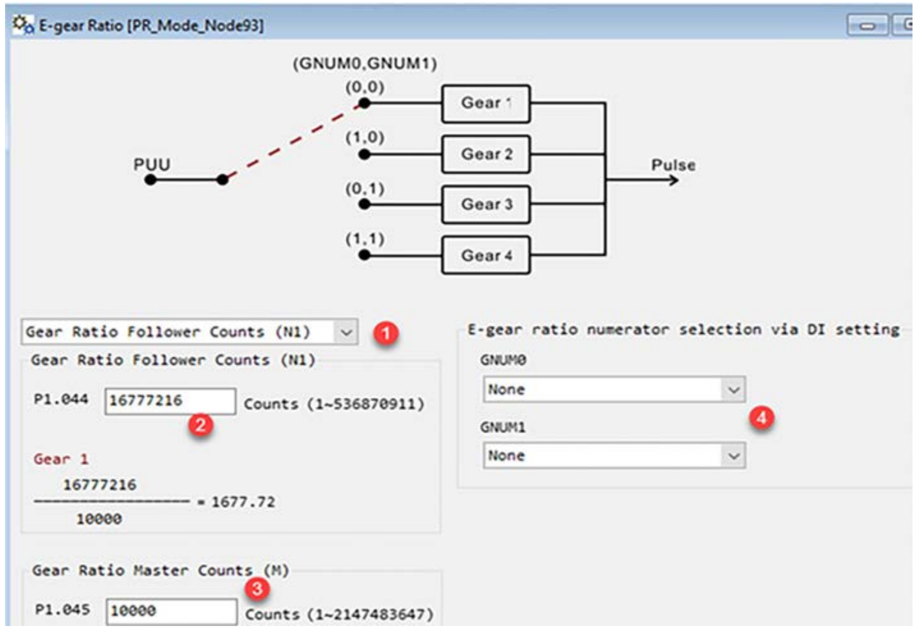
**IMPORTANT**
- If you change gear ratio during operation, you can cause an abrupt, uncontrolled motion event.
- ID236 (P2.060), ID237 (P2.061), and ID238 (P2.062) are for PT Mode only. ID151 (P1.044) is for both PR Mode and PT Mode. All of the parameters can be changed in PT Mode only.
- If PT/PR Mode is selected, and ID151 (P1.044) is changed in PT Mode, it remains active through any subsequent execution if you switch to PR Mode.

See Description of Digital Input Functions on page 425.



To configure the E-Gear ratio, open the E-Gear Ratio dialog box in the KNX5100C software (from the Function List, select Start > Kinetix 5100 > Setting > E-gear Ratio). The different settings in the E-Gear Ratio dialog box are explained.

**Figure 79 - E-Gear Ratio**




| Item | Description |
|---|---|
| 1 | Gear Ratio Selection - Pull-down menu to choose the different ratios (N1…N4). |
| 2 | Gear Ratio Follower Counts (N1) - Set this value as the motor feedback resolution. |
| 3 | Gear Ratio Master Counts (M) - This value is set depending on the Operation Mode. Default values are 100,000 counts for a high-resolution encoder. |
| 4 | GNUM0/1 - These choices are mapped to the Digital Inputs that represent binary weighted values to select the Gear Ratio value. |

The Gear Ratio Selection (1) and GNUM0/1 (4) are not used in IO mode. They are used in PT Mode to select different gear ratios.

*Setting Gear Ratio Follower Counts (ID151, P1.044)*

The Gear ratio Follower Counts is sometimes called the numerator, because when you look at how it is used in the drive, it is used to determine the internal 'ratio' of the drive (shown as 1677.72 in Figure 79). Therefore, the E-Gear ratio Follower equals the Effective Resolution of the motor feedback.

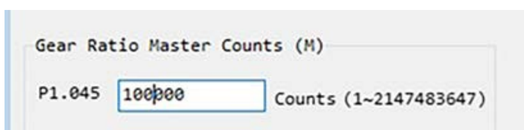
**Figure 80 - Motor Selection > Feedback Dialog Box**

| | |
|---|---|
| **IMPORTANT** | The numerator is always set as the Effective Resolution. We use Master counts (denominator) to represent your ratio (depending on your Operation Mode). When using DI.GNUM0 and DI.GNUM1 for different gear ratios, we are changing the Slave/Follower Counts entry. DI.GNUM0/1 can only be entered as Follower Counts (ID236…ID238, P2.060…P2.062), this means the desired ratio must be normalized - because we can only represent DI.GNUM0/1 as Follower Counts value, but the Master Counts represents your ratio. Normalizing is done by changing the Drive Ratio (shown in Figure 79 as 1677.72). |

*Setting Gear Ratio Master Counts (ID152, P1.045) - PT Operation Mode*

The Gear ratio Master Counts parameter ID152 (P1.045) is sometimes called the denominator, which by default is defined as 100,000 counts/motor rev. You can also use with IO mode - raC_*xxx*_K5100_MAG Add-On Instruction.

**Figure 81 - Gear Ratio Master Counts**




When the Follower counts is set equal to motor effective resolution, then the Gear Ratio Master counts is desired counts/motor rotation. Desired counts, in this case, are not used for position scaling, but are used to define the gearing ratio. The Master counts are set based on the number of feedback pulses you expect to receive from the Master source input and is used to define your overall gearing relationship. So, this Master counts value is used to define the effective 'ratio' of your gearing relationship.

For example, the master in our system is a 4000 ppr encoder. Which means, when the encoder makes one revolution, we expect the Slave1 drive to see 4000 pulses. Our application requirement is that we want to follow this encoder at a 1:2 relationship. Which means, when the master encoder moves 1 encoder revolution, the motor rotates 2 revolutions. The Master PPR is not entered anywhere, but it is required that we know this value. We calculate the E-Gear Master Counts value knowing the Master PPR counts and the relationship we want in the motor of Slave1. In our example, the Gear Ratio Master Counts = 2000, which means when Slave 1 sees 2000 pulses from the master, it rotates 1 revolution, and thus, as the master moves 4000 pulses (one rotation), Slave1 moves 2 rotations.


| | |
|---|---|
| **IMPORTANT** | When you change the E-Gearing ratio, you are affecting the position scaling of your drive. So, you cannot expect to position correctly if you change modes to a positioning mode when you are finished following pulses. You must first re-establish a home, then set the E-Gear ratio correctly for your application Position units. |

| | |
|---|---|
| **IMPORTANT** | There is NO positioning ability while using the pulse follower function in PT Mode. Furthermore, when the E-Gear ratio is changed in PT Mode, and you change sub-modes back to a position-based mode (this means using any other Opr_AOI), your position scaling changes. When you keep a 'fixed' gearing ratio, then the positioning is maintained because the E-Gear ratio values did not change. The drive follows pulses based on the present value of the E-Gear ratio. |

*Setting Gear Ratio Master Counts (ID152, P1.045) - Using any other Positioning Mode*

The Gear ratio Master Counts (Figure 81) parameter is sometimes called the denominator, which by default is defined as 100,000 counts/motor rev.

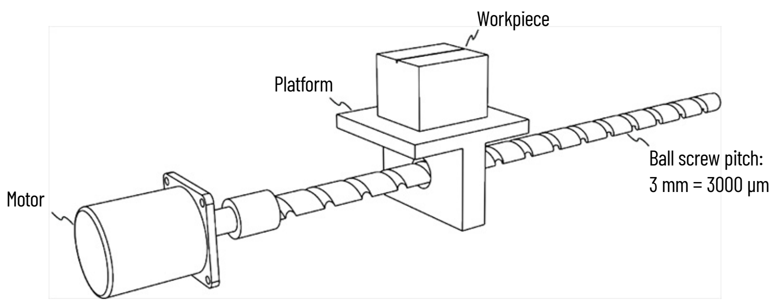
The Master counts value is desired counts/motor rotation. So, this Master counts value is used to set the 'position scaling' for your axis. The value can be any encoder count value that can be converted to give you your position units/ motor rotation, which includes your mechanical transmission.

You can create Position Units in the Logix environment by using the Device Object Handler Add-On Instruction

| | |
|---|---|
| **IMPORTANT** | When you change the E-Gearing ratio, you are affecting the position scaling of your drive. So, you cannot expect to position correctly after you have changed the E-Gear ratio. You must first re-establish a home, then set the E-Gear ratio correctly for your Position units. |

For example:

The ball screw pitch is 3 mm, when using a 4 bit encoder, if the E-Gear ratio is set to 16777216/3000, then the workpiece moves 1 µm per 1 pulse command.




| E-Gear Status | Gear Ratio | Moving Distance per 1 Pulse Command |
|---|---|---|
| E-Gear is not applied | $=\frac{1}{1}$ | $=\frac{3000\,\frac{\mu m}{rev}}{16777216\,\frac{pulse}{rev}} \times \frac{1}{1} = \frac{3000}{16777216}$ (Unit: $\frac{\mu m}{pulse}$) |
| E-Gear is applied | $=\frac{16777216}{3000}$ | $=\frac{3000\,\frac{\mu m}{rev}}{16777216\,\frac{pulse}{rev}} \times \frac{16777216}{3000} = 1$ (Unit: $\frac{\mu m}{pulse}$) |

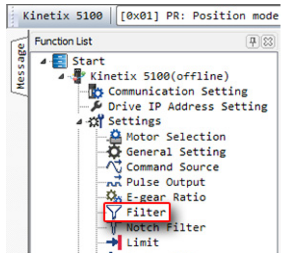
## Configure Filter

There are different filters available to use with the Kinetix 5100. There is a Low Pass Filter and Moving Average Filter which are both used to remove unwanted resonance from the drive (these filter types are available for use in different drive modes). See Filter on page 250 for more information.

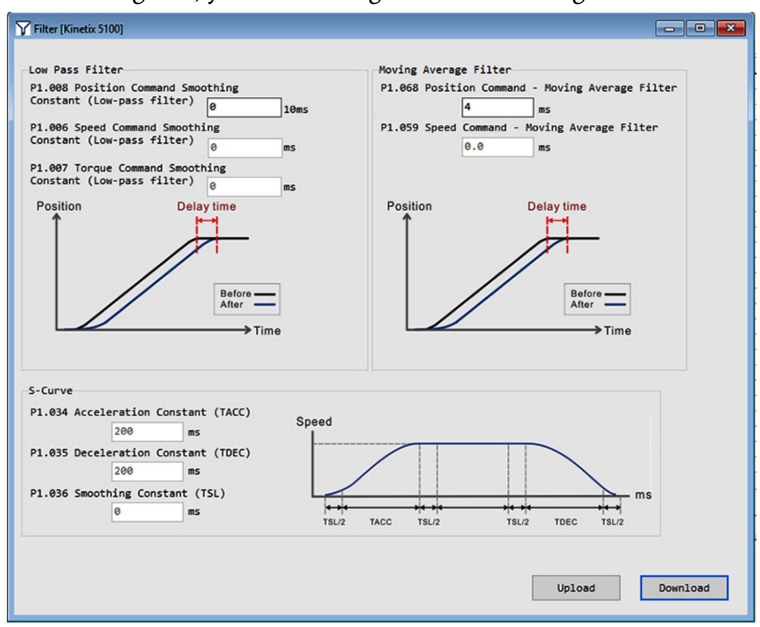
Use the Filter dialog box to configure the Kinetix 5100 Low Pass and Moving Average Filters.

To access Filter, perform the following steps.

1. From the Function List, choose Start > Kinetix 5100 > Setting > Filter.

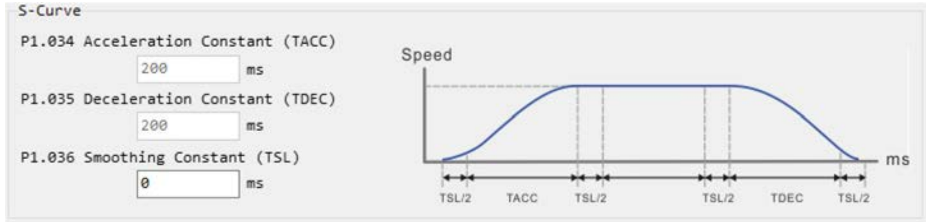



2. In the Filter dialog box, you can configure the following:

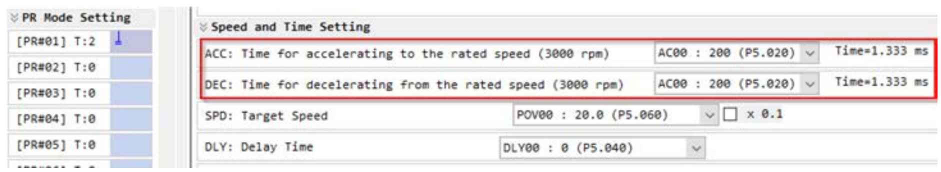



- The Low Pass Filter smoothing time constant parameters for Position Command ID124 (P1.008), Speed Command ID122 (P1.006) and ID123 (P1.007). This filter is a first order low pass filter. This filter is a smoothing filter that creates a gradually increasing output when an input step is applied. The time constant determines how fast the Low Pass Filter output reaches the level of input applied. This filter uses the Position Command Smoothing Constant ID124(P1.008) to determine the cutoff frequency. The cutoff frequency is 1/(2*PI*P1.008). The units for ID124(P1.008) are in 10 ms, which means if 100 is entered into ID124(P1.008), the actual value that is used by the formula is 1000 ms. The same cutoff frequency formula is used for the Speed and Torque Command Smoothing Constant (ID122(P1.006) and ID123(P1.007)) except the units are ms and not 10 ms.
- The Moving Average Filter time constant parameters for Position Command ID170 (P1.068), and Speed Command ID164 (P1.059).

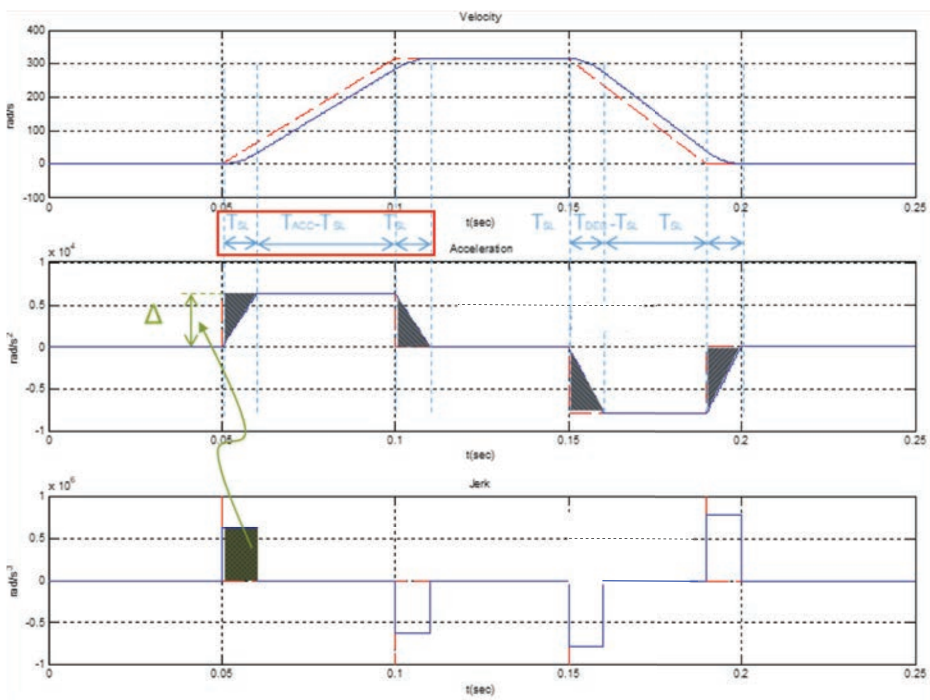
- S-curve.




These features are only applicable to S-curve profile types. The Acceleration ID141(P1.034) and Deceleration ID145(P1.035) Constants come from the cycle profile Acc/Dec settings. In this image, the PR Index Accel/Decel values are 200 ms. These values are populated in ID141(P1.034) and ID145(P1.035).




The smoothing constant (TSL) provides a way to add smoothing to the jerk properties and is shown in this diagram.




Filters available for Position Mode, Speed Mode, and Torque Mode are described in Filter on page 250 in Chapter 10, Modes of Operation.

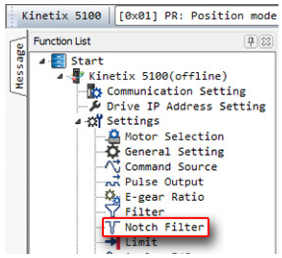
3. Click Download to send any changes to the servo drive.

## Configure Notch Filter

The Notch Filter is used to attenuate a specific resonant frequency. The Kinetix 5100 drive uses up to five Notch Filters simultaneously.

To access the Notch Filter, perform the following steps.

1. From the Function List, choose Start > Kinetix 5100 > Setting > Notch Filter.

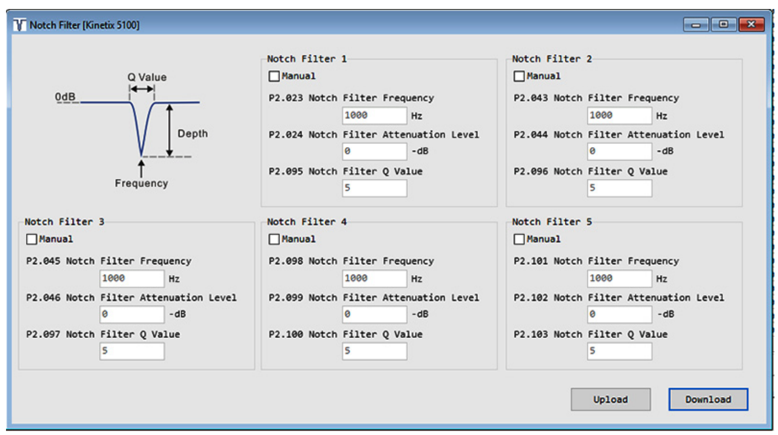



2. In the Notch Filter dialog box, you can modify the five notch filters.

To edit any notch filter parameter, you must first check Manual for that notch filter.

You can use any frequency diagnosing tool (FFT) to diagnose the frequency and magnitude of the resonance.

You can use the System Analysis tool to diagnose the frequency of resonance.

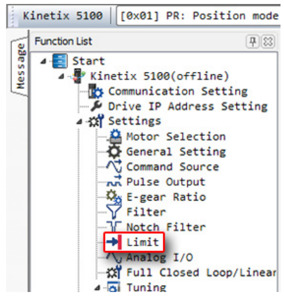



3. Click Download to send any changes to the servo drive.

   For more information, see Resonance Suppression (Notch Filter, Speed Mode) on page 253.

## Configure Limits

From the Function List, choose Limit to configure Position, Speed, and Torque Limits.

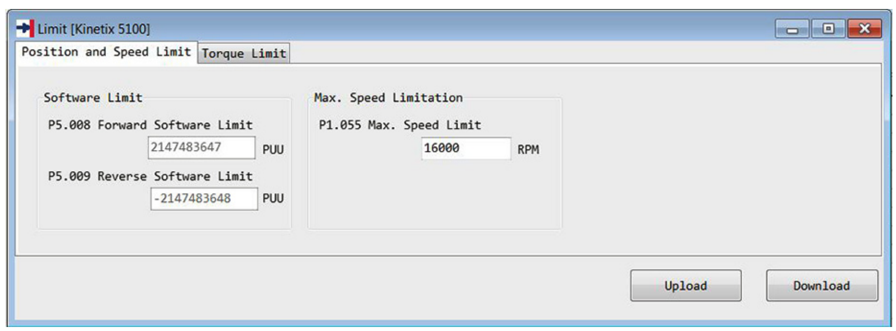



In the Limit dialog box, there are two tabs: Position and Speed Limit, and Torque Limit.

*Position and Speed Limit*

On the Position and Speed Limit tab, the Software Limits define a linear counts range for valid travel. When motor travel is outside the travel limit, an alarm is generated (A283/A284) and motion is permitted in the opposite direction of the limit.

You can change the accel/decel rates used for the detection of the software limits in Function List>Motion Control>PR Mode Editor>Deceleration Time for Auto-protection ID296 (P5.003)

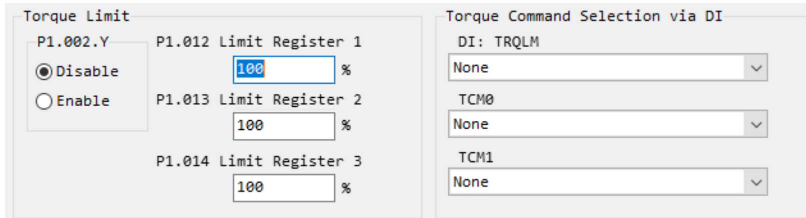



Click Download to send any changes to the servo drive.

For more information, see Analog Outputs and Monitoring on page 276.

*Torque Limit*

On the Torque Limit tab, you can enable or disable torque limits and set torque limit values. You can use limited torque values by setting P1.002.Y to 1 (Enable) or 0 (Disable) or by using the digital input DI:TRQLM. You can also select torque command preset values by changing binary weighted digital inputs, TCM1 and TCM2.



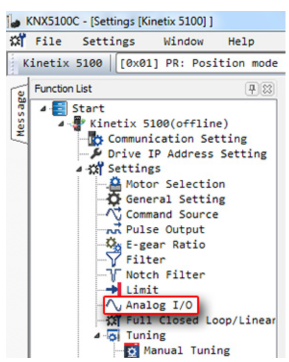

For more information on the torque limit, see Analog Outputs and Monitoring on page 276. For more information on digital input function descriptions, see Description of Digital Input Functions on page 425.

## Configure Analog I/O

The Kinetix 5100 servo drive can use different analog input signals for commands. These operations include using analog inputs representing Position, Speed, or Torque from another command source (another controller for example).

The drive can use up to two analog outputs to display selected drive parameters. This output is typically used to provide status information to another device. This servo drive provides two output channels for this purpose, MON1 and MON2.

From the Function List, choose Analog I/O to select the type of analog command input and the output data to be monitored.

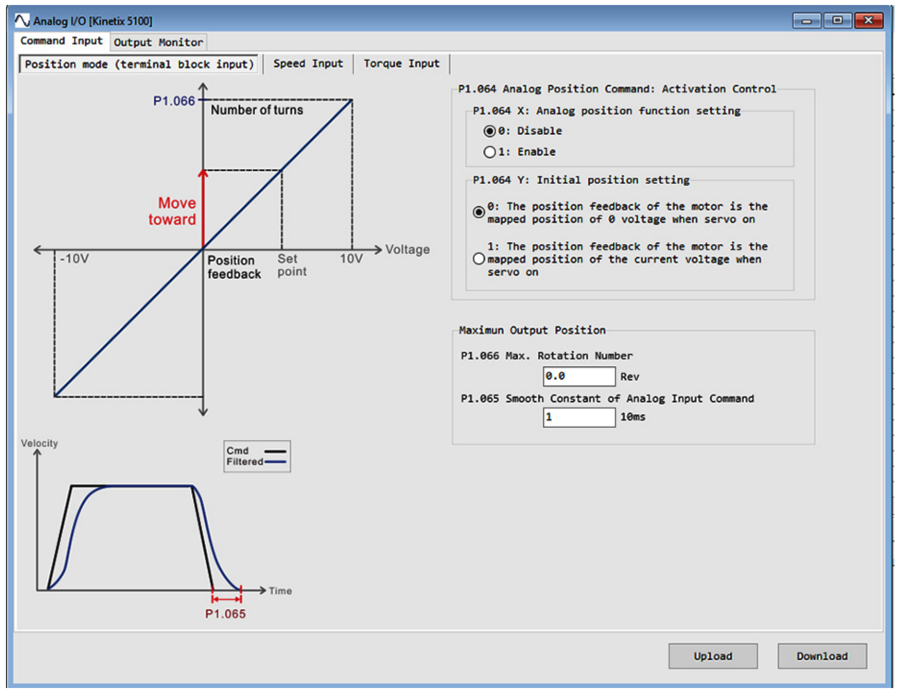



In the Analog I/O dialog box, there are two tabs: Command Input and Output Monitor.


On the Command Input tab, you can configure three types of analog input: position mode (I/O terminal block input), speed input, and torque input.

*Position Mode (I/O terminal block input) Tab*

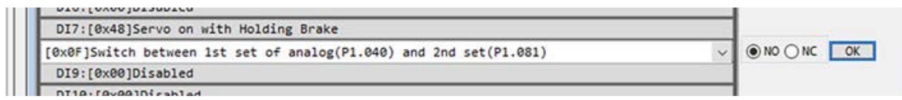
This mode is useful when you want to relate an analog voltage command to motor position. By using the analog input, you can relate an analog voltage to a number of motor rotations. Use this feature for positive (up to +10V) or negative (down to -10V) rotations. The conversion of volts/motor revs used here is: 10V yields a maximum of P1.066 (Maximum Rotation Number) motor revs. The volts/rev is scaled using this formula. On this tab, you can enable the analog position function, set the initial position of the motor, and the maximum motor position value (in motor rotations).



### *Speed Input Tab*

This mode is useful when you want to relate an analog voltage command to motor speed. By using the analog input, you can relate an analog voltage to a motor speed in RPM. Use this feature to define positive (up to +10V) or negative (down to -10V) speed. The conversion of volts/motor RPM used here is:
10V yields a maximum of P1.040 (Maximum Output Speed) RPM.
The volts/RPM is scaled using this formula. For example, if a ControlLogix® 1756-M02AE module was configured for Velocity mode, its analog output could be used with this speed input for the Kinetix 5100 drive to provide full closed-loop control.

On this tab, you can set the maximum output speed by using parameters ID147 (P1.040) and ID679 (P1.081). Select the Max Speed value by using a Digital Input.



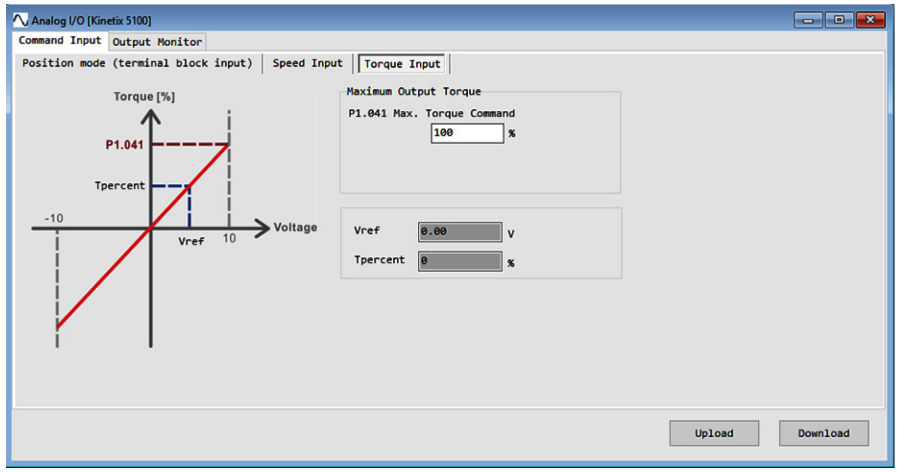

Click Download to write any changed parameters to the servo drive.


### *Torque Input Tab*

This mode is useful when you want to relate an analog voltage command to motor torque. By using the analog input, you can relate an analog voltage to a motor torque. Use this feature to define positive (up to +10V) or negative (down to -10V) torque limits. The conversion of volts/motor torque used here is: 10V yields a maximum of P1.041 (Maximum Output Torque). The volts/motor torque % is scaled by using this formula. For example, if a ControlLogix 1756-M02AE module was configured for Torque mode, its analog output could be used with this torque input for the Kinetix 5100 drive to provide full closed-loop control.

On this tab, you can change the maximum output torque command by using parameter ID148 (P1.041).

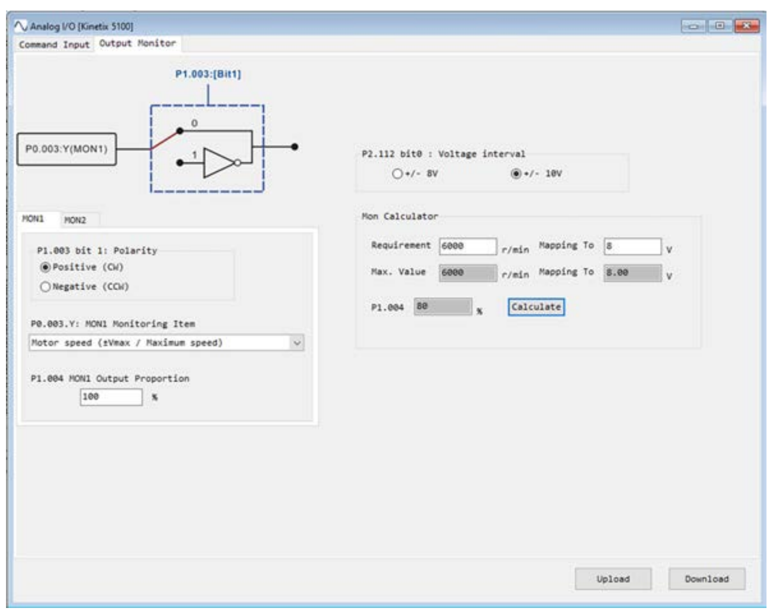
Click Download to write any changed parameters to the servo drive.




*Output Monitor Tab*

On the Output Monitor tab, you can change the Monitored Value using a pull-down menu. You can change the scaling, proportion, and the polarity of the output.

The Mon Calculator lets you enter a unique Motor Speed (can be the maximum Motor Speed) with your desired Analog Voltage at that speed. Click Calculate to determine the corresponding Maximum values and analog scaling ID120 (P1.004). For more information, see Analog Outputs and Monitoring on page 276.



## Configure Position, Velocity, and Current Loops

The Operation Mode selection dictates which control loops are active and that you can modify. Each dialog box lets you configure the parameters for the gain and filter values that correspond to the command type.

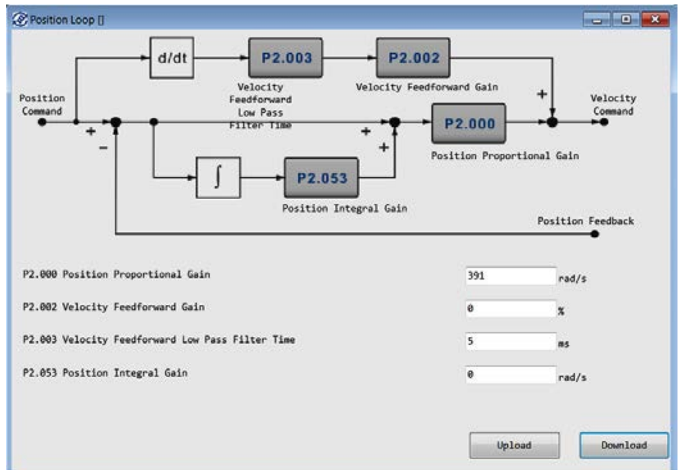
### Configure Position Loop

From the Function List, choose Position Loop to view or change the parameters that apply to the position command.

**Table 73 - Position Loop Parameters**

| Parameter | Name |
|---|---|
| ID185 (P2.000) | PositionProportionalGain |
| ID187 (P2.002) | VelocityFeedforwardGain |
| ID188 (P2.003) | VelocityFeedforwardLowPassFilterTimeConstant |
| ID235 (P2.053) | PositionIntegralGain |

Click Download to download any changed parameters to the servo drive.



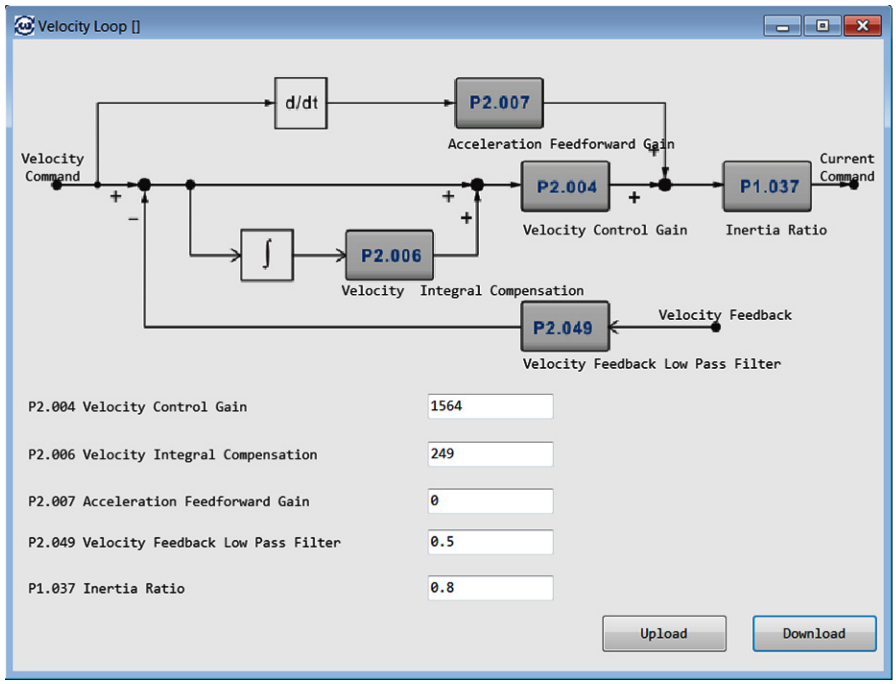
## Configure Velocity Loop

From the Function List, choose Velocity Loop to view or change the parameters that apply to the velocity command.

**Table 74 - Velocity Loop Parameters**

| Parameter | Name |
|---|---|
| ID189 (P2.004) | VelocityProportionalGain |
| ID191 (P2.006) | VelocityIntegralGain |
| ID192 (P2.007) | AccelerationFeedforwardGain |
| ID232 (P2.049) | VelocityFeedforwardLowPassFilterTimeConstant |
| ID144 (P1.037) | LoadInertiaRatio |

Click Download to write any changed parameters to the servo drive.

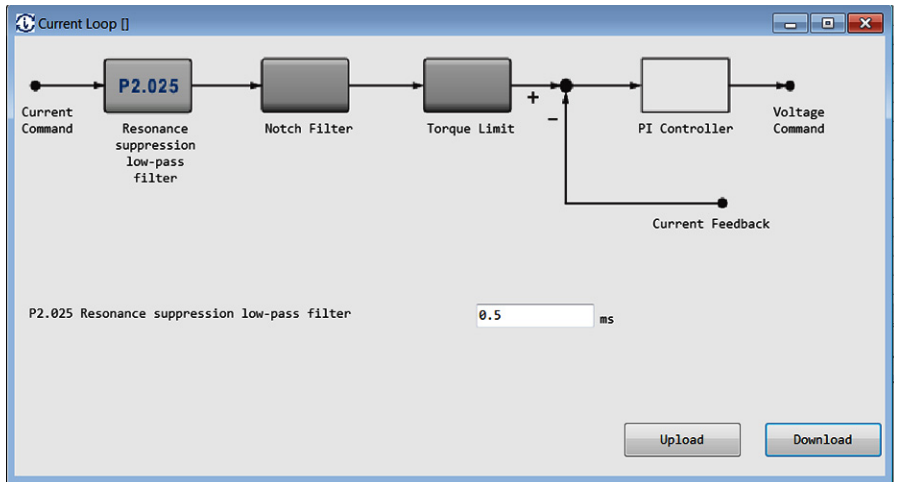


## Configure Current Loop

From the Function List, choose Current Loop to view or change the parameters that apply to the current command.

The affected parameter is ID210 (P2.025) Resonance Suppression Low Pass Filter Time Constant. This Low Pass Filter is used to dampen an aggressive output that can potentially cause an unwanted resonance with the mechanical equipment.

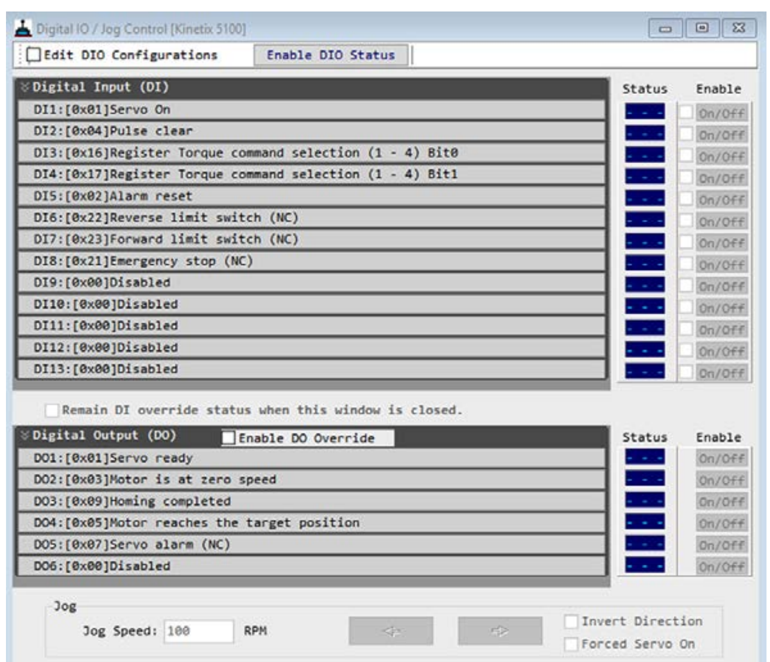
Click Download to write any changed parameters to the servo drive.




## Digital I/O and Jog Function in KNX5100C Software

From the Function List, choose Digital IO/Jog Control to view or change the I/O function and to see the status of digital inputs (DI) and digital outputs (DO), or to control the I/O signals manually.

There are three sections in the dialog box: Digital Input (DI), Digital Output (DO), and Jog Control.



## Configuration and Status of Digital Input (DI) and Digital Output (DO) Signals

In the Digital Input (DI) and Digital Output (DO) sections, the user defined signals are shown with their individual configurations.

If the contact type of the DI or DO signal is normally closed, 'NC' is added at the end of the signal name. Click 'Edit DIO Configurations' to change the configuration of the signal.

The Status column shows the status of the digital I/O. This is the LOGICAL level of the input that is based on the use of N.O. or N.C. This is NOT the actual voltage on the terminals (0V DC = OFF, 24V DC = ON).

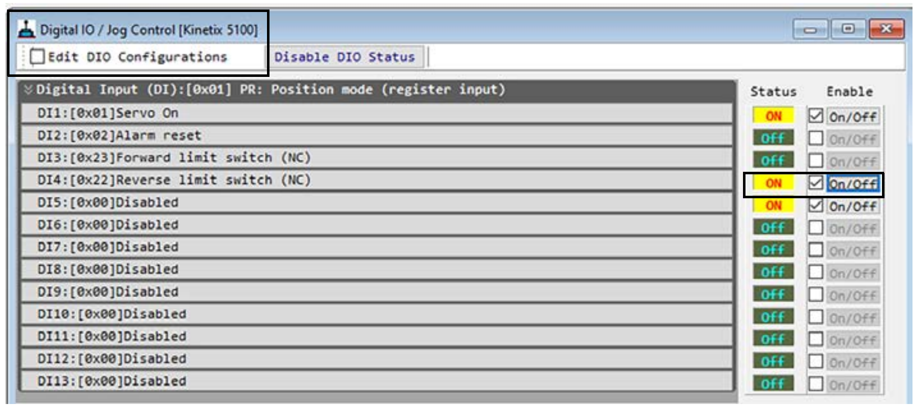
An example is shown in Figure 82. DI3 is configured as an N.C. input. The demo box has DI3 toggle switch ON (24V DC to the input). Notice that the Status in the Control Panel is Off. This is because the configuration is NC, the drive interprets (and expects) this state/condition as being OFF.

**Figure 82 - Status Example**


This dialog box also shows the On/Off status of the DI or DO signals and offers manual control of the DI or DO signal state. This control is useful when testing or troubleshooting the signals.

### Control Digital Input Signals Manually

To control the digital input signals manually, go online with the drive, then clear the Edit DIO Configurations checkbox and click the Enable checkbox. Use the On/Off buttons on the right side to enable the DI and DO control. You can use these On/Off buttons to control the DI or DO signals while the drive is connected.




To change and control the DI signals manually, perform the following steps.

1. Check Enable DIO Configurations.
2. Configure the Digital Inputs as required.
3. Clear the Edit DIO Configurations checkbox.
4. Go online with the drive. You might have to download your KNX5100C project file.
5. Check Enable so that On/Off is visible.
6. Click On/Off to change the status of the DI signals directly.

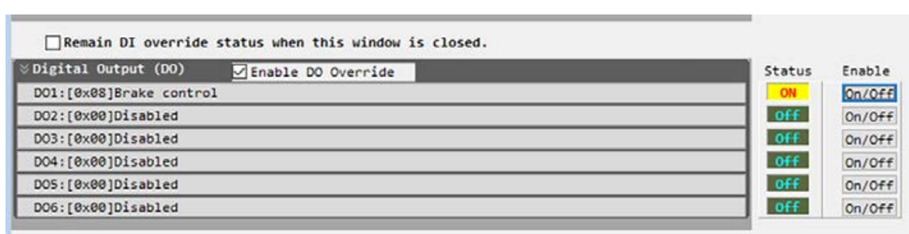
   You can see the signal status by looking at the Status window.

### Control Digital Output Signals Manually

To change and control the digital outputs via the communication software settings when the servo drive is connected, perform the following steps.

1. Check Edit DIO Configurations.
2. Configure the Digital Outputs as required.
3. Clear the Edit DIO Configurations checkbox.
4. Go online with the drive. You might have to download your KNX5100C project file.
5. Check Enable DO Override so that On/Off is visible.
6. Click On/Off to change the status of the DO signals directly.

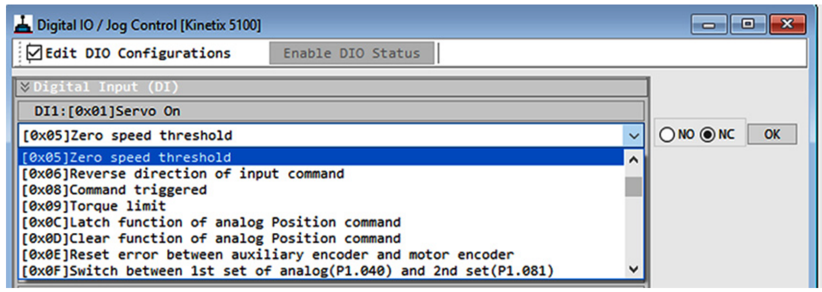
   You can see the signal status by looking at the Status window.



## Edit DIO Configurations

When Edit DIO Configurations is checked, the digital input (DI) and digital output (DO) actual state is always Off. To change the function and status of DI and DO signals, perform the following steps.

1. Check the box next to Edit DIO Configurations to enable the editing function.
2. Use the pull-down menu to change the DIO function in the drive.
3. Click OK to save the changes and write to the drive.




4. When you have configured all your I/O, clear the Edit DIO Configurations checkbox.

## Jog Function

See Description of Digital Input Functions on page 425 for information on the individual DI functions.

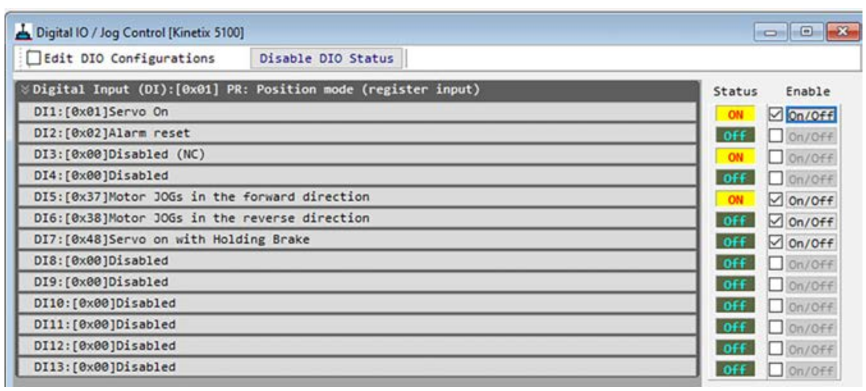
See Description of Digital Output Functions on page 429 for information on the individual DO functions.

The Jog Function commands the motor to run at a constant speed (Jog Speed). To control the jog operation, enter the desired jog speed and then determine the motor rotation direction. The existing motor rotation (Settings > General Setting > Rotation Direction) is used as the directional context in this dialog box.

There are two ways to initiate a Jog function on the Kinetix 5100 drive.

1. Use DIO to configure the Jog and Servo On Digital Inputs. Use Enable On/Off of DI1 (Servo On) signal manually.
   a. Check Enable DIO Configurations.
   b. Configure the Servo On Digital Input.
   c. Configure the  Motor JOGs in the forward direction input and, if required, configure the reverse direction.
   d. Clear the Edit DIO Configurations checkbox.
   e. Go online with the drive.
   f. Check Enable so that On/Off is visible.
   g. Click On/Off to change the status of the DI signals directly.

   You can see the signal status by looking at the Status window. To jog the motor, first enable the drive by using Servo On, then Jog forward or reverse as your application requires.




2. Use the Jog Control Panel and check Forced Servo On.
   a. When Forced Servo ON is checked, or your digital input is ON, click the left and right arrows to jog the motor in that specific direction.
   b. Stop clicking the left and right arrows to stop the motor rotation.
   c. If the observed rotation is opposite to what is desired, check Invert Direction.

   The direction of the jog command is inverted.

# Notes:

# Configure the Drive in Studio 5000 Logix Designer Application



## Studio 5000 Logix Designer Application

For help using the Studio 5000 Logix Designer® application as it applies to configuring the ControlLogix® or CompactLogix™ controllers, see the Additional Resources on page 8.

| IMPORTANT | Support for Studio 5000 Logix Designer is available only when you set Control Mode parameter (ID117 (P1.001)) to IO Mode (0x0C). |
|---|---|

### Version History

Each release of the Studio 5000 Logix Designer application makes possible the configuration of additional Allen-Bradley® motors, actuators, power supplies, and drive features not available in previous versions.

| IMPORTANT | To configure additional motors, actuators, and drive features with your Kinetix® 5100 servo drive, you must have drive firmware revision 1.*xxx* or 2.*xxx*. Refer to Table 75 to determine if you need to install the Kinetix 5100 drive Add-on Profile. |
|---|---|

Table 75 shows whether the AOP must be downloaded and installed. In later versions of Logix Designer application, the AOP is already installed.

**Table 75 - AOP Installation Requirement**

| Drive Firmware Revision | Logix Designer Application Version | Kinetix 5100 AOP Needed |
|---|---|---|
| 1.*xxx* or 2.*xxx* | 30.00, 31.00, 32.00 | Yes |
| | 33.00 or later | No |

**IMPORTANT** Although the AOP can come installed with the Logix Designer application, you might require interim features or functions that occur between Logix Designer application major releases. In this case, you would have to install your AOP manually.

## Install the Kinetix 5100 Add-On Profile

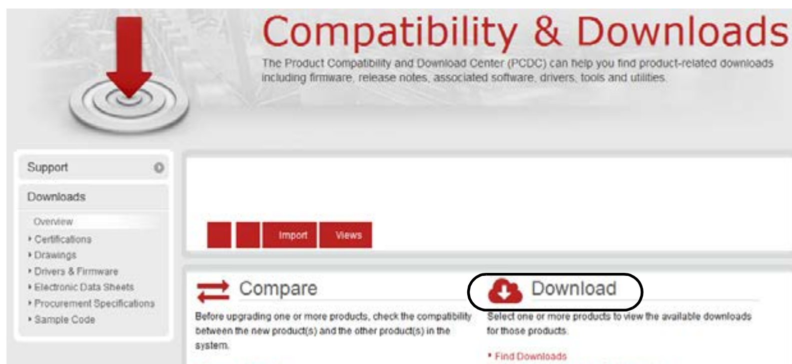
If Table 75 indicates you must download the AOP, download Add-On profiles (AOP) from the Product Compatibility Download Center (PCDC) website: rok.auto/pcdc.

Follow these steps to download the Kinetix 5100 Add-On Profile.

1. Go to the Product Compatibility Download Center.

   The Compatibility & Downloads webpage appears.

2. Click Download.




3. Enter Kinetix 5100 in the Search PCDC window.
4. Click the appropriate AOP revision and follow prompts to download.
5. Extract the AOP zip file and run Setup.

## Configure the Logix 5000 Controller

These procedures assume that you have wired your Kinetix 5100 drive system. These procedures show the dialog boxes for following devices.

- ControlLogix 5570 controller with a 1756-EN2TR EtherNet/IP™ communication module
- CompactLogix 5370 controller with an embedded EtherNet/IP connection

See the list of other compatible Logix PAC® and PLC Controller Platforms in Kinetix 5100 Drive System Overview on page 11.

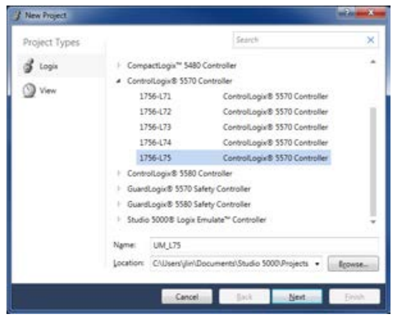
**IMPORTANT** To use your Kinetix 5100 servo drive with the provided AOP and pre-defined Add-On Instructions, you must configure your Kinetix 5100 drive in KNX5100C software first and change the control mode to IO Mode. See Download KNX5100C Software on page 124.

To configure your controller do the following.

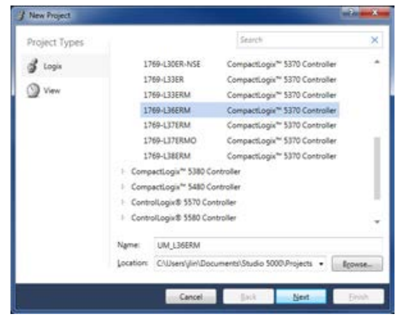
1. Apply power to your controller and run the Studio 5000 Logix Designer application.
2. From the Create menu, choose New Project.

   The New Project dialog box appears.

ControlLogix 5570 Controller



CompactLogix 5370 Controller



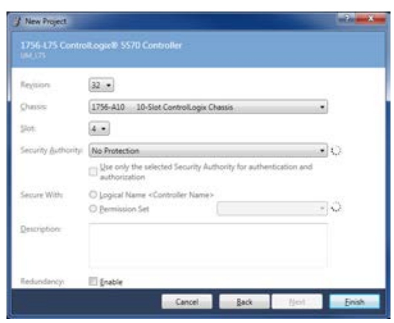
In this example, the typical dialog boxes for 1756-EN*x*T EtherNet/IP modules and CompactLogix 5370 controllers with embedded Ethernet are shown.

Follow these steps to configure your Logix 5000™ controller.

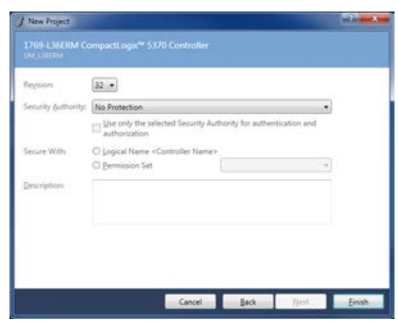
1. Expand the Logix 5000 controller family and select your controller.
2. Type the file Name.
3. Click Next.

   The New Project dialog box appears.

ControlLogix 5570 Controller



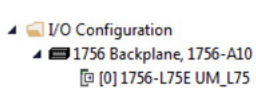
CompactLogix 5370 Controller



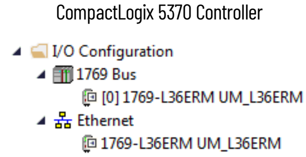
4. From the Revision pull-down menu, choose your software revision.
5. Click Finish.

   The new controller appears in the Controller Organizer under the I/O Configuration folder.

ControlLogix 5570 Controller

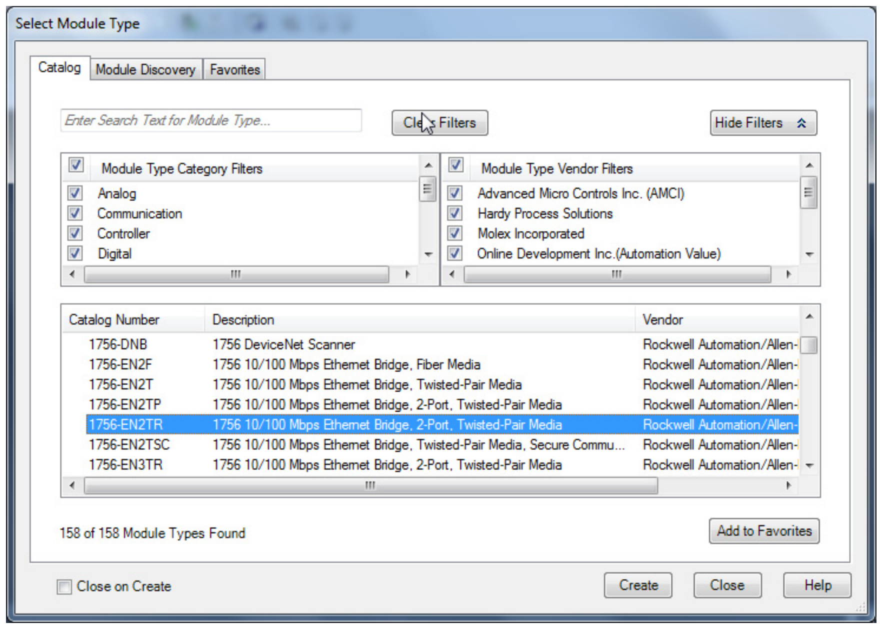



CompactLogix 5370 Controller



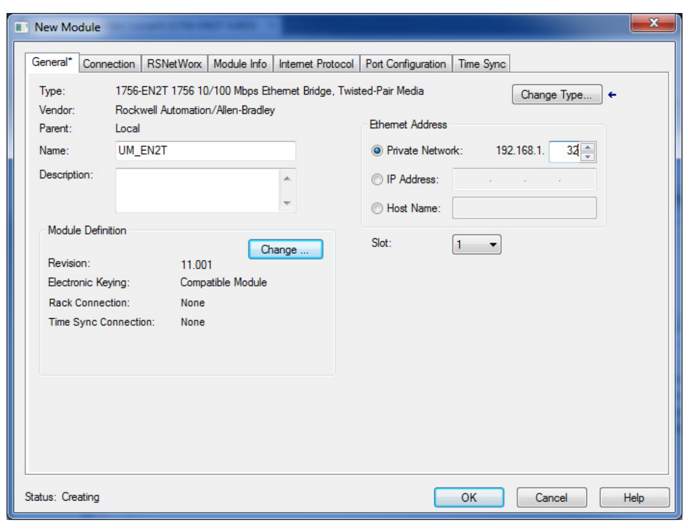
| **IMPORTANT** | If your project includes a ControlLogix or GuardLogix® 5570 controller, you need to add an EtherNet/IP communication module to your Bulletin 1756 chassis and configure it for use in your application.<br>• For ControlLogix 5570, and GuardLogix 5570 controllers, go to step 6.<br>• For CompactLogix 5370, Compact GuardLogix 5370, CompactLogix 5380, ControlLogix 5580, or GuardLogix 5580 controllers, go to step 13.<br>Refer to the EtherNet/IP Network Configuration User Manual, publication ENET-UM006 for more information on EtherNet/IP modules. |
|---|---|

6. Right-click I/O Configuration in the Controller Organizer and choose New Module.




7. By using the filters, check Communication and Allen-Bradley, and select 1756-EN2T, 1756-EN2TR, or 1756-EN3TR as appropriate for your hardware configuration. In this example, the 1756-EN2T module is selected.
8. Click Create.

   The New Module dialog box appears.




9. Configure the new module.
   a. Type the module Name.

b. Enter the Logix EtherNet/IP module slot (leftmost slot = 0).
c. Select an Ethernet Address option.

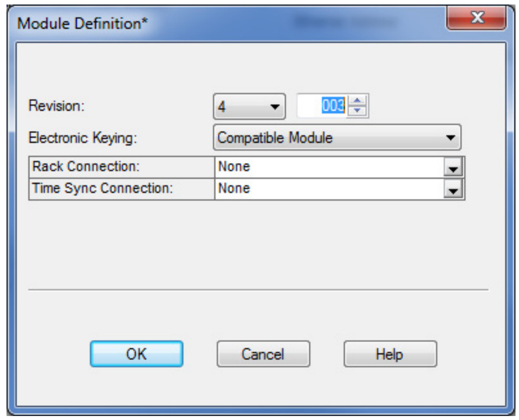
In this example, the Private Network address is selected.

d. Enter the address of your EtherNet/IP module.

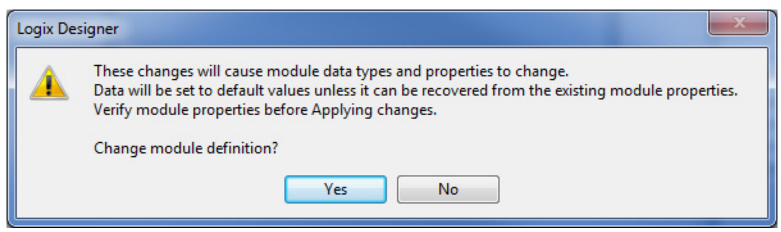
In this example, the last octet of the address is 32.

e. Click Change in the Module Definition area.

The Module Definition dialog box opens.




10. To close the Module Definition dialog box, click OK.
11. When prompted to confirm your module definition changes, click Yes.




12. To close the New Module dialog box, click OK.

Your new 1756-EN*x*T Ethernet module appears under the I/O Configuration folder in the Controller Organizer.

13. Click OK.

# Configure the Kinetix 5100 Drive Modules

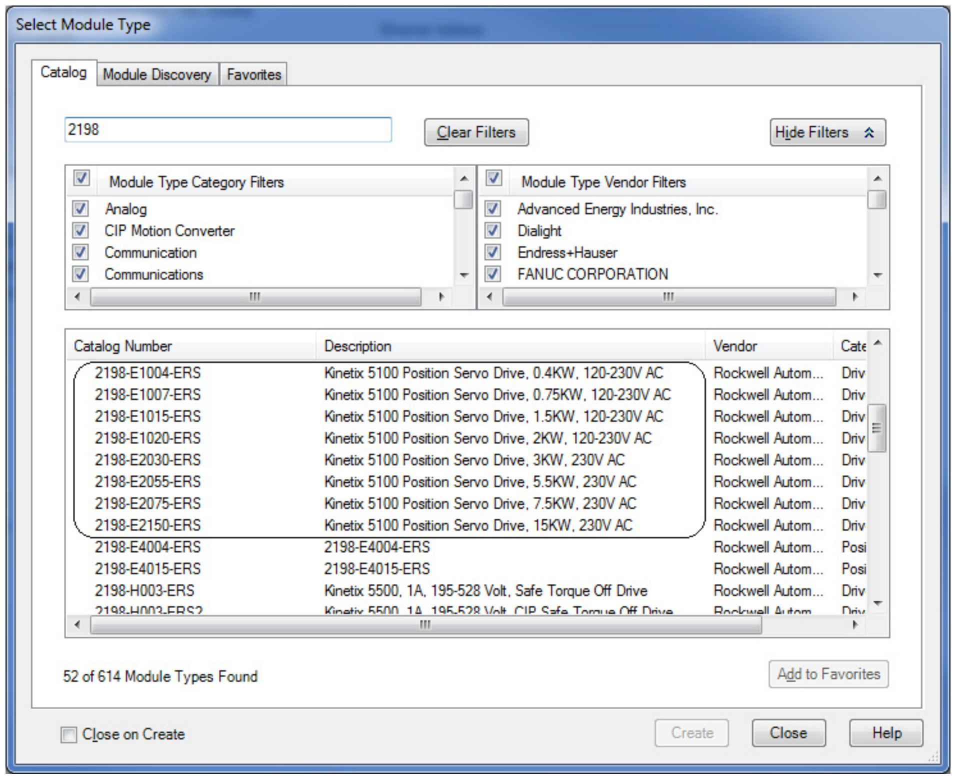
**IMPORTANT** To configure Kinetix 5100 drive systems, you must be using the Logix Designer application, version 30.00 or later.

In this example, a 2198-E1004-ERS drive is configured.

Follow these steps to configure Kinetix 5100 drives.

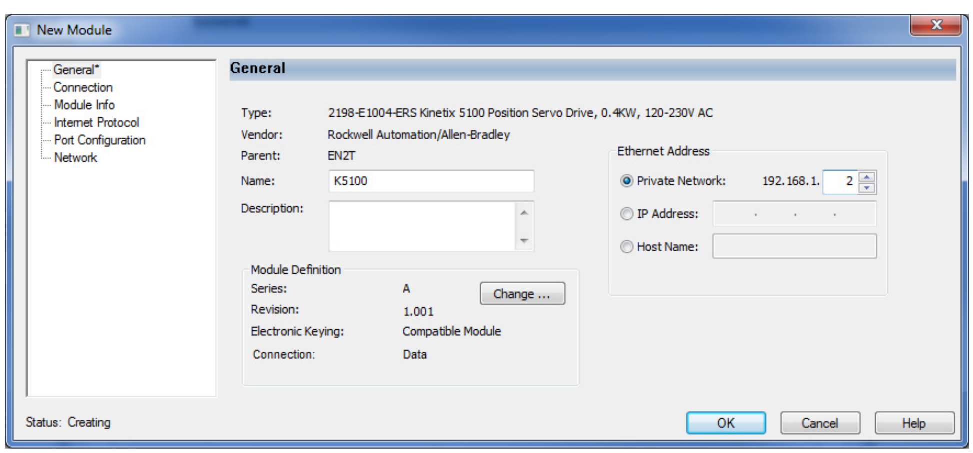
1. Right-click Ethernet/IP Module and choose New Module.

   The Select Module Type dialog box appears.




2. By using the filters, check Motion and Allen-Bradley, and select your 2198-E*xxxx*-ERS drive as appropriate for your hardware configuration.
3. Click Create.

   The New Module dialog box appears.



4. Configure the new drive.
   a. Type the drive Name.
   b. Select an Ethernet Address option.

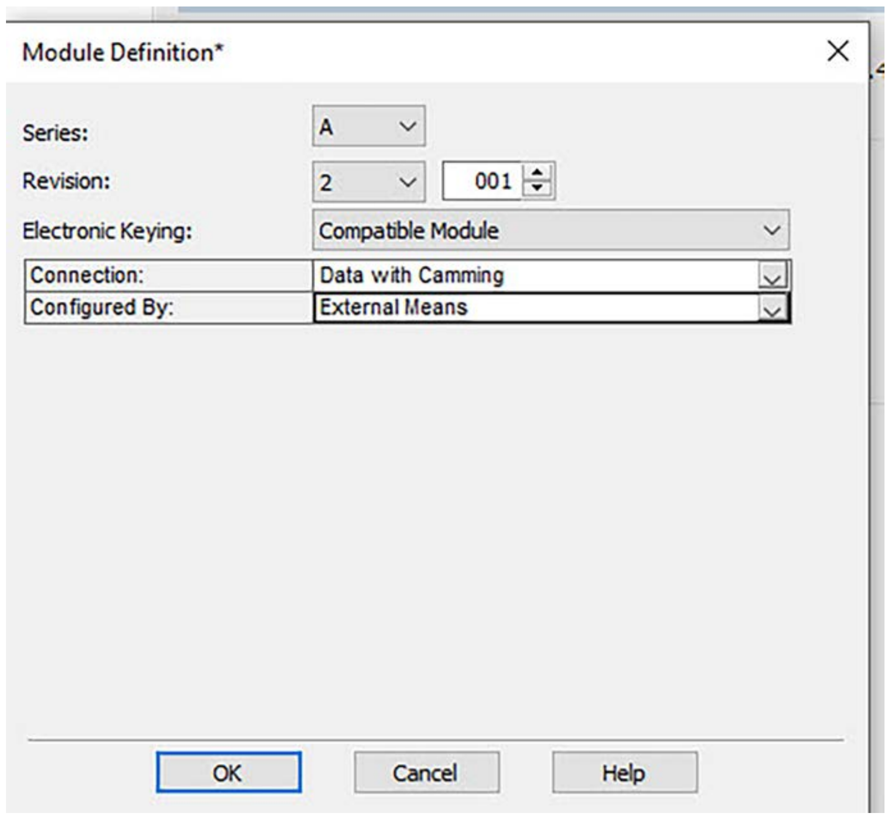
   In this example, the Private Network address is selected.

   c. Enter the address of your 2198-E*xxxx*-ERS drive.

   In this example, the last octet of the address is 2.

   d. Under Module Definition click Change.

   The Module Definition dialog box appears.




   e. Set Series and Revision to match your drive.
   f. Choose an Electronic Keying option.

   The electronic keying feature automatically compares the expected module, as shown in the configuration tree, to the physical module before communication begins. We recommend using either `Exact Match' or `Compatible Keying'. You cannot use Disable keying with safety applications. For more information about electronic keying, see the Electronic Keying in Logix 5000 Control Systems Application Technique, publication LOGIX-AT001.

   g. From the Connection pull-down menu, choose the Connection mode for your motion application.

| IMPORTANT | For new applications, it is typical to use Data with Camming. For legacy applications, use the following guidance to choose Data or Data with Camming. |
|---|---|

When Connection is Data, assembly output instance 104 is configured, or AOP revision 2 is used, then use the Add-On Instructions: raC_Dvc_K5100_MAG, raC_Dvc_K5100_ MAT, and structure AssemblyOutIOM from the 'Version 1' firmware folder.

When Connection is Data with Camming or assembly output instance 106 is configured, AOP version 2 or later must be used. The Operation Add-On Instructions can be used. (raC_Opr_K5100_*xxxx*)

h. From the Configured By: pull-down menu, when 'External Means' is used with AOP version 2.0 or later, ADC (Automatic Device Configuration) is not used. When 'This Controller' is used with AOP version 2.0 or later, ADC is used.

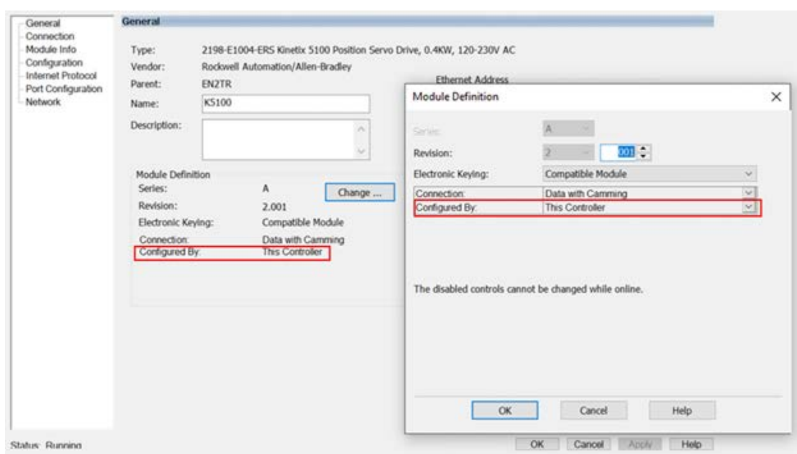
5. To close the Module Definition dialog box, click OK.
6. To close the Module Properties dialog box, click OK.
7. To close the Select Module Type dialog box, click Close.

Your 2198-*xxxxx*-ERS drive appears in the Controller Organizer under the Ethernet network in the I/O Configuration folder.

ControlLogix 5570 Controller CompactLogix 5370 Controller

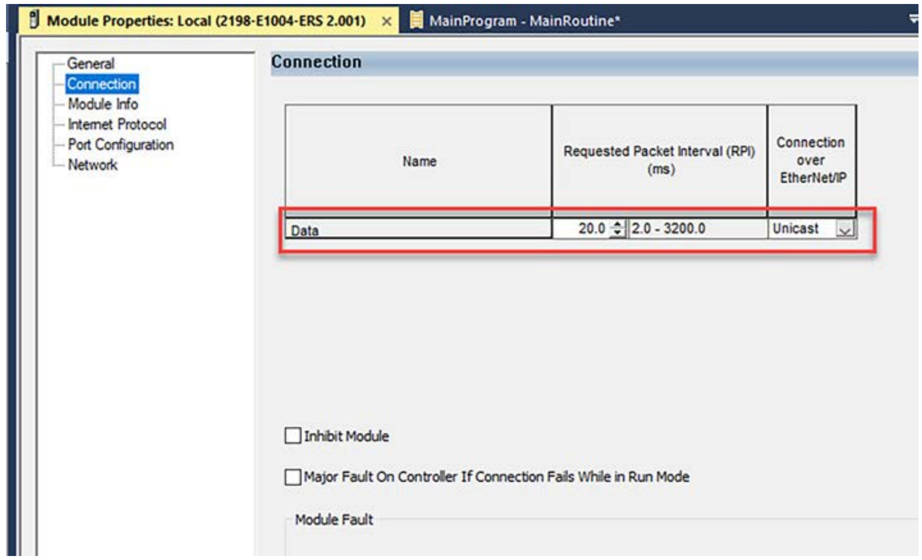

## Support Automatic Device Configuration (ADC) in AOP Version 2 and Later

ADC function can be enabled by setting 'Configured by' as 'This Controller'.



## Connection RPI

Choose the RPI (Requested Packet Interval) for your drive. In previous firmware revisions, the default was 2.0ms. We recommend 20 ms since this is a simple I/O device and not an integrated motion on EtherNet/IP (CIP) drive.

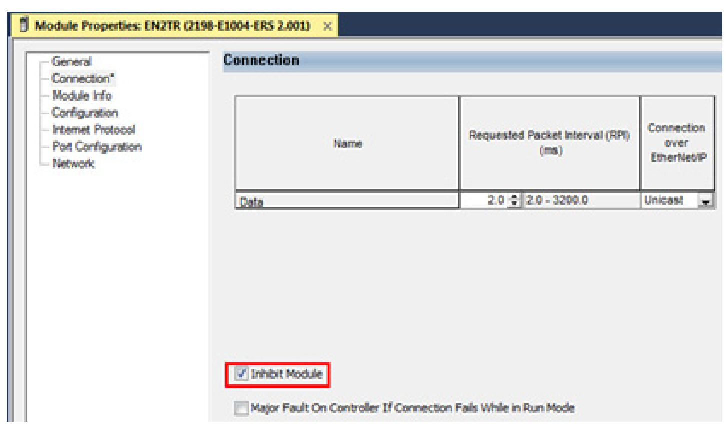



## Inhibiting/Un-inhibiting an I/O Connection

To inhibit the I/O connection, check 'Inhibit Module', then click 'Apply'.
To uninhibit the I/O connection, uncheck 'Inhibit Module', then press 'Apply'.

| | |
|---|---|
| **IMPORTANT** | The KNX5100C software does not permit configuration changes while an I/O connection exists with the controller. To enable configuration changes using the KNX5100C software, check 'Inhibit Module' and apply changes. If ADC is not configured, uncheck 'Inhibit Module' and apply changes after configuration changes are completed. If ADC is configured, import the configuration changes into the Studio 5000 project and controller before un-inhibiting the I/O connection. |

**Figure 83 - Inhibit Module**



## Download the Program

When the Logix Designer application development is complete, the file is saved. You must download your program to the Logix 5000 controller.

For legacy applications, we have developed some sample logic that you can use to import the entire Add-On Instruction library into your Studio 5000 Logix Designer application by using an .L5X file as the import mechanism. See Appendix C on page 479 for details on the Add-On Instruction library.

For new applications, use the Logix Designer application with the Plug-in Wizard once the Power Device library (which includes the new Add-On Instructions) is downloaded from the PCDC site.

# Tuning

This chapter provides information about tuning.



This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

See Motion System Tuning, publication MOTION-AT005 for more information regarding tuning.

**IMPORTANT** Linear motors are not supported with Autotune.

# Tuning Process

## Reset Gains to Default

The drive uses default tuning gains when the drive and motor catalog number are chosen. If you are unsure of the present drive tuning, it might be necessary to revert the drive to the default gains. To revert to the default, use GainAdjustMode ID217 (P2.032) = 4. This change resets the gains to default values. Once the gain reset is complete, restore the value to its original setting where:

- 0 = manual
- 1 = Mode1,
- 2 = Mode2,
- 3 = reserved
- 4 = reset to default

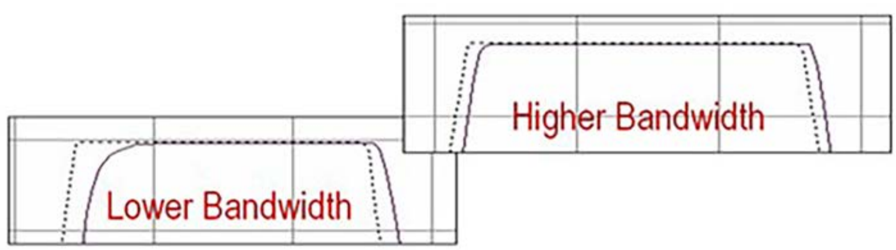
The autotuning test moves the motor (and the load if attached) and attempts to determine the optimal settings for the drive/motor combination relating to the gains and filters. If autotuning does not provide suitable performance, then tuning mode 1, tuning mode 2, and manual tuning mode can be used. You can use the System Analysis tool to generate a system response after the different tuning types are executed.

The flowchart in Figure 84 provides an overview of the tuning process.

Before we examine gains (and consider changing them) if the default gain model is not sufficient for your application, understanding some control theory terms and concepts is important. It can help you understand what is important about the tools and gain settings.

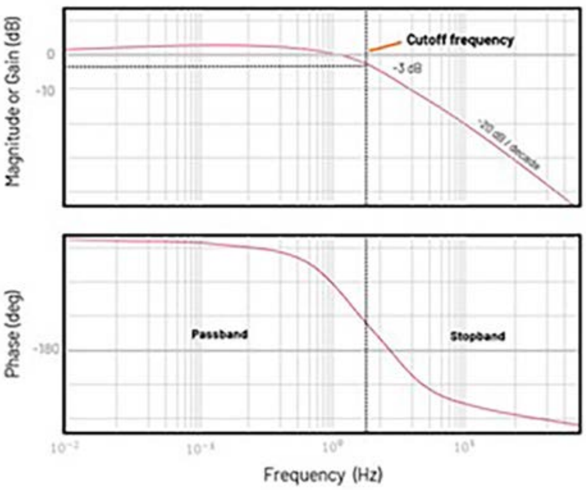
## Bandwidth

Bandwidth is the measure of the system performance. The bandwidth is typically measured in Hertz (Hz). When the Bandwidth is higher, that indicates a responsive system, as can be seen from this image; the dotted line indicates a command signal, and the solid line indicates the actual response from the load. Lower bandwidth systems indicate a lower response. See MOTION-AT005 for additional details on the bandwidth term.



A good way to understand the characteristics of your system (and its performance) is to use a Bode plot.

As shown in this bode plot using Hz (left), the usable bandwidth is the area below the -3.0dB point and cutoff frequency. This same representation is shown in Hz (right) and the bandwidth is indicated.



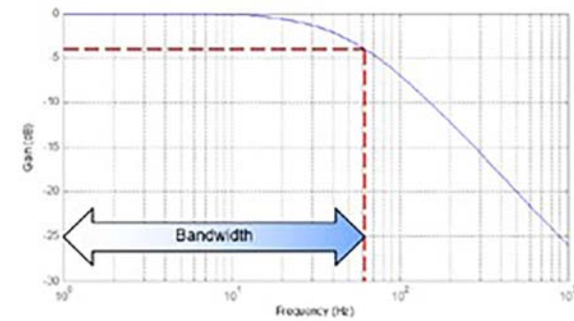
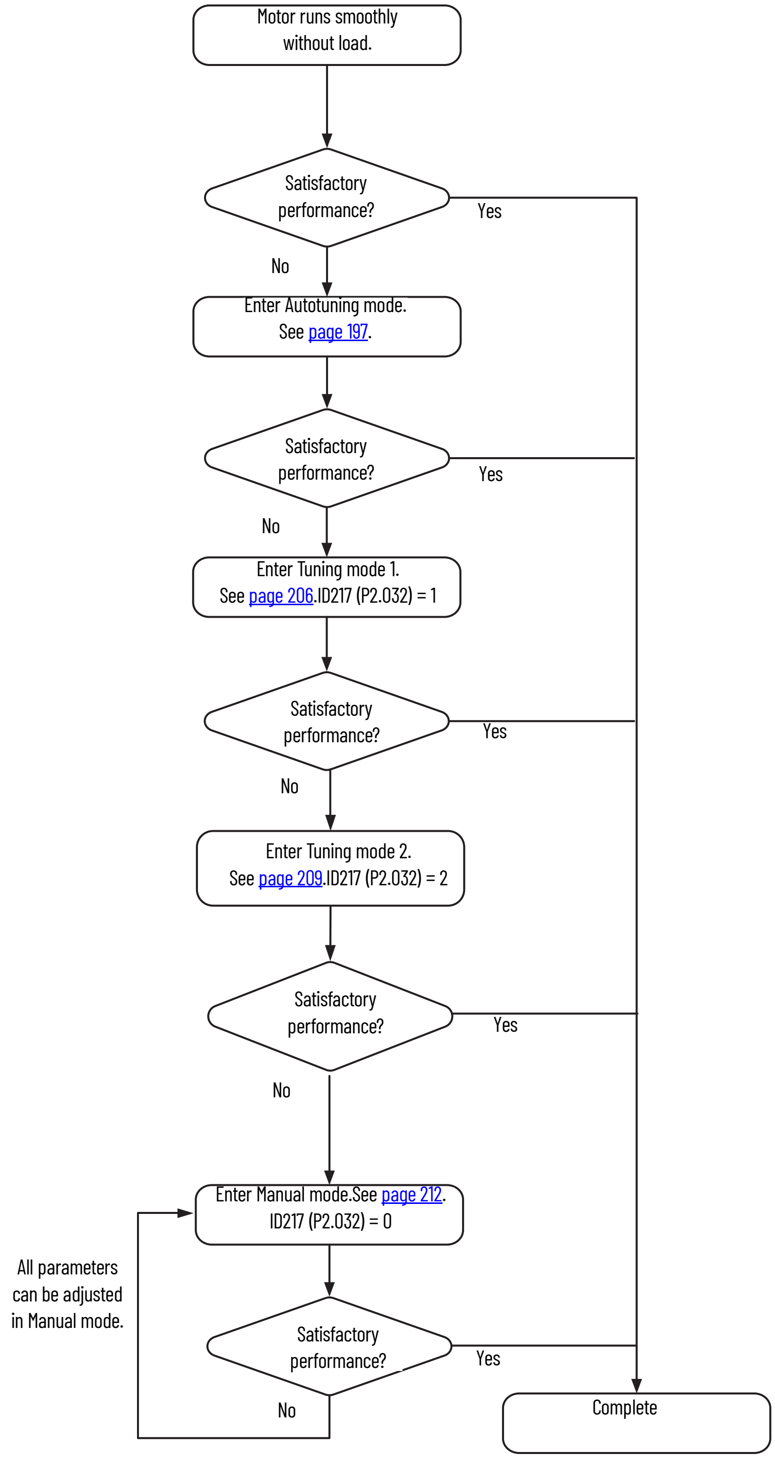



**Figure 84 - Tuning Procedure Flowchart**



# Autotuning

Autotuning can be performed via KNX5100C software or via the drive panel. Currently, autotuning cannot be performed via Studio 5000 Logix Designer® application. Autotuning works best when performed on a mechanism with a load ratio (load:motor inertia ratio) of < 50:1.

Through the autotuning function, the servo drive helps you find the most suitable parameters for your mechanical system. The values of the parameters listed in the following tables can change as a result of autotuning.

**Table 76 - Gain-related Parameters**

| Parameter | Name |
|---|---|
| ID144 (P1.037) | LoadInertiaRatio |
| ID185 (P2.000) | PositionProportionalGain |
| ID189 (P2.004) | VelocityProportionalGain |
| ID191 (P2.006) | VelocityIntegralGain |
| ID216 (P2.031) | SystemGainResponseLevel |
| ID217 (P2.032) | GainAdjustMode |

**Table 77 - Filter and Resonance Suppression Parameters**

| Parameter | Name |
|---|---|
| ID135 (P1.025) | LowFreqVibrationSuppression1Frequency |
| ID136 (P1.026) | LowFreqVibrationSuppression1Gain |
| ID137 (P1.027) | LowFreqVibrationSuppression2Frequency |
| ID138 (P1.028) | LowFreqVibrationSuppression2Gain |
| ID208 (P2.023) | NotchFilter1Frequency |
| ID209 (P2.024) | NotchFilter1Depth |
| ID210 (P2.025) | ResonanceSuppressionLowPassFilterTime |
| ID226 (P2.043) | Notch Filter2Frequency |
| ID227 (P2.044) | Notch Filter2Depth |
| ID228 (P2.045) | Notch Filter3Frequency |
| ID229 (P2.046) | Notch Filter3Depth |
| ID232 (P2.049) | VelocityFeedbackLowPassFilterTime |
| ID257 P(2.098) | Notch Filter4Frequency |
| ID258 P(2.099) | Notch Filter4Depth |
| ID260 P(2.101) | Notch Filter5Frequency |
| ID261 P(2.102) | Notch Filter5Depth |

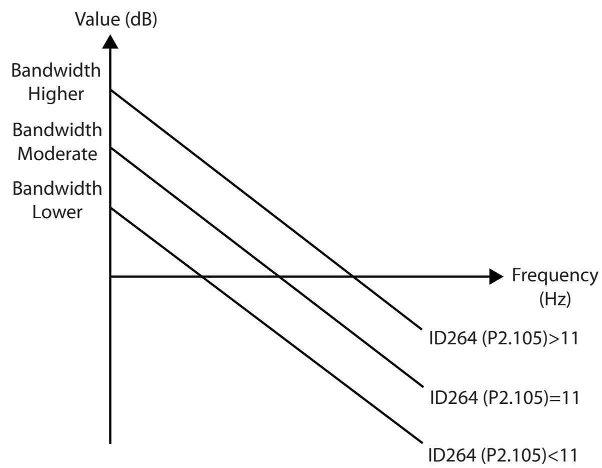
## Autotuning Configuration Parameters

Parameters ID264 (P2.105) AutoTuningBandwidth and ID265 (P2.106) Auto TuningOvershoot can be used to adjust the responsiveness and stiffness, respectively, in autotuning mode.

*ID264 (P2.105) - AutoTuningBandwidth Parameter*

This parameter is used to adjust the system bandwidth in conjunction with autotuning. If this value is larger than the default response of 11, the bandwidth after autotuning is higher, this higher bandwidth might be problematic for your load, causing machine resonances or even instability. If this value is smaller, the bandwidth after autotuning is lower, and the system response is lower.

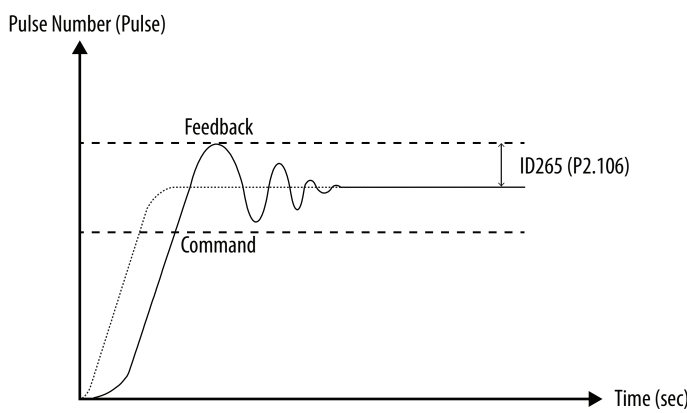
**Figure 85 - AutoTuningBandwidth Parameter Graph**




*ID265 (P2.106) - AutoTuningOvershoot Parameter*

This parameter is used to adjust the maximum allowable overshoot when autotuning. The overshoot range is set according to the user or machine. If this value is larger, the maximum overshoot that is allowed by autotuning is greater, and the response is faster. If this value is smaller, the maximum overshoot that is allowed by autotuning is smaller, but the response is slower.

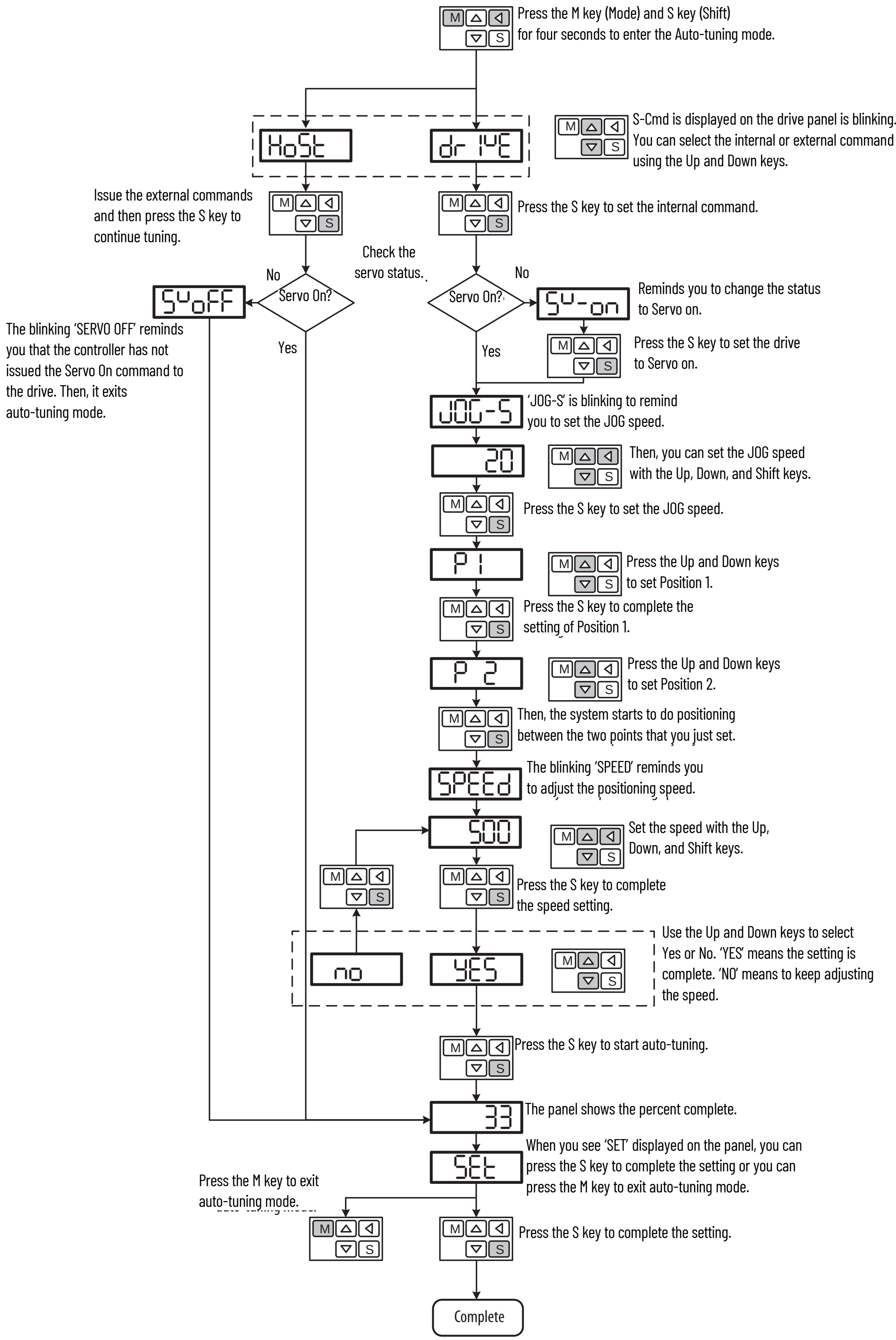
**Figure 86 - AutoTuningOvershoot Parameter Graph**




## Autotuning via the Drive Panel

See Figure 87 for an overview of autotuning via the drive panel. Make sure that the emergency stop and the positive and negative limit works properly before you start to tune the system.

**Figure 87 - Autotuning Via the Drive Panel Flowchart**



## Autotuning via KNX5100C Software

Autotuning can be performed by using KNX5100C software. When the drive and motor are connected, and the drive is online with the KNX5100C software, follow these steps to autotune the drive. You can autotune with or without the load attached. The autotune is effective when used with a Load:Motor inertia ratio of less than 50:1 with a rigid load.

There are two options available that determine how the motor is commanded to drive.

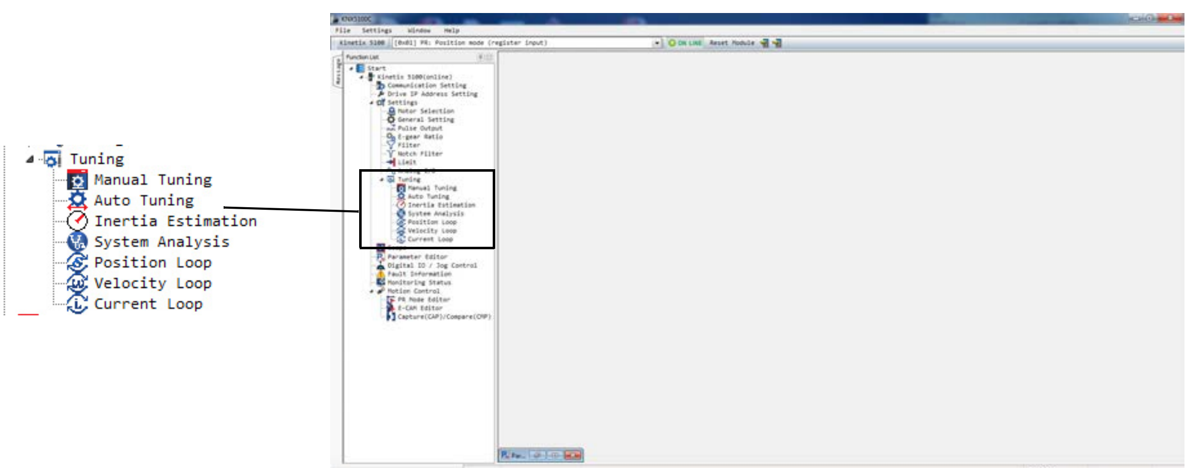
- Host controller plans the path and issues the command to drive the motor
- Drive plans the path and issues the command to drive the motor

**ATTENTION:** The motor rotates during this tuning procedure. Hazard of personal injury exists due to motor shaft rotation and/or machinery motion.

*Connect to Drive and Select Autotuning*

1. Select Add New Drive from the New menu.
2. On the New Device dialog box, click Add.

   Once you are connected with your drive and you are Online, the following window is displayed.
3. Click Auto Tuning from the Function list Settings>Tuning .



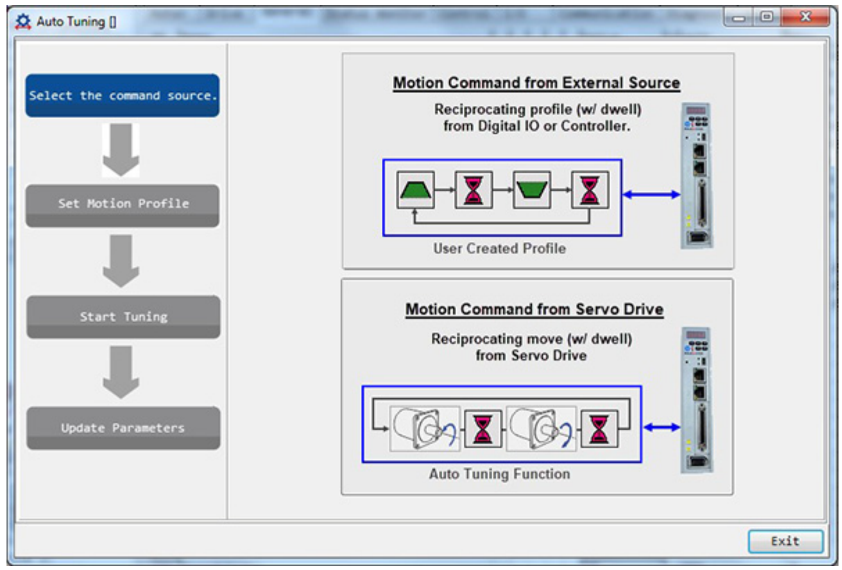

4. Continue with the steps that are shown in Motion Command From Controller or Motion Command From Servo Drive.

### *Motion Command From Controller*

Follow these steps to have the host controller plan the path and issue the command to drive the motor. The path for autotuning must be bi-directional and contain a dwell to support the drive firmware.

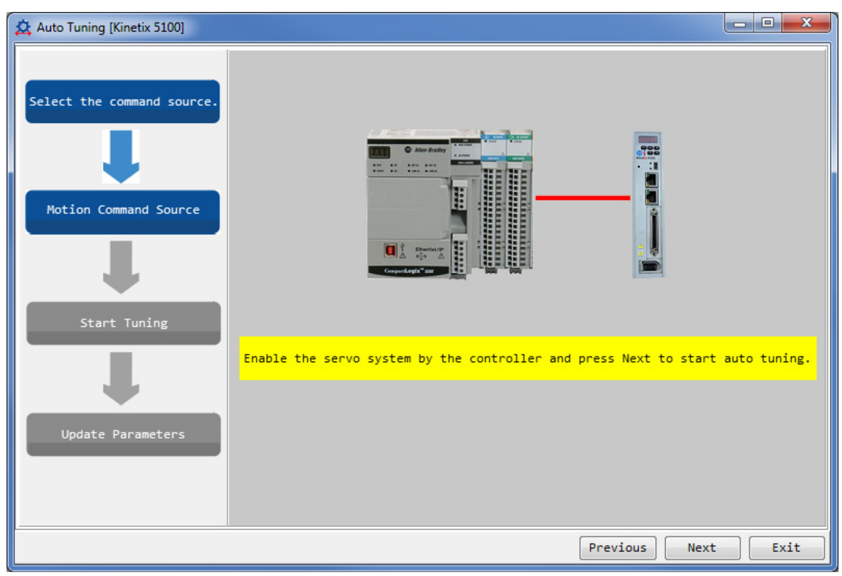
1. Select **Controller: Motion Command From External Source** and make sure that the motion path is set correctly.

   The controller is generating a bi-directional profile with a dwell segment between each path. The graphic shows the path.

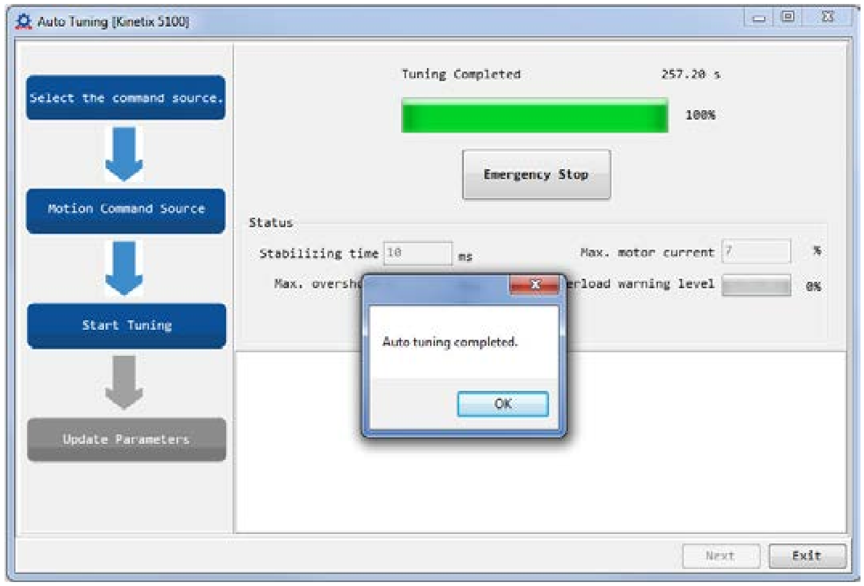



Set the motor to operate at least one cycle in both forward and backward directions.

2. After the setting is done, run the motor repeatedly by using the path you just set, and then click Next.

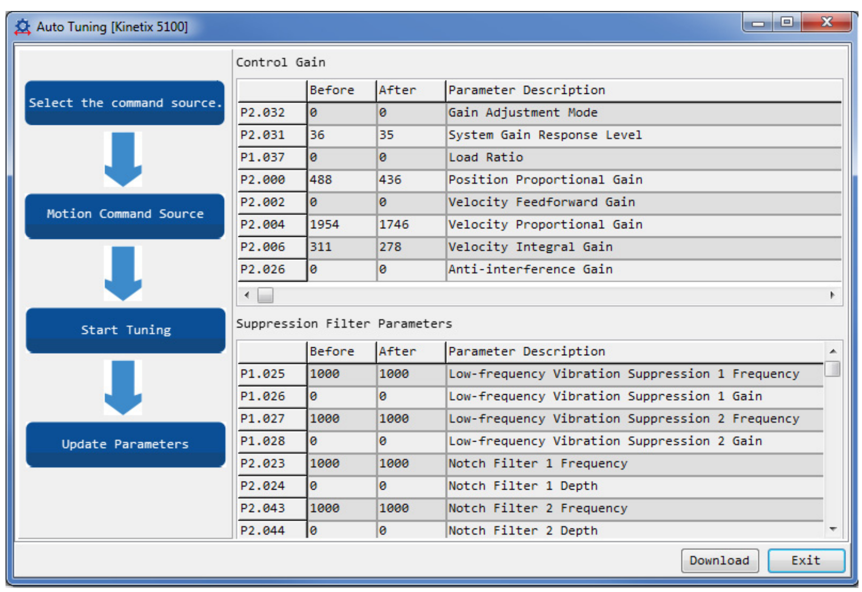


3. Wait until the tuning progress bar reaches 100%, a dialog box showing autotuning completed is displayed, and then click OK.




You can click Emergency Stop to stop the tuning process.

A table is displayed that shows the values of parameters before and after autotuning.

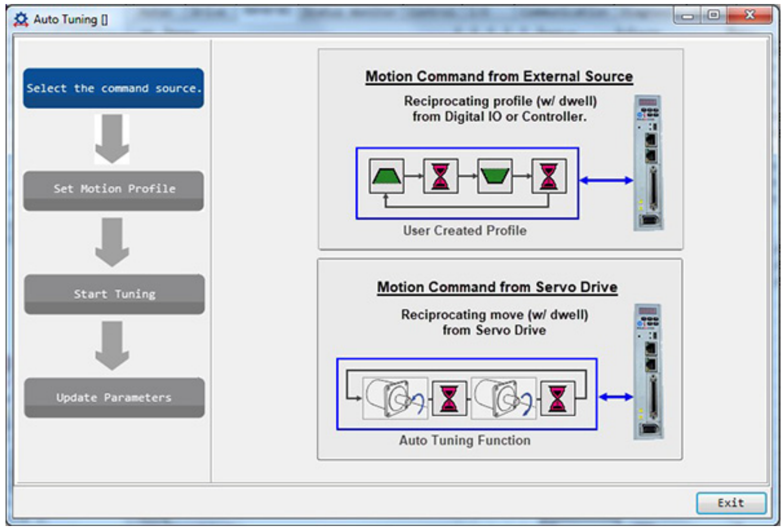



4. Click Download (apply the tuning result) or Exit (ignore the tuning result) to complete autotuning.

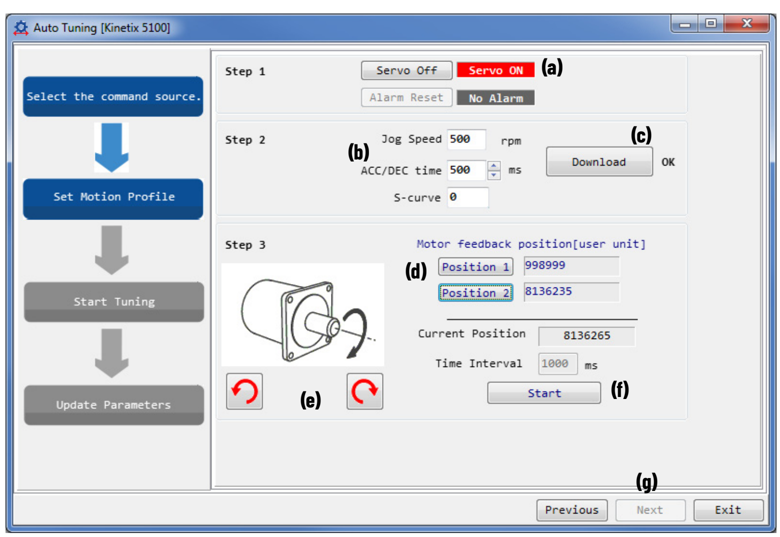
### Motion Command From Servo Drive

Follow these steps to have the drive plan the path and issue the command to move the motor.

1. Select **Drive: Motion Command From Servo Drive**.

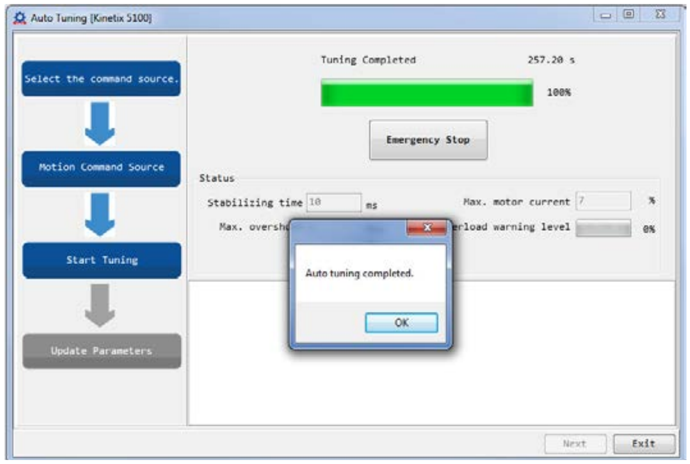



2. Complete the following steps to set the running path of the motor.
   a. Set the system to Servo ON state.
   b. Set the acceleration/deceleration time and jog speed.
   The default setting of acceleration/deceleration time is 500 ms.
   Set the jog speed to no less than 500 rpm. Set these values similarly to your application requirements.
   c. Click Download.
   d. When the motor dynamics are set (Step 2 of the Autotuning dialog box), click Position 1 to register a start position for the bi-directional autotune index.
   e. Use  or  to jog the motor away from Position 1 and to generate Position 2. When you have chosen a location for Position 2, click Position 2.
   f. Then, click Start to move the motor between the two positions. The motor uses bi-directional movements between Position 1 and Position 2.
   g. Click Next.



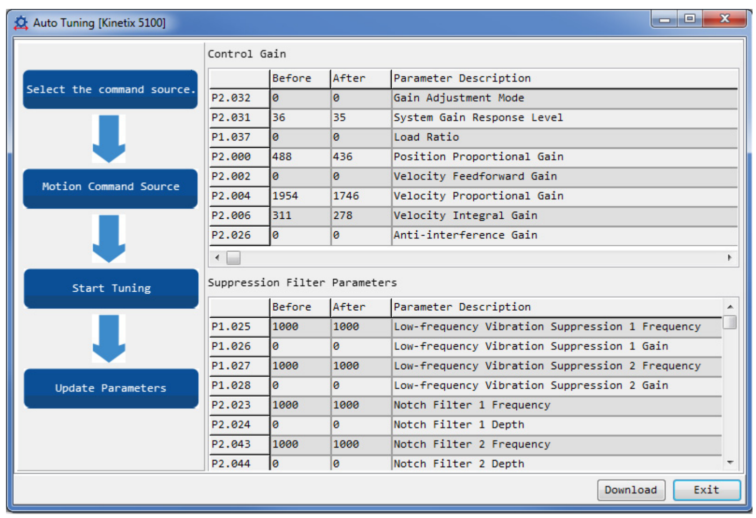
3. Wait until the tuning progress bar reaches 100%, a dialog box showing Auto tuning completed is displayed, and then click OK.

   The autotune process can take a few minutes to complete. The drive is measuring resonance and gain output. You might hear vibrations and noise from the motor during the autotune, which is normal.




You can click Emergency Stop to stop the tuning process.

A table is displayed that shows the values of parameters before and after autotuning.

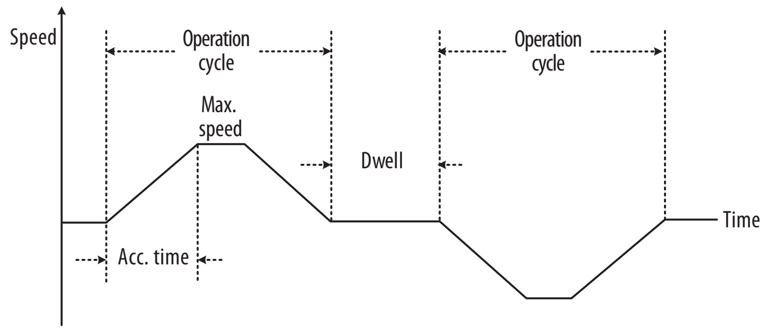



4. Click Download (apply the tuning result) or Exit (ignore the tuning result) to complete autotuning.

## Alarms Related to Autotuning

When using Autotune: Motion Command from External Source, the operation cycle (such as acceleration, constant speed, and deceleration) and dwell time are vital to the correct execution of the Autotune test. See Figure 88.

**Figure 88 - Settings Required for Autotuning**




If any of these settings are not correct, the servo drive stops and displays a fault. See Table 78 for possible causes and solutions.

**Table 78 - Faults Related to Autotuning**

| Fault Code | Fault Name | Possible Causes | Possible Solutions |
|---|---|---|---|
| E 08A | Autotuning command error | The external source command was not issued. | Check the external source command. |
| | | Cable connection error. | Check the cable connection. |
| | | Position 1 and 2 were the same when command was issued. | Reconfigure position 1 and 2. |
| E 08B | Dwell time too short | Dwell time too short. | Setting the dwell time is required. Increase the dwell time to more than 1 second. |
| E 08C | Inertia estimation error | Acceleration/deceleration time was too long. | Verify that the acceleration/deceleration time for motor to start from 0…3000 rpm is within 1.5 sec. |
| | | Speed is too slow. | The lowest possible speed setting is 200 rpm. The maximum speed is 3000 rpm, set the value as high as your application allows. |
| | | Inertia mismatch. | Verify that load inertia is not more than 50 times the motor inertia. |
| | | Inertia variation is too vigorous. | Resize the system requirements. |

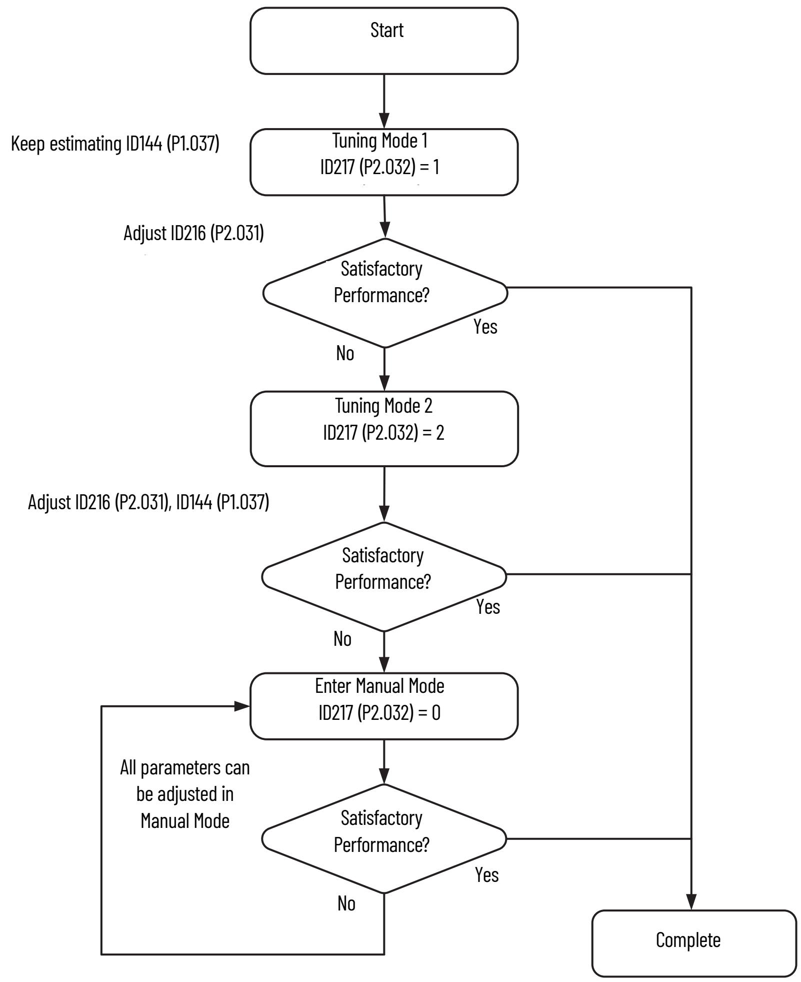
# Tuning via Tuning Mode 1 and Tuning Mode 2

Apart from the autotuning function described earlier, there are two other tuning modes provided to fine-tune the system.

## Tuning Mode Process

See Figure 89 for an overview of the tuning mode process.

**Figure 89 - Tuning Mode Process**



## Tuning Mode 1

In this mode, the drive keeps estimating the mechanical inertia and updating the value of parameter ID144 (P1.037). As shown in Table 79, note that you can adjust the parameters in the Manual Tuning column while in Tuning Mode 1, but the parameters in the Autotune column are still adjusted automatically.

**Table 79 - Tuning Mode 1, Related Parameters**

| ID217 (P2.032) Setting Value | Tuning Mode | Inertia Estimation | Parameter | |
|---|---|---|---|---|
| | | | Manual Tuning | Autotuning |
| 1 | Tuning Mode 1 | Real-time estimation | ID216 (P2.031) | ID144 (P1.037) |
| | | | | ID185 (P2.000) |
| | | | | ID189 (P2.004) |
| | | | | ID191 (P2.006)( |
| | | | | ID208 (P2.023) |
| | | | | ID209 (P2.024) |
| | | | | ID210 (P2.025) |
| | | | | ID229 (P2.046) |
| | | | | ID226 (P2.043) |
| | | | | ID 227 (P2.044) |
| | | | | ID228 (P2.045) |
| | | | | ID232 (P2.049) |
| | | | | ID257 (P2.098) |
| | | | | ID258 (P2.099) |
| | | | | ID260 (P2.101) |
| | | | | ID261 (P2.102) |

*Inertia Estimation*

Inertia Estimation occurs while the motor is indexing and under acceleration and deceleration. It does not estimate while the motor is at standstill. When the present value of Inertia is similar to the estimated value, the present value is maintained.

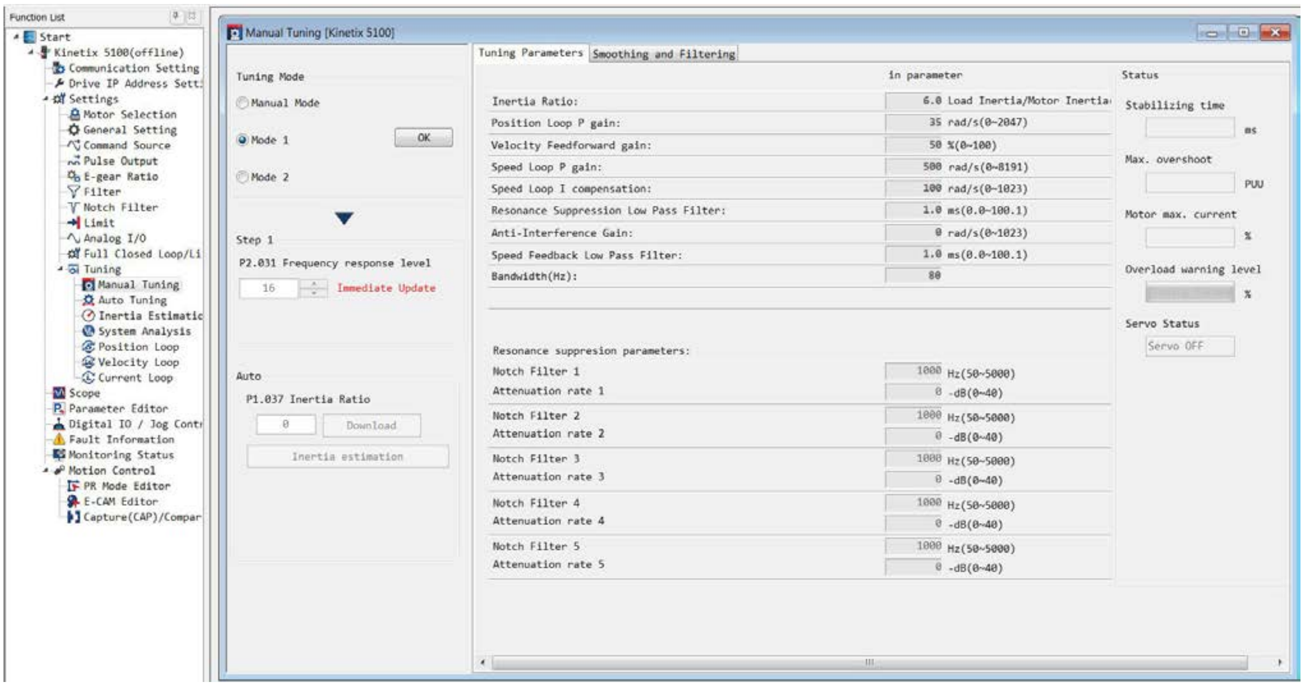
Requirements for Inertia estimation:

- User defined movement (an indexing PR for example).
- Motor speed increases from 0 rpm…3000 rpm within 1.5 seconds.
- It is suggested to set the speed to 500 rpm or greater. Set the lowest speed no less than 200 rpm.
- The load inertia should be less than 50 times the motor inertia.
- The change in the external force or inertia ratio cannot be too great.

### *Tuning Mode 1 in KNX5100C Software*

You can use KNX5100C software for manual tuning in Mode 1 by choosing Manual Tuning from the Function List and selecting Mode 1.

**Figure 90 - Selecting Mode 1 Manual Tuning**




The Smoothing and Filtering tab lets you configure the parameters related to the Low Pass and Moving filters and S-curve, depending upon your configured Operating mode. See Chapter 10 for details on filters and s-curves.

## Tuning Mode 2

When Tuning Mode 1 does not meet your performance requirements, you can try Tuning Mode 2 to tune the servo system. In Tuning Mode 2, the system does not automatically estimate the inertia, but rather it lets you choose the Inertia Estimation to occur once by using a user-defined movement created in the KNX5100C software. As shown in Table 80, note that the parameters in the Manual Tuning column can be adjusted while in Tuning Mode 2, but the parameters in the Autotune column are still adjusted automatically.

The correct mechanical inertia ratio must be entered in parameter ID144 (P1.037).

**Table 80 - Tuning Mode 2, Related Parameters**

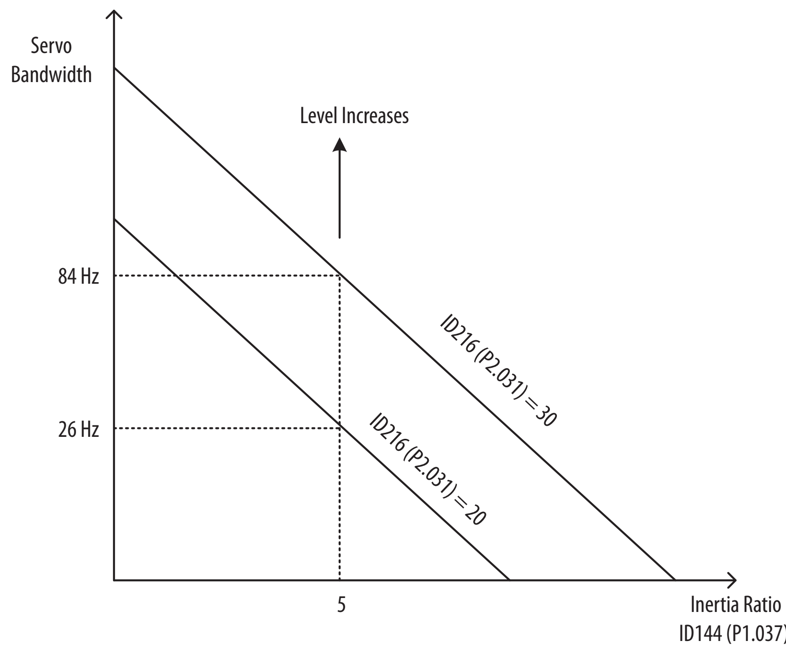
| ID217 (P2.032) Setting Value | Tuning Mode | Inertia Estimation | Parameter | |
|---|---|---|---|---|
| | | | Manual Tuning | Autotuning |
| 2 | Tuning Mode 2 | Value of ID144 (P1.037) | ID144 (P1.037)<br>ID216 (P2.031) | ID185 (P2.000)<br>ID189 (P2.004)<br>ID191 (P2.006)<br>ID208 (P2.023)<br>ID209 (P2.024)<br>ID210 (P2.025)<br>ID226 (P2.043)<br>ID227 (P2.044)<br>ID228 (P2.045)<br>ID229 (P2.046)<br>ID232 (P2.049)<br>ID257 (P2.098)<br>ID258 (P2.099)<br>ID260 (P2.101)<br>ID261 (P2.102) |

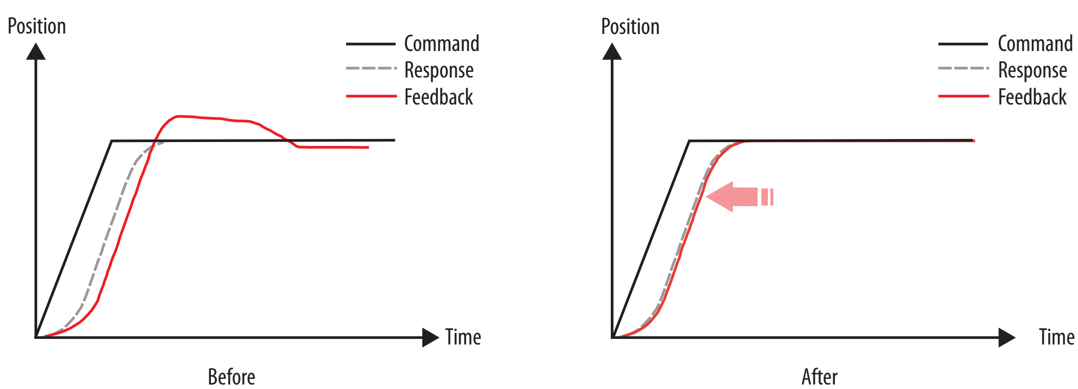
### *Setting ID216 (P2.031) SysGainResponseLevel*

Parameter ID216 (P2.031) SysGainResponseLevel is provided to tune the servo system in an easy and user-friendly way. When using the fixed inertia ratio and increasing this parameter, the servo bandwidth is also increased. If resonance occurs, lower the bandwidth levels and it is possible to use resonance mitigation techniques to resolve the resonance. Adjust the bandwidth level according to the actual application.

For instance, if the setting value of ID218 (P2.031) was 30, the bandwidth level can be reduced to 28. When adjusting the value of this parameter, its corresponding parameters is adjusted by the servo system, such as ID185 (P2.000) PositionProportionalGain and and ID189 (P2.004) VelocityProportional Gain.

**Figure 91 - Settings for SysGainResponseLevel**

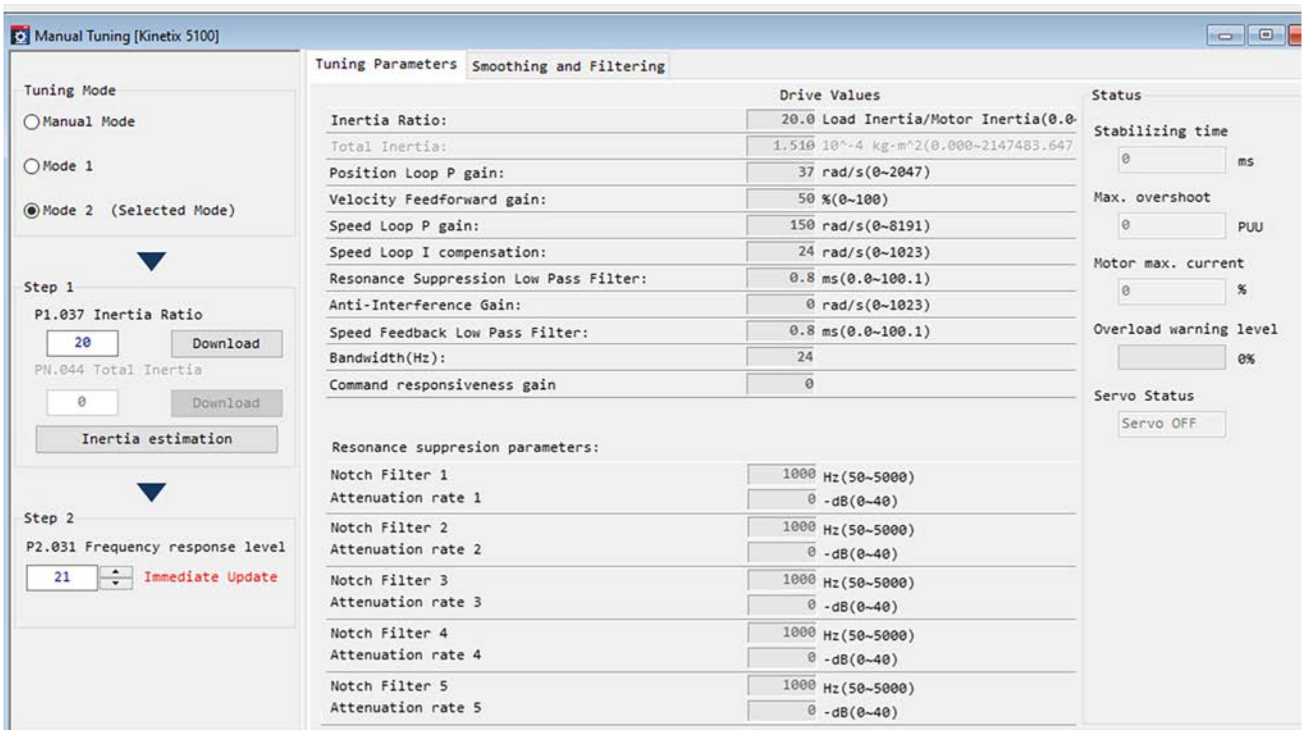


### *Tuning Mode 2 in KNX5100C Software*

You can use KNX5100C software for manual tuning in Mode 2 by choosing Manual Tuning from the Function List and selecting Mode 2.

**Figure 92 - Selecting Mode 2 Manual Tuning**




The Smoothing and Filtering tab lets you configure the parameters related to the Low Pass and Moving filters and S-curve, depending upon your configured Operating mode. See Chapter 10 for details on filters and s-curves.

# Tuning in Manual Mode

## Nested P-I Loop Gain Adjustment

There are two types of gain adjustment for the position and velocity loops: auto and manual.

**Auto adjustment** is achieved when an Auto Tuning procedure is executed in the Kinetix 5100 drive.

For a detailed description, refer to Autotuning on page 197.

**Manual adjustment** is when the inside-out tuning method is used and user adjustments are made.

## Manual Mode Tuning

Manual tuning can result in the optimum performance for complex mechanisms. See Motion System Tuning, publication MOTION-AT005 for more information regarding tuning in manual mode. You can reference this publication for best practices that are common to inside-out tuning.

Table 81 lists parameters used in Manual Mode tuning.

**Table 81 - Manual Mode Tuning**

| ID 217 (P2.032) Gain Adjustment Mode Setting | Tuning Mode | Inertia estimation | Parameter | |
|---|---|---|---|---|
| | | | Manual Tuning | Autotuning |
| 0 | Manual | Value of ID144 (P1.037) | ID144 (P1.037)<br>ID188 (P2.000)<br>ID189 (P2.004)<br>ID191 (P2.006).<br>ID208 (P2.023)<br>ID 209 (P2.024)<br>ID210 (P2.025)<br>ID211 (P2.026)<br>ID226 (P2.043)<br>ID227 (P2.044)<br>ID228 (P2.045)<br>ID229 (P2.046)<br>ID232 (P2.049)<br>ID257 (P2.098)<br>ID258 (P2.099)<br>ID260 (P2.101)<br>ID 261 (P2.102 | – |

The machinery stiffness and the application determines the selection of the position and speed response frequency. Generally, for applications or machines that require high speed and high precision, higher bandwidth is required. However, increasing the bandwidth might cause resonance.

When the resonance frequency is unknown, you can gradually increase the gain parameter values to increase the system response bandwith until you hear the sound of resonance. Then, decrease the gain parameter values until the resonance is removed. You can use the System Analysis test to diagnose resonant frequencies, also there are many FFT (Fast Fourier Transform) tools that you can use to diagnose resonant frequencies. You can use the drive filtering described in Filter on page 250. Generally, if the dominant resonant frequency is within the servo loop bandwidth, the gain values (and system response) must be lowered.

The following are the descriptions of the gain adjustment parameters used with different application types.

**Table 82 - Gain Selection Based on Application Type**

| Application Type | Applications | $K_{PI}$ | $K_{VI}$ | Integrator Hold | $K_{VFF}$ | $K_{AFF}$ |
|---|---|---|---|---|---|---|
| Basic | Basic smooth motion | | | | X | |
| Tracking | • Converting<br>• Printing<br>• Web<br>• Flying shear<br>• Coordinated motion<br>• Rotary knife<br>• Packaging | | X | | X | X |
| Point to Point | • Pick and place<br>• Indexing<br>• Robotics<br>• Palletizing | X | | X | | |
| Constant Speed | • Conveyors<br>• Line shafts<br>• Cranks | | X | | X | |
| Positioning | High performance position control | X | | | X | X |

## Gain Adjustment of the Position Loop

The position loop gain should not be larger than the velocity loop gain.

$fp \leq \frac{fv}{4}$ *Where:*
fv = response bandwidth of **speed** loop (Hz)
fp = response bandwidth of **position** loop (Hz)

$KPP = 2 \times \pi \times fp$ *Example:* If the desired position bandwidth is 20 Hz, then adjust the KPP (ID185, P2.000) to 125 ($2 \times \pi \times 20$ Hz = 125).

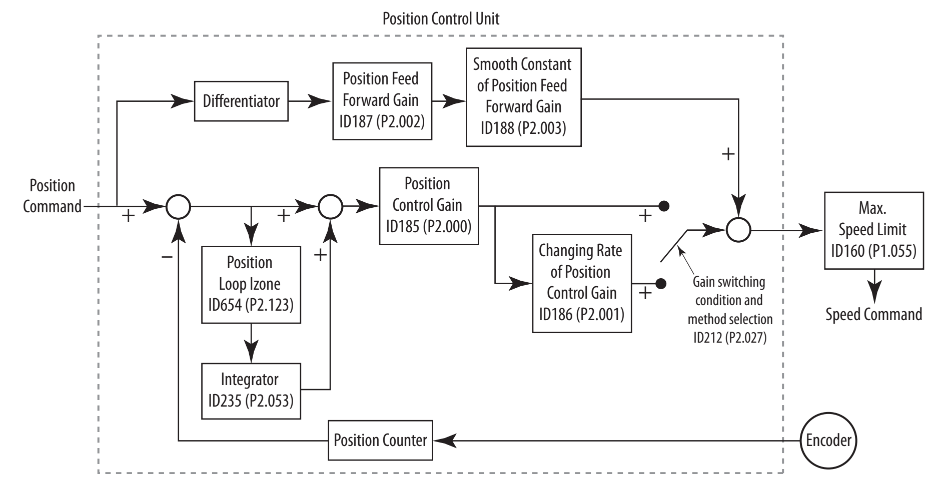


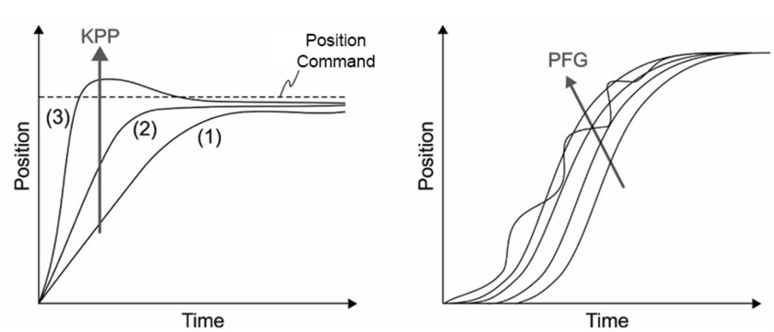

**Table 83 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID185 (P2.000) | PositionProportionalGain (KPP) |
| ID235 (P2.053) | PositionIntegralGain (KPI) |
| ID187 (P2.002) | VelocityFeedForwardGain (KVFF) |

There are three types of gain:

1. Proportional gain: a larger gain increases the response of its loop.
2. Integral Gain: a larger gain increases the steady-state performance.
3. Feed forward gain: reduces the deviation of phase delay.

By using inside-out tuning, we tune the inner loop (velocity) first. The VelocityProportional Gain ID189 (P2.004) and VelocityIntegralGain ID191 (P2.006) are in the Velocity (Speed) loop and once they are set, you can manually change the outer loop (position) gains. The PositionProportionalGain ID185 (P2.000), PositionIntegralGain ID235 (P2.053), and VelocityFeedforwardGain ID187 (P2.002).




The actual position curve changes from (1…3) with the increase in the KPP value.

*ID185 (P2.000) PositionProportionalGain [KPP]*

This parameter determines the response of the position loop. The larger the KPP value, the higher the response frequency of the position loop. This lowers following error and position error, and shortens the settling time. However, if you set the value too high, it can cause instability. The calculation of position loop frequency response is as follows:

$$\text{Frequency response bandwidth of position loop (Hz)} = \frac{\text{KPP}}{2\pi}$$

*ID 235 (P2.053) PositionIntegralGain (Kpi)*

This gain may not be used (zero). This gain is used in positioning and tracking applications to improve the steady-state positioning . Set this gain such that:

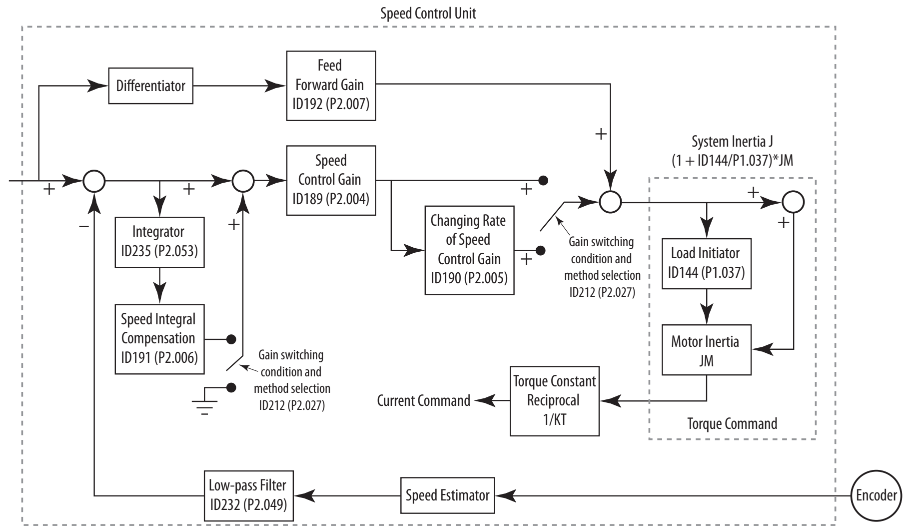
$$0 \leq Kpi \leq Kpp/4$$

See Nested P-I Loop Gain Adjustment on page 212 for more information.

*ID187 (P2.002) VelocityFeedforwardGain [PFG]*

This parameter can reduce the position error and shorten the settling time. However, if you set the value too high, it might cause overshoot in positioning.

## Gain Adjustment of Velocity Loop




*Manual Mode*

When the Gain Adjustment Mode parameter ID217 (P2.032) is set to 0, Manual Mode tuning is used and you must set parameters VelocityProportionalGain ID189 (P2.004), VelocityIntegralGain ID191 (P2.006), and AccelFeedforwardGain ID192 (P2.007). More detail about adjusting the gains is as follows:

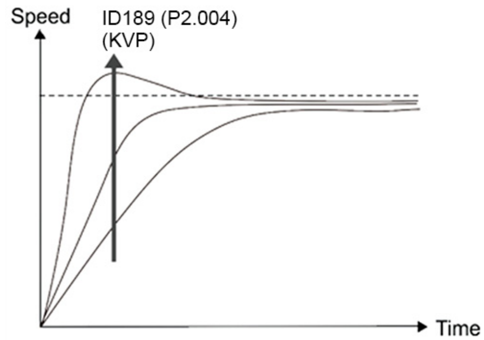
- Velocity loop gain: The higher the gain, the bigger bandwidth of velocity loop response is.
- Integral gain: Increasing this gain will increase the low frequency rigidity and reduce the steady-state error. However, phase margin is smaller. If this gain is set too high, the system stability will be reduced.
- Feed forward gain: Diminish the deviation of phase delay.

**Table 84 - Relevant Parameters**

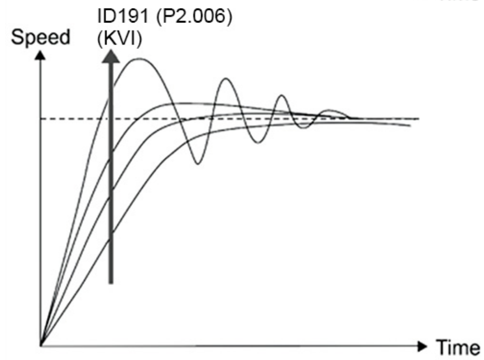
| Parameter | Name |
|---|---|
| ID189 (P2.004) | VelocityProportionalGain (KVP) |
| ID190 (P2.006) | VelocityIntegralGain (KVI) |
| ID191 (P2.007) | AccelFeedForwardGain (KAFF) |

Theoretically, a stepping response can be used to explain proportional gain (KVP), integral gain (KVI), and feed forward gain (KVF). Speed over time diagrams are shown below to illustrate the basic principle.

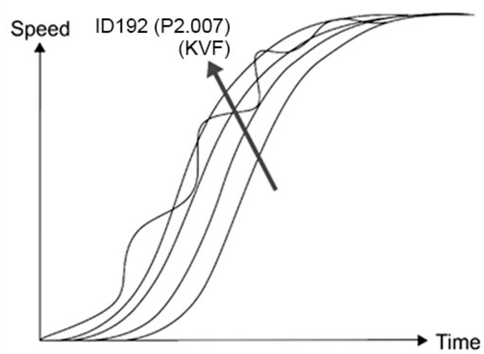
*Timing Diagrams*




Impact of Speed Proportional Gain (KVP) Setting
The higher the KVP value, the larger the bandwidth, and the speed increase time also shortens. However, if the value is set too high, the phase margin is too small. The effect is not as good as KVI for the steady-state error but is better for the effect on following.




**Impact of Speed Integral Gain (KVI) Setting**
The higher the KVI value, the larger the low frequency gain. It shortens the time for the steady-state error to reduce to zero. However, it does not significantly reduce the following error.




Impact of Acceleration Feedforward Gain (KVF) Setting
The closer the KVF value is to 1, the more complete the forward compensation. The following error becomes very small. But a KVF value that is set too high also causes vibration.

*ID189 (P2.004) VelocityProportionalGain [KVP]*

This parameter determines the response of velocity loop. The larger the KVP value, the higher the response frequency of the velocity loop and the lower the velocity error. However, if you set the value too high, it could cause instability. Typically, the response frequency of the velocity loop must be 4…6 times higher than the response frequency of the position loop; otherwise, instability can occur. The calculation of velocity loop frequency response is as follows:

$$fv = \left(\frac{KVP}{2\pi}\right) \times \left(\frac{1 + (P1.037)/10}{1 + \frac{JL}{JM}}\right) Hz$$

JM= Motor Inertia; JL: Load Inertia; ID144 (P1.037): 0.1 (times)

When ID144 (P1.037) (auto estimation or manually set value) is equal to the real inertia ratio (JL / JM), the real velocity loop frequency response is:

$$fv = \left(\frac{KVP}{2\pi}\right) Hz$$

### *ID191 (P2.006) VelocityIntegralGain [KVI]*

KVI is used to provide better tracking during motion. The larger the value, the smaller the tracking error. Set the value as follows:

$$\text{KVI (P2.006)} \leq 0 \leq \text{Kvi} \leq \text{Kvp}/4$$

### *ID210 (P2.025) ResonanceSuppressionLowPassFilterTime [NLP]*

A large inertia mismatch forces a reduction in the frequency response of the velocity loop. Therefore, you must increase the KVP value to maintain the response frequency. Increasing KVP value might cause machinery resonance. Use this parameter to mitigate the resonance. The higher the value, the better the capability for reducing high-frequency noise. However, if you set the value too high, it can cause instability in the velocity loop and overshoot in positioning. It is suggested that you set the value as follows:

$$\text{NLP (P2.025)} \leq \frac{10000}{6 \times \text{Speed loop frquency response (Hz)}}$$

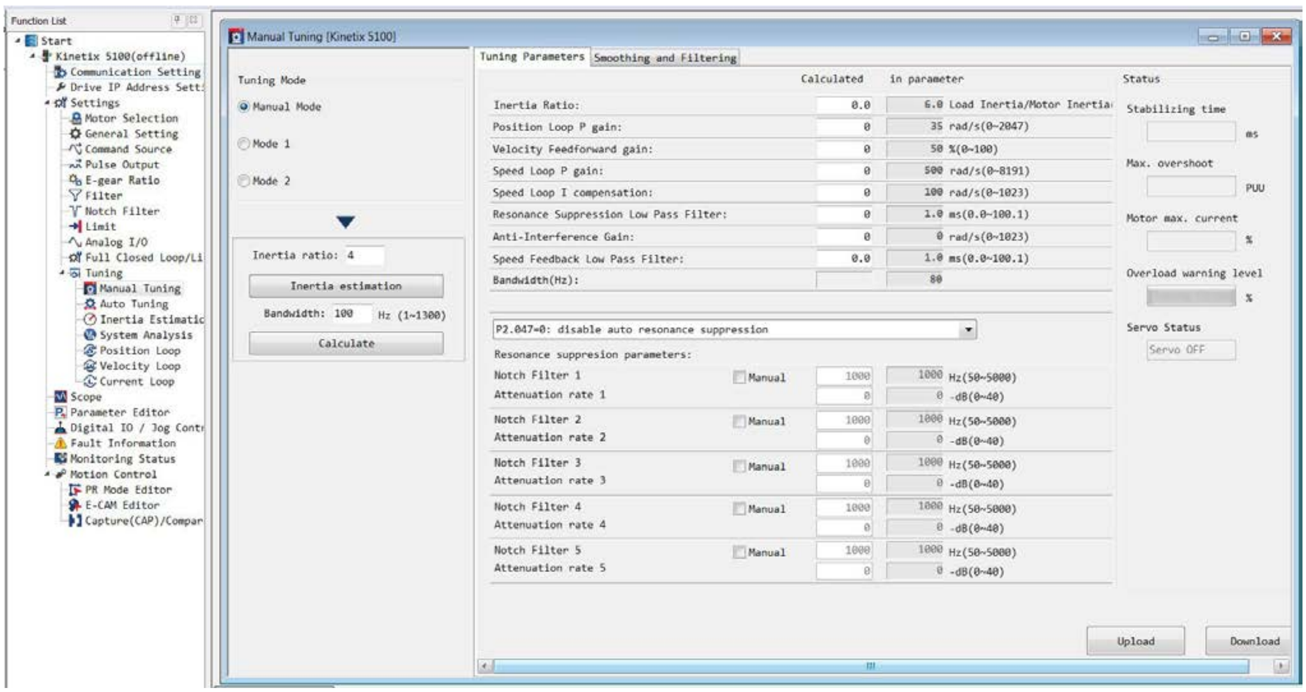
### *ID211 (P2.026) AntiInterferenceGain [DST]*

Use this parameter to increase the ability to resist external force and mitigate overshoot during acceleration / deceleration. The default value is 0. This value is not typically set when you use Manual Tuning. It is set when you use Mode 1, Mode 2, or Autotune.

### *Manual Mode Tuning in KNX5100C Software*

You can use KNX5100C software for manual mode tuning by choosing Function List>Tuning>Manual Tuning.

**Figure 93 - Selecting Manual Mode Tuning**




The Smoothing and Filtering tab lets you configure the parameters related to the Low Pass and Moving filters and S-curve, depending upon your configured Operating mode. See Chapter 10 for details on filters and S-curves.

## Low Frequency Vibration Suppression in Position Mode

If the mechanism is compliant, the resonance can be present even when the motor stops running after positioning command is executed completely. The Low Frequency vibration suppression can reduce, or remove, the resonance. The suppression range is between 1.0 Hz and 100.0 Hz. Both manual setting and auto setting are available.

You can use any FFT tool to diagnose the resonant frequency that exists on the mechanism.

**Table 85 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID135 (P1.025) | LowFreqVibrationSuppression1Frequency |
| ID136 (P1.026) | LowFreqVibrationSuppression1Gain |
| ID137 (P1.027) | LowFreqVibrationSuppression2Frequency |
| ID138 (P1.028) | LowFreqVibrationSuppression2Gain |
| ID139 (P1.029) | LowFreqVibrationSuppressionMode |
| ID140 (P1.030) | LowFreqVibrationDetectionLevel |

*Automatic Setting*

If you have difficulty determining the resonant frequency, you can enable the auto low frequency vibration suppression function, which searches for the resonant frequency. When parameter LowFreqVibrationSuppressionMode ID139 (P1.029) is set to 1, the drive automatically searches for the resonant frequency. This state remains active (ID139 (P1.029) =1) until a resonant frequency is determined, or no vibration or resonance is detected. Once the vibration suppression is applied, and the resonance is removed, this parameter is reset to 0, and the resonant frequency that was obtained, is stored inLowFreqVibrationSuppression1Frequency (ID135, P1.025). We recommend that you use a LowFreqVibrationSuppressionGain ID138 (P1.028) of 1. The second frequency suppression is used when multiple resonances are present. A second resonance suppression operates the same way the first resonance suppression operates.

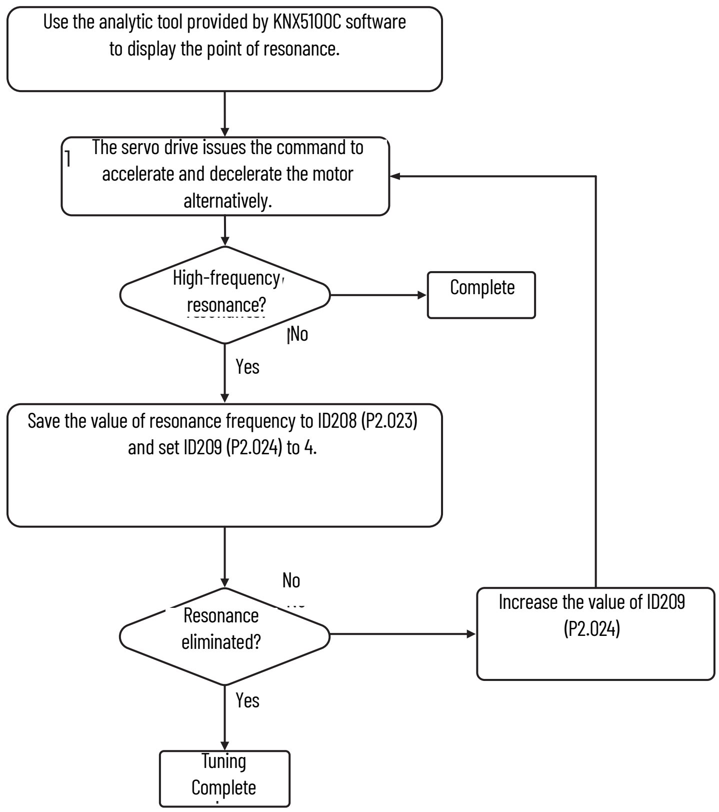
LowFreqVibrationDetectionLevel ID140(P1.030) is used when the LowFreqVibrationSuppressionMode =1. The detection level value is the size of the resonance in encoder counts. Setting this value too large can result in misrepresenting a resonance for actual motion or missing the resonance entirely. Setting a value too small, typical motor current noise can be misdiagnosed as a resonance. The default for this value is 8000 counts. This value changes based on your E-Gear scaling value.

| | |
|---|---|
| **IMPORTANT** | When the detection level is set too small, noise might be regarded as low-frequency vibration. |

## Mechanical Resonance Suppression

Figure 94 shows an overview of the procedure to suppress mechanical resonance. Five sets of notch filters are provided to suppress mechanical resonance. All five sets can be set to auto-resonance suppression (set by parameter ID230 (P2.047) ResonanceSuppressionConfig) and manual adjustment.

**Figure 94 - Mechanical Resonance Suppression Flowchart**



## System Analysis

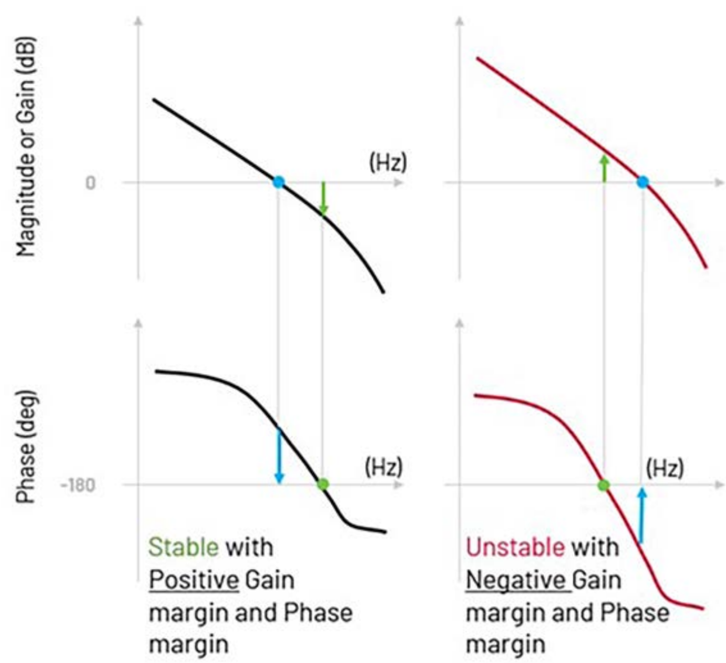
The Kinetix 5100 drive can create a bode plot by using the System Analysis test. The bode plot lets you see the frequency response of a system. By applying an input signal and comparing it to an output signal, we can see a variation in the magnitude and shift in phase of that signal. The Bode plot shows these variations as part of the System Analysis test in the KNX5100C software.

### Phase Margin and Gain Margin

The phase margin is the amount of open-loop change required to make a closed loop system unstable. In other words, the available Phase (degree) before the system becomes unstable. The phase margin is measured at the 0 dB Magnitude point of the bode plot. When the Phase (degree) reaches -180, the signal flips, which causes instability. The Phase Margin is the available phase from the System's phase measurement to the -180-degree point. If the Phase margin is close to zero (or negative), the system is susceptible to ringing and overshoot, which is shown in Figure 95.

The gain margin is a measure of gain amplification used to reduce error between the input and output signals. Gain Margin is the available gain before the system becomes unstable. When the Phase (deg) reaches -180 degrees, the signal will flip causing instability. The Gain Margin is measured at this point of the bode plot and is shown as the available gain until the 0 dB point is reached, which is shown in Figure 95.

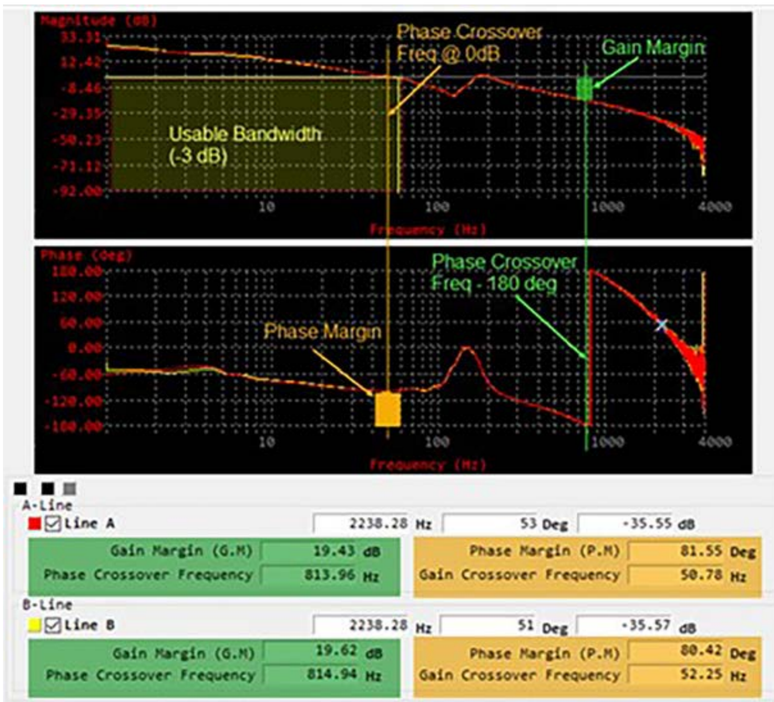
**Figure 95 - Phase and Gain Margin**



## Guidelines for Gain/Phase Margin

- Gain and phase margin must be positive values.
- Phase margin range between 30…60 is considered acceptable. A value lower than 30 will lead to instability. This means you must lower gains to raise the Phase margin, which means you lower the performance (Bandwidth). A value greater than 45 means you have a stable system, and you can increase the gains further, which means you raise the performance (Bandwidth).
- Gain margin range between 5…10 dB is considered acceptable. This should be positive, if its negative, the system is unstable.
- If the response curves never cross 0 dB or -180 degrees, the system has low performance, but is likely stable.
- The gain and phase margin values vary by machine (mechanism) type and by the inertia reflected to the motor shaft.

**Figure 96 - System Analysis Tool - Bode plot**




## Method for Using the System Analysis Tool

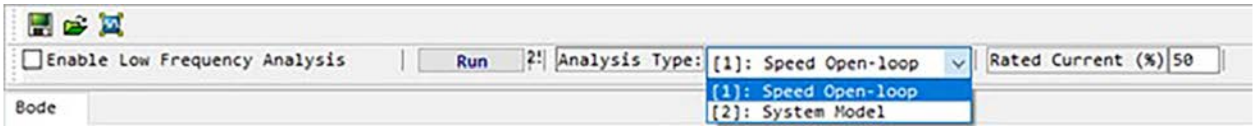
You can use the System Analysis tool to develop a bode plot; and ultimately characterize your system. This type of information is useful with complex mechanisms that are difficult to tune.

Before any tuning is attempted, a baseline System Analysis test should be performed so you can quantify the improvements from any tuning changes (default, autotune, or manual tuning). Once tuning changes are made, the System Analysis can be used again to verify the response and see if it has improved.

The System Analysis can also show resonances that exist with your system. If you are not able to use an FFT (Fast Fourier Transform) tool, you can use the System Analysis tool.

### System Analysis Tool

The System Analysis can be accessed from KNX5100C software Function List>Settings>System Analysis. This Analysis will attempt to estimate the Phase Margin and Gain Margin for your load.




Analysis Type:

- Speed Open-Loop - Speed control is performed open-loop. The bode plot analysis is based on Kvp (speed loop proportional gain) and Kvi (speed loop integral gain). This is the method that is generally used for good results.
- System Module - System module attempts to analyze your mechanism. This analysis type will not provide gain or phase margin; instead, it attempts to provide a mechanical representation of the system and will not be impacted by your existing gains. This method should not be used on a compliant mechanism as variation of these mechanisms cannot typically be transferred to the bode plot. When you need to analyze the allowable command response or resonance, or if abnormal vibration occurs that cannot be removed, the System Module can be used to analyze the mechanism.
- Rated Current (%) - This is the current level to use for the test. This can be set up to 300%. The larger the load inertia of the mechanism, the higher this setting should be. However, the setting is typically below 100%. The test results may be incorrectly reported using values that are too large (or too small).
- Enable Low Frequency Analysis - This is typically used when you want the analysis to be focused on low frequency response, ie: within the servo loop bandwidth. This is typically not used.

### Execute the System Analysis

When the system is ready to be tested, press Run. The test will generate small oscillations at different frequencies. When the test is complete, you can click Ok and the Bode plot is generated. The figure below shows the usable Bandwidth (-3dB point - green area of graph). The system analysis test shows a grey line to show the -3dB point of your system.

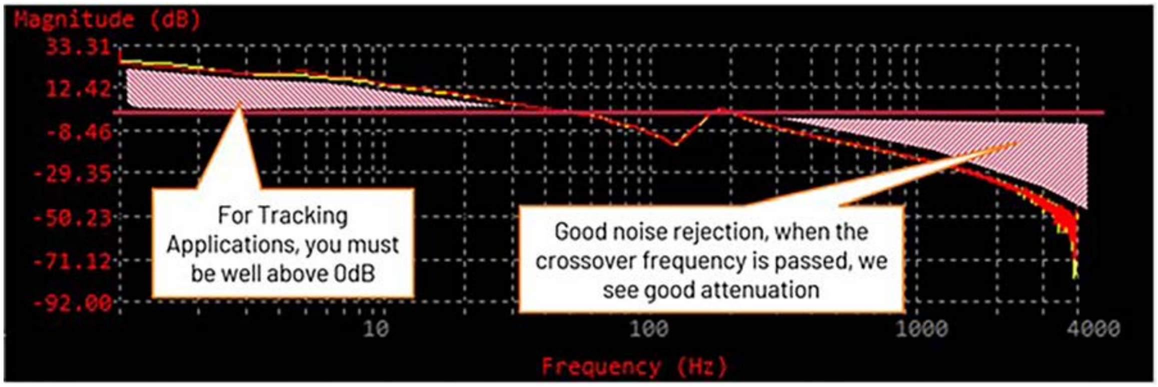
- Line A - Figure 96 on page 223 shows the Line-A plot (Red curves). These curves are the measurements after the System Analysis test is performed. After each test is executed, these curves are the only values that change.
- Line B - Figure 96 on page 223 shows the Line-B plot. These curves are the measurements before the System Analysis is performed. To transfer these measurements from Line-A to Line-B, click >>.

## System Analysis Results

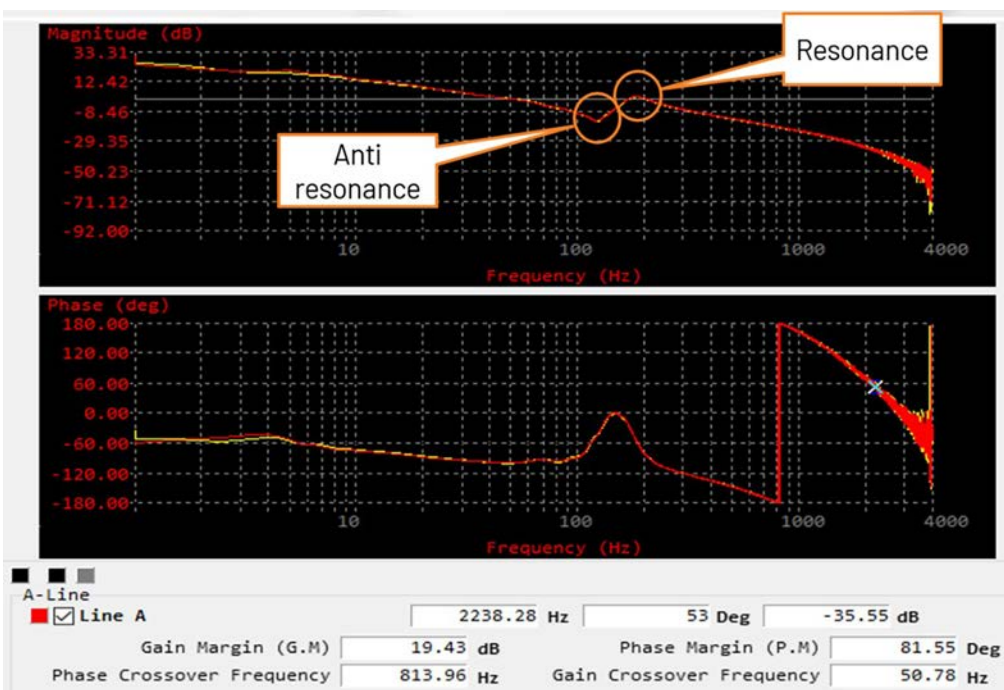
Now that the bode plot is understood, we can show some examples from the test.

The larger the magnitude of gain above 0 dB, the better the ability to track (command vs. actual). Generally, a larger magnitude means the command is being tightly followed by the motor and a higher performing system. If gains are changed, you can execute the System Analysis to see the new results from the bode plot, which tells you if the system response has improved.

Once we pass the crossover frequency, we want a high level of attenuation on the signal, which indicates good noise rejection.




The bode plot is a good way to see resonance that occurs either naturally or because of a problem in your system. It is common to use an FFT (Fast Fourier Transform) tool that can help diagnose the frequency of the resonance (see MOTION-AT005). If such a tool is not available, you can also see resonance (and anti-resonance) frequencies from the bode plot.



# Notes:

# Modes of Operation



This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

The following sections describe the operation of each mode, including the mode structure, command source, selection and processing of the command, and gain adjustment.

**Table 86 - Kinetix 5100 Drive Control Modes**

| Control Mode | Short Name | Description |
|---|---|---|
| Position mode (I/O terminal block input) | PT | This mode is sometimes referred to as Pulse Train Output or Step and Direction. The servo drive receives the Position command and commands the motor to run to the target position. The Position command is communicated through the I/O terminal block and the signal type is pulse. |
| Position mode (register input) | PR | This mode contains the drive indexing capabilities. The servo drive receives the Position command and commands the motor to run to the target position. Position commands are issued from the program registers (99 sets in total). You can select the register number with binary-weighted DI signals or through communication. |
| Speed mode | S | The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command is issued from preset speed internal registers (3 sets in total) or by analog voltage (-10V…+10V) that is communicated through the analog inputs on the I/O terminal block. You can select the command with binary-weighted DI signals. |
| Speed mode (no analog input) | Sz | The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command can only be issued from the preset speed internal registers (4 sets in total, one is fixed at 0). You can select the command with binary-weighted DI signals. |
| Torque mode | T | The servo drive receives the Torque command and commands the motor to run using the target torque. The Torque commands can be issued from the preset torque internal registers (3 sets in total) and by analog voltage (-10V…+10V) that is communicated through the I/O terminal block. You can select the command with binary-weighted DI signals. |
| Torque mode (no analog input) | Tz | The servo drive receives the Torque command and commands the motor to run using the target torque. The Torque command can only be issued from the preset torque internal registers (4 sets in total, one is fixed at 0). You can select the command with binary-weighted DI signals. |
| IO mode | IO | The servo drive receives commands from the Logix controller through the EtherNet/IP network Class 1 connection. Commands are issued through the Add-On Profile (AOP) and uses the Add-On Instruction instructions in the Logix Designer application. |

**Table 86 - Kinetix 5100 Drive Control Modes (Continued)**

| Control Mode | Short Name | Description |
|---|---|---|
| Dual mode[1] | PT-S | Switches PT and S mode with DI signals. |
| | PT-T | Switches PT and T mode with DI signals. |
| | PR-S | Switches PR and S mode with DI signals. |
| | PR-T | Switches PR and T mode with DI signals. |
| | S-T | Switches S and T mode with DI signals. |
| | – | Reserved |
| | PT-PR | Switches PT and PR mode with DI signals. |
| Multi-mode[1] | PT-PR-S | Switches PT, PR, and S mode with DI signals. |
| | PT-PR-T | Switches PT, PR, and T mode with DI signals. |

(1) When these modes are used, the changes are immediate, which can result in unintended motion.

## Select Operation Mode and Direction Control

You can change the Direction Control and Operation Mode by using KNX5100C software and by changing parameters, either programmatically or by using the Parameter Editor.

### Change using the Parameter Editor by using KNX5100C Software or Programmatically

*Changing the Operation Mode with Programming/Parameter Editor*

1. Disable the drive (Servo power is off).
2. Set ID117 (P1.001) and refer to YX: Control Mode Setting for the mode selection.
3. After setting the parameter, cycle power to the servo drive.

The following tables show how to set the ID117 (P1.001) Control Mode parameter.

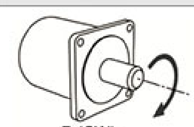
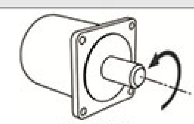
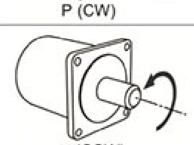
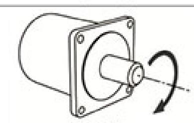
Settings:


| | YX = Control Mode Setting | Z = Directional Control | U = DIO Setting Value Control |
|---|---|---|---|
| Where: | See below | 0 = Forward direction | 0 = Same value |
| | | 1 = Reverse direction | 1 = Resets to default value |

- YX: Control Mode Setting

| Mode | PT | PR | S | T | Sz | Tz |
|---|---|---|---|---|---|---|
| 00 | ▲ | | | | | |
| 01 | | ▲ | | | | |
| 02 | | | ▲ | | | |
| 03 | | | | ▲ | | |
| 04 | | | | | ▲ | |
| 05 | | | | | | ▲ |
| Dual mode | | | | | | |
| 06 | ▲ | | ▲ | | | |
| 07 | ▲ | | | ▲ | | |
| 08 | | ▲ | ▲ | | | |
| 09 | | ▲ | | ▲ | | |
| 0A | | | ▲ | ▲ | | |
| 0B | Reserved | | | | | |
| 0C | I/O (Ethernet) | | | | | |
| Multi-mode | | | | | | |
| 0E | ▲ | ▲ | ▲ | | | |
| 0F | ▲ | ▲ | | ▲ | | |

- Z: Direction Control

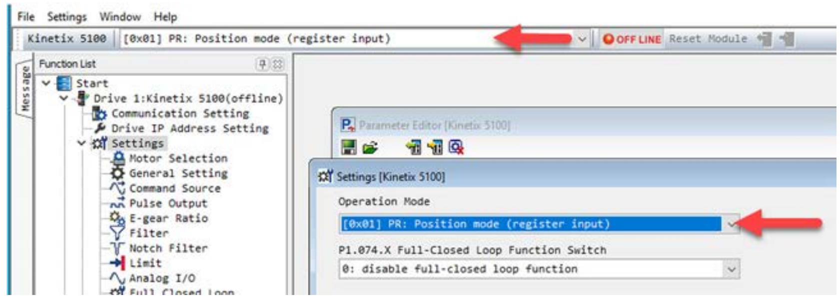
| | Z = 0 | Z = 1 |
|---|---|---|
| Forward direction |  P (CW) |  P (CCW) |
| Reverse direction |  N (CCW) |  N (CW) |

- U: DIO Setting Value Control

| Setting No. | Description |
|---|---|
| 0 | When switching modes, DIO settings ID195...ID207 (P2.010...P2.022) remain the same value. |
| 1 | When switching modes, DIO settings ID195...ID207 (P2.010...P2.022) and ID220...ID225 (P2.036...P2.041)are reset to the default of each mode. |

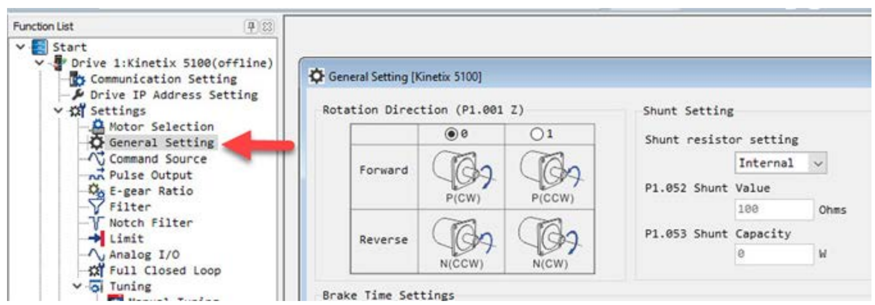
*Change Operation Mode by using KNX5100C Software*

From Function List > Settings, use the pull-down menu to select your new drive operating mode or select the mode from the top status bar next to the Offline/Online status.




*Change the Motor Rotation Polarity by using KNX5100C Software*

From Function List > Settings > General Setting, choose the direction that represents your desired direction of rotation.




## Position Control

Three input modes for position control are available on the drive: External pulse or analog input (PT Mode), internal register (PR Mode) and IO Mode.

In PT Mode, the servo drive is able to receive either analog (+/- 10V analog input) used to position or pulse commands that represent position step and motor direction. The drive can handle an input pulse rate up to 4 MHz.

In PR Mode (Position Register) the drive's indexing and program capabilities are used. The drive provides 99 command registers and these position registers are executed in one of two ways:

- Using standalone PR operation mode.
  - Pre-program the program registers (up to 99 individual registers)
  - Enable the drive
  - Use DIPOS0...DIPOS6 signals on the I/O connector to represent the binary weighted PR number to execute
  - Execute the PR commands using the DI Command Triggered
  - You can directly set the register values via communication

- Using IO operation mode.

  The position command can also come from the Logix controller when the operating mode ID117 (P1.001) is set to IO Mode (0xC). There are several drive commands that you can execute in this mode. These commands include:
  - Jogging
  - Indexing
  - Gearing

Details are found in IO Mode on page 265.

## PT Mode (Position Command with I/O Terminal Block Input)

You can configure PT Mode by using KNX5100C software or by directly changing the drive parameters. There are three pulse types and each type has positive/negative logic, which can be set in ID116 (P1.000).

The following tables explain how to set the ID116 (P1.000) External Pulse Type parameter.

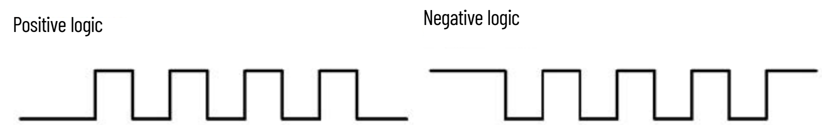
Settings:

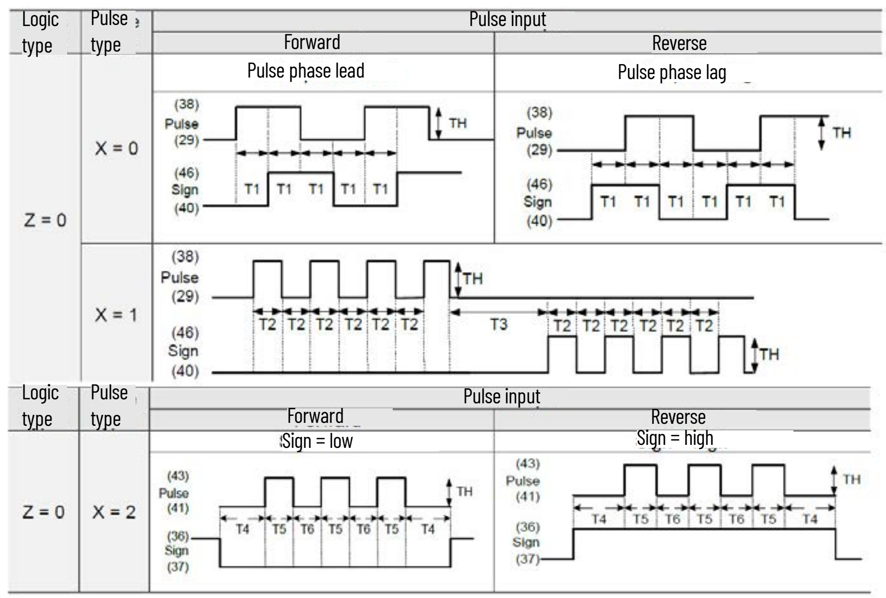

| | X =Command Source | Z =Logic Type | UY =Filter Width |
|---|---|---|---|
| Where: | 0 = I/O, AB phase pulse (4x)<br>1 = I/O, Clockwise and counterclockwise pulse<br>2 = I/O, Pulse + direction<br>3 = Reserved<br>4 = AUX, AB phase pulse (4X)<br>5 = AUX, clockwise and counterclockwise pulse<br>6 = AUX, pulse + direction | 0 = Positive logic<br>1 = Negative logic | See UY: Filter Width Setting on page 233 |

- Z: Logic Type

Digital circuits use 0 and 1 to represent the voltage level of low and high respectively. Using positive logic, 1 represents high voltage and 0 represents low voltage; using negative logic, 1 represents low voltage and 0 represents high voltage.

For example:




| Pulse Specification | Max. Input Frequency | Min. Allowed Time Width | | | | | |
|---|---|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T4 | T5 | T6 |
| Differential signal | 4 MHz | 62.5 ns | 125 ns | 250 ns | 200 ns | 125 ns | 125 ns |
| Open-collector | 200 kHz | 1.25 µs | 2.5 µs | 5 µs | 5 µs | 2.5 µs | 2.5 µs |

| Pulse Specification | Max. Input Frequency | Voltage | Forward current |
|---|---|---|---|
| Differential signal | 4 MHz | 5V | < 25 mA |
| Open-collector | 200 kHz | 24V (Max.) | < 25 mA |

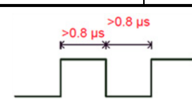
- UY: Filter Width Setting

As the pulse frequency increases, the pulse width becomes smaller. When the pulse width becomes smaller than the filter width setting, those pulses are filtered out as noise. Thus, the filter width must be set smaller than the actual pulse width. Set the filter width to be four times smaller than the actual pulse width.

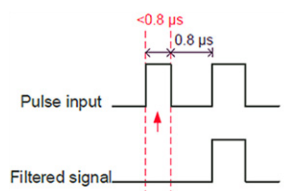
| Y Setting Value | U = 0<br>Unit: µs (kHz) | U = 1<br>Unit: µs (kHz) |
|---|---|---|
| 0 | No filter function | No filter function |
| 1 | 2 (250) | 0.2 (2500) |
| 2 | 3 (166) | 0.3 (1666) |
| 3 | 4 (125) | 0.4 (1250) |
| 4 | 5 (100) | 0.5 (1000) |
| 5 | 6 (83) | 0.6 (833) |
| 6 | 7 (71) | 0.7 (714) |
| 7 | 8 (62) | 0.8 (625) |
| 8 | 9 (55) | 0.9 (555) |
| 9 | 10 (50) | 1 (500) |
| A | 11 (45) | 1.1 (454) |
| B | 12 (41) | 1.2 (416) |
| C | 13 (38) | 1.3 (384) |
| D | 14 (35 | 1.4 (357) |
| E | 15 (33) | 1.5 (333) |

For example:

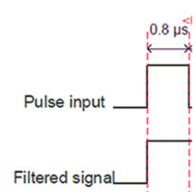
| If | Then |
|---|---|
| U is set to 1 and Y is set to 1 (filter width is 0.2 µs [2500 kHz]) and<br>The high and low duty width of the command pulse are both larger than 0.8 µs (625 kHz) (filter width is four times of 0.2 µs [2500 kHz]) | The pulse command is not filtered out. |




When the high or low duty width of the pulse is smaller than the filter width, then the pulse command is filtered out.




If this first pulse width is shorter than 0.8 µs (625 kHz), it can be filtered, and thus two input pulses are regarded as one pulse. If this pulse width is shorter than 0.2 µs (2500 kHz), it is filtered.



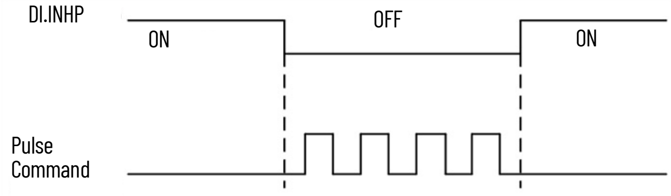

If this low level pulse width is shorter than 0.8 µs (625 kHz), it can be filtered, and thus two input pulses are regarded as one pulse. If this low level pulse width is shorter than 0.2 µs (2500 kHz), it is filtered.

If 125 ns (4 MHz) input pulse is used, set the filter setting value Y to 0 as no filter function.

**IMPORTANT** When the signal is the high-speed pulse specification of 125 ns (4 MHz) and the setting value of the filter is 0, then the pulse is not filtered.

## Pulse Command Input Inhibitor (INHP)

In PT Mode, when a DI is configured for Disable External Pulse (DI.INHP) and the signal is on, the drive ignores incoming pulses and the motor stops motion. Using this Pulse Command Inhibit feature requires you to configure DI8 as the Disable External Pulse DI. A different Digital Input cannot be used for this feature.




For more information on the INHP function, see the Description of Digital Input Functions on page 425.

## Analog Input

The position using analog input mode is active when the drive is in PT Mode and the Command Source is set for Analog Input ID167 (P1.064 X=1). The source for the analog position command comes from two terminals of the 50-pin I/O connector: 42 (V_REF) and 44 (GND).

**Figure 97 - Analog Input**

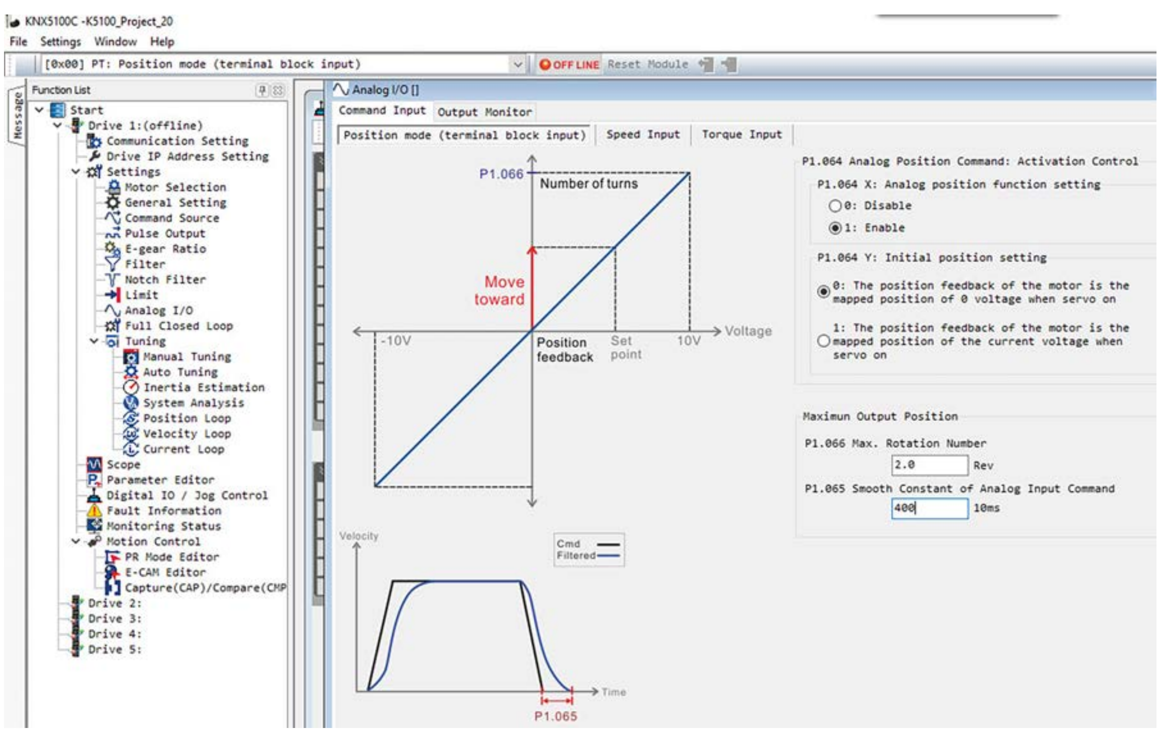


**Table 87 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID167 (P1.064) | AnalogToPositionStartupConfiguration |
| ID168 (P1.065) | AnalogToPositionSmoothTime |
| ID169 (P1.066) | AnalogToPositionMaxRotationNum |

The decryption of ID167 (P1.064) is shown in the segment display image that corresponds to the table:


| Bit X: | Bit Y: | Bit U/Z: |
|---|---|---|
| 0 = The analog position function is not used (disabled). | 0 = When the drive transitions to ON, the current motor position is considered 0V; the motor now moves to the corresponding motor position based on the voltage level at V_REF/GND. The amount of movement is defined by the volts/rev setting shown below and the speed of the movement uses the Smoothing Constant described below. | Reserved |
| 1 = The analog position function is used (enabled). | 1 = When the drive transitions to ON, the current motor position is considered 0V; the motor now moves to the corresponding motor position based on the voltage level at V_REF/GND. The amount of movement is defined by the volts/rev setting shown below and the speed of the movement uses the Smoothing Constant described below. | |

*Settings for ID168 (P1.065):*

The analog position command smoothing constant is only valid for analog position commands. This value is the amount of smoothing that is used essentially for speed control when the motor is moving towards the analog setpoint. The smaller value (0) is a very aggressive speed that is used to move to the analog setpoint. The largest value (1000) is a very slow speed that is used to move to the analog setpoint.

| | |
|---|---|
| **IMPORTANT** | Choose the smoothing constant carefully because aggressive speed settings can potentially damage your equipment. By using a smoothing constant of 0 or 1, you are creating, essentially, a step input to maximum speed as defined by the Volts/(Max. Rotation Number). A typical value for the smoothing constant is 200…400. |

*Settings for ID169 (P1.066):*

This parameter is the maximum number of revolutions used when the maximum analog input voltage (+10V) is reached. Analog position command is determined as follows:

$$\frac{\text{Input voltage value}}{10} \text{ x ID168 (P1.066) setting} = \text{Analog position command revolutions}$$

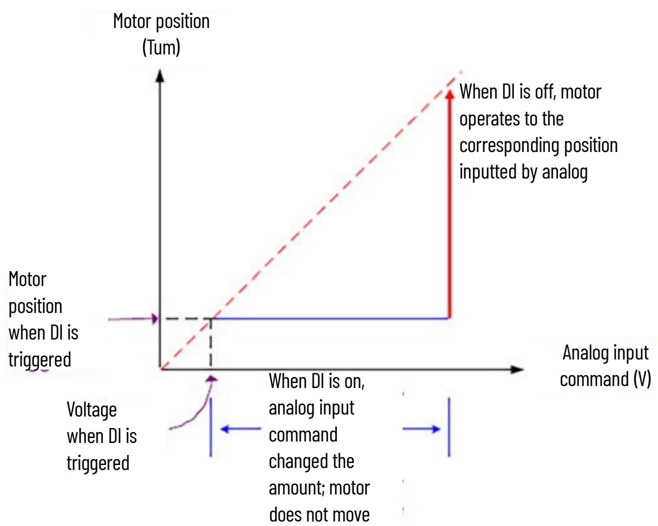
For example:

If the parameter ID169 (P1.066) is set to 30 from the panel and the external voltage is input 5V, then the analog position command is as follows:

$$\frac{5\text{V}}{10} \text{ x } 30 = 15 \text{ revolutions}$$

*Latch Function of Analog Position Command (DI code:0x0C)*

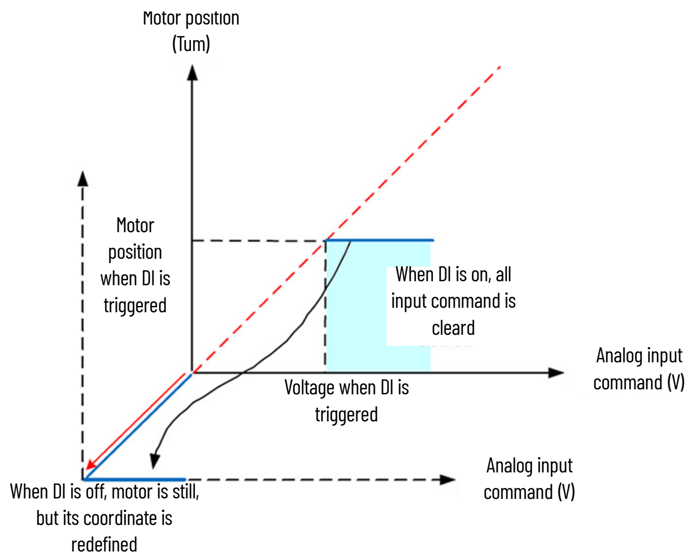
When a Digital Input (DI) is configured for Latch function of analog Position command, and this DI is ON, the motor position is held at the current position when the DI was triggered. While this DI is ON, the motor does not move, even if there is a change of analog input command. When this DI is OFF, the motor completes any change to the position command while the DI was ON.



*Clear Function of Analog Position Command (DI code:0x0D)*

When a Digital Input (DI) is configured for Clear function of analog Position command, and this DI is ON, the motor position is held at the current position when the DI transitions ON.

While this DI is ON, the motor does not move, even if there is a change of analog input command. When the motor transitions to OFF, the current motor position is redefined to the position that corresponds with the analog input voltage on VREF/GND.




## PR Mode (Position Command with Internal Register Input)

PR Mode is typically used to control your application when standalone operation is required. This mode contains the indexing functionality and program control that you can customize for your application.

The drive supports the following motion command types, which are described in detail in Chapter 11, Motion Control in PR Mode:

- Homing
- Speed
- Position (indexing)
- Jump
- Parameter write
- Arithmetic operation

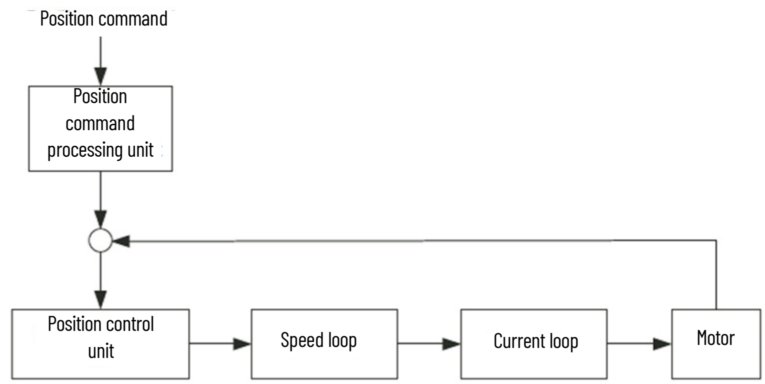
The drive provides the following methods to initiate a PR:

- Digital input (DI)
- Event-triggered
- PRCmdTrigger Digital Input ID300 (P5.007) with PR selection using binary weighted Digital Inputs
- Capture (high-speed position capturing)
- Compare-triggered (high-speed position comparing)
- E-CAM

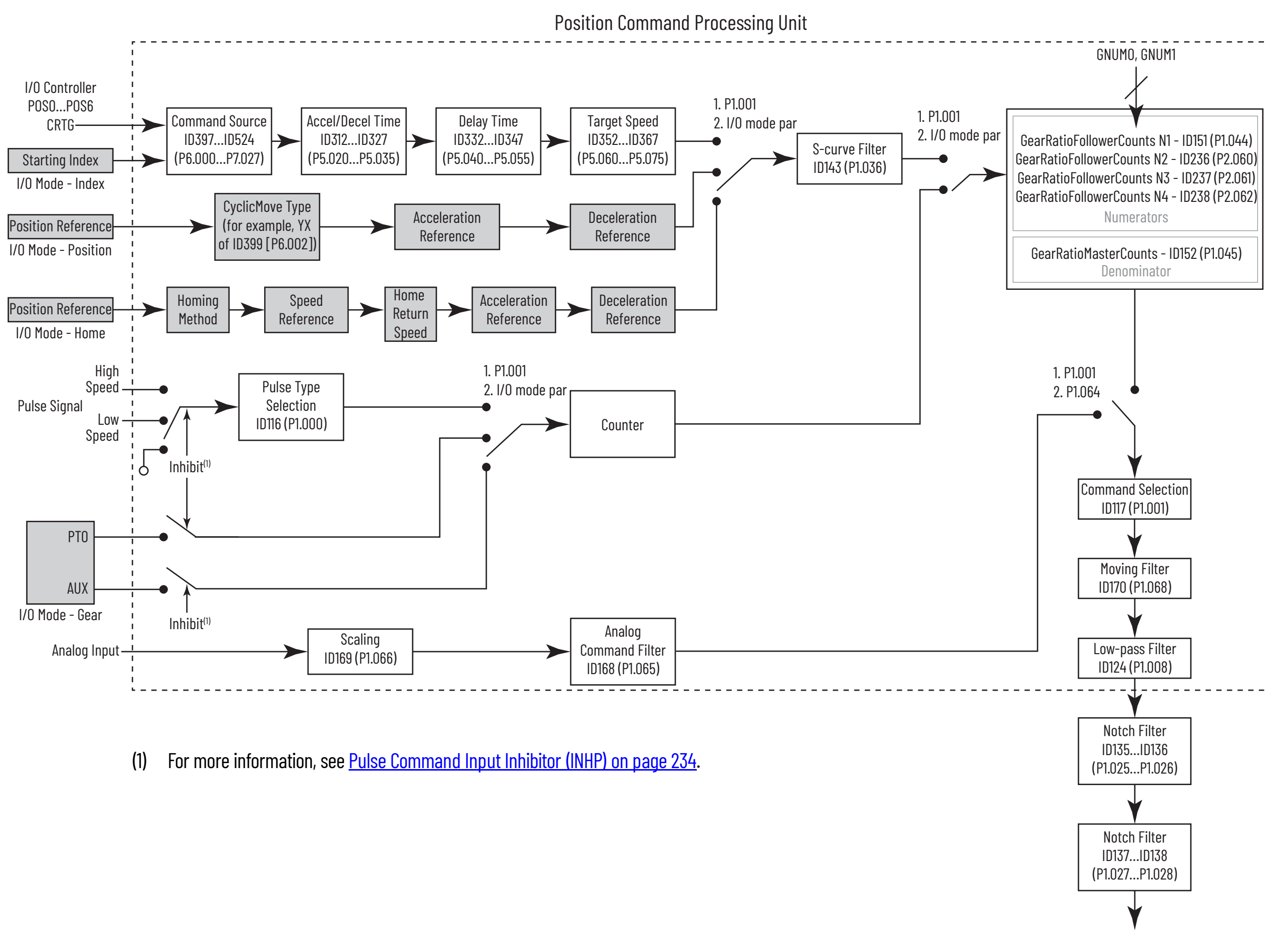
You can choose the most suitable triggering method according to the applications and requirements. For detailed descriptions of the methods, see Trigger Methods for PR Commands on page 347.

## Control Structure of Position Mode

The basic control structure is as follows:



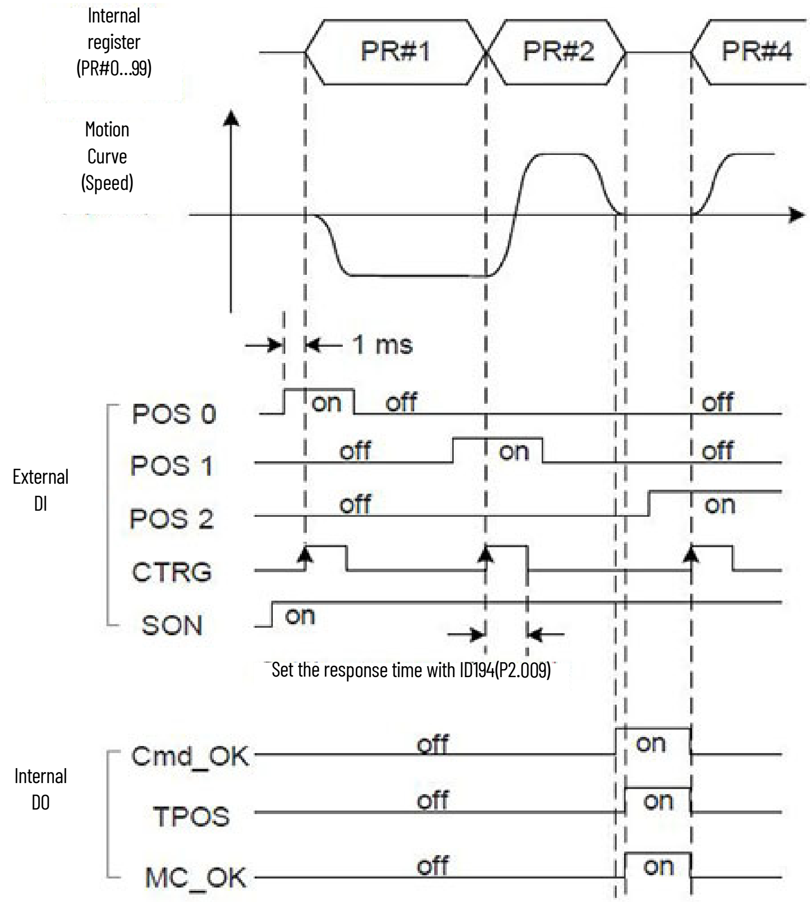

For better control, the pulse signals are processed by the position command processing unit. Structure is shown in the following diagram.




(1) For more information, see Pulse Command Input Inhibitor (INHP) on page 234.

## Position Mode Timing (PR Mode)

In PR Mode, the program (PR) is selected by using DI (binary weighted POS0…POS6) and triggers the program (PR) using the Command Triggered (CTRG) Digital Input. These timing diagrams show the timing used to execute programs in PR Mode. SON represents Servo ON Digital Input.




The following apply to the internal digital output (DO) timing diagram:

- Cmd_OK is on when PR command is completed.
- TPOS is on when the error is smaller than value set by the ID159 (P1.054) In Position Window parameter.
- MC_OK is on when Cmd_OK and TPOS are both on.

**Table 88 - Relevant Parameter**

| Parameter | Name |
|---|---|
| ID159 (P1.054) | InPositionWindow |

When the deviation between the target position and the actual motor position is smaller than the setting range of ID159 (P1.054) in PR Mode, then the DO.TPOS signal is on.

## Speed Mode

This mode is used when the operation mode is set for Speed Control (S) or Zero speed/Internal speed register mode (Sz).

Speed commands can come from the analog input terminals (COMMAND2-Speed, 42, Analog GND, 13). The analog voltage (+/-10V) represents a bi-directional velocity signal and is configured with the Analog I/O page in KNX5100C software.

Speed commands can come from preset speed registers with digital I/O to select speeds, the binary weighted DIs represent which preset speeds are selected. Use these presets with both the Speed (S) and Speed Register (Sz) mode.

When using IO mode, the raC_*xxx*_K5100_MAJ Add-On Instruction is used to provide a constant speed to the motor.

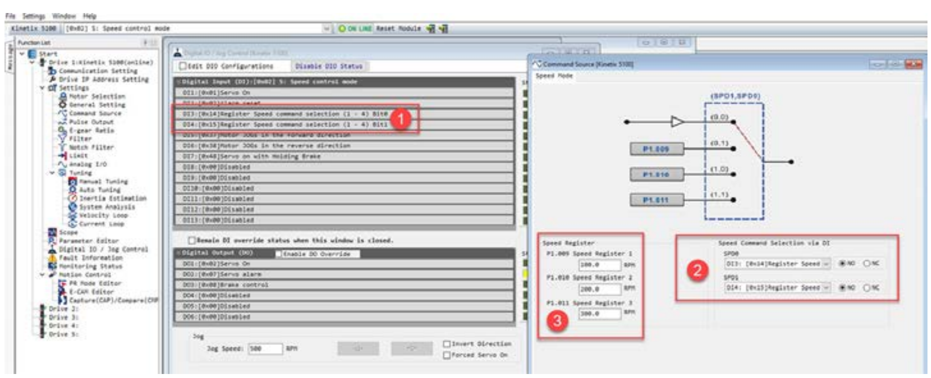
When preset speeds are used back-to-back, there can be a problem with speed discontinuity. You can use the S-curve smoothing time filter to smooth the transition between preset speeds. The S-curve filter is explained on page 168 and page 250.

### Configure and Select the Preset Speeds

An example of how to set speed presets is shown on page 258.

The speed command origin depends on the Operation Mode setting. Speed Control mode, Sz mode, and IO mode can all generate speed commands.

When Speed Control mode is used, an analog voltage is used to generate the speed command. Presets are also available in Speed Control mode. When the binary weighted speed preset of 0 is used for the preselected speed, the analog speed terminals are used for the speed command. When Sz mode is used, the analog speed terminals are ignored.



In the KNX5100C software:

1. From Function List > Digital I/O/Jog Control, edit the DIO configuration to add the speed command selection bits (bits 0 and 1).
2. From Function List > Analog I/O, use the pull-down menus for SPD0 and SPD1 to associate the Digital I/O with the appropriate binary weighting.

3. Enter the Preset Speeds to use for your application.

   Notice that you can change the Preset Speeds by using the ID125, ID126 and ID127 (P1.009, P1.010, and P1.011) respectively.

This table shows the binary weighting representation:

| Speed Command | SPD0 | SPD1 |
|---|---|---|
| Analog Input Speed | 0 | 0 |
| Speed Register 1 | 0 | 1 |
| Speed Register 2 | 1 | 0 |
| Speed Register 3 | 1 | 1 |

## Scaling the Analog Command (Speed Mode)

The motor speed command is determined by the analog voltage difference between V_REF and VGND. Use parameters AnalogToVelocityScale ID147 (P1.040) and AnalogToVelocityScale2 ID679 (P1.081) to adjust the slope of speed and its range.

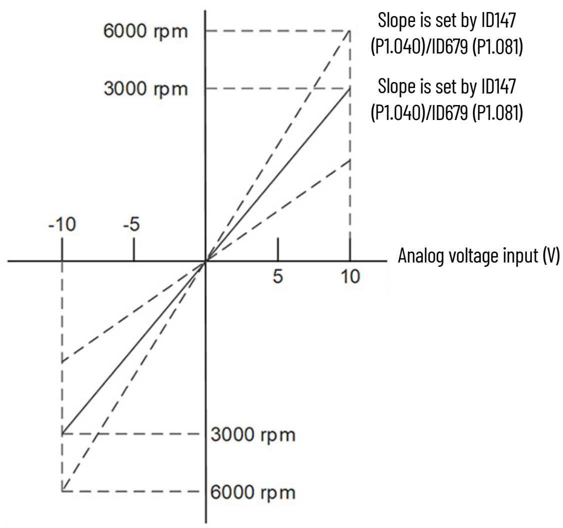
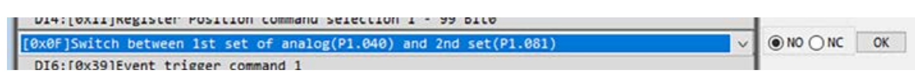



**Table 89 - Relevant Parameters**

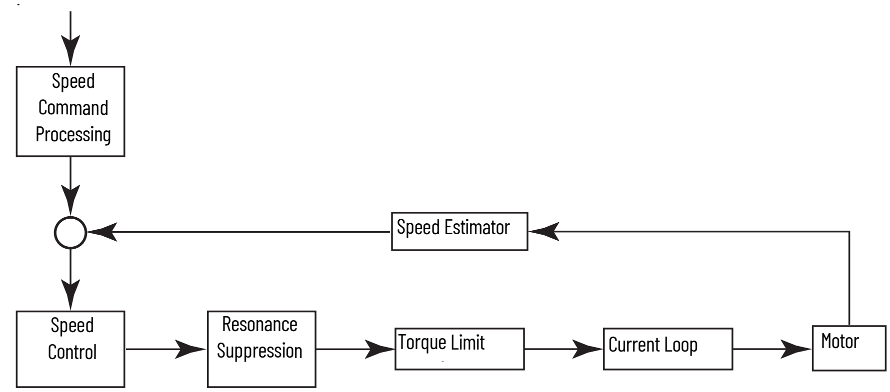
| Parameter | Name |
|---|---|
| ID147 (P1.040) | AnalogToVelocityScale |
| ID679 (P1.081) | AnalogToVelocityScale2 |

**IMPORTANT:** Use a digital input 0x0F (shown below) to switch between ID147 (P1.040) and ID679 (P1.081).

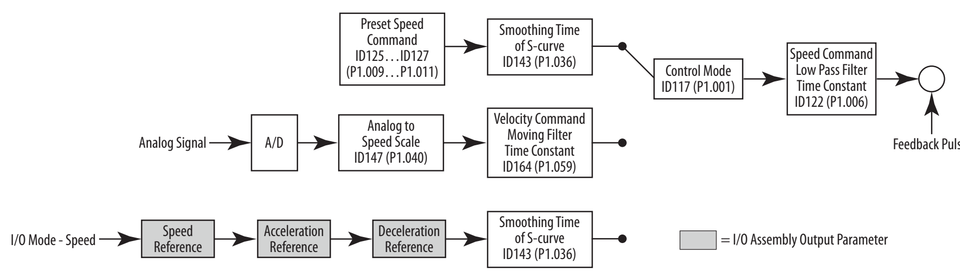


## Control Structure of Speed Mode

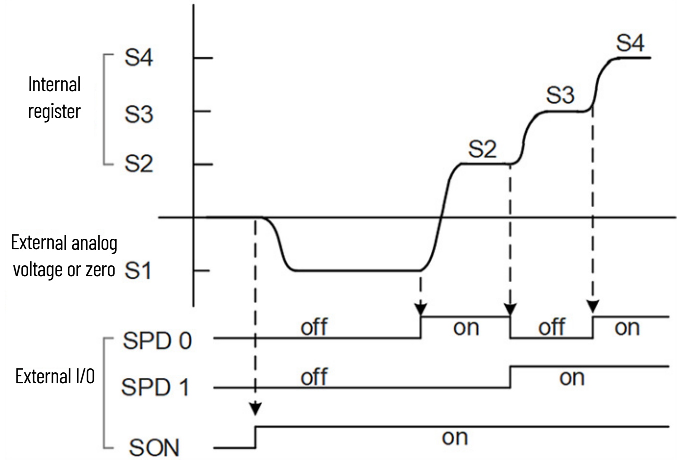
The following diagram illustrates the basic control structure.




The speed command processing unit is to select the command source, including the parameter ID147 (P1.040) scaling setting for rotation speed and S-curve setting for smoothing the speed. The speed control unit manages the gain parameters of the servo drive and calculates the current command for servo motor.



## Speed Mode Timing




In the Speed mode timing diagram, the following applies.

- ‘Off’ signifies the contact is open while ‘On’ signifies the contact is closed.
- When the drive is in Sz operation mode, the speed command is disabled, therefore S1=0.

  When the drive is in S Speed Control mode, the speed command S1 is represented as the analog voltage input.
- SON represents the Servo On digital input and is on when the drive is enabled.
- When the drive is enabled (SON=on), the command is selected according to the state of digital inputs SPD0 and SPD1.

## Zero Speed Threshold Function

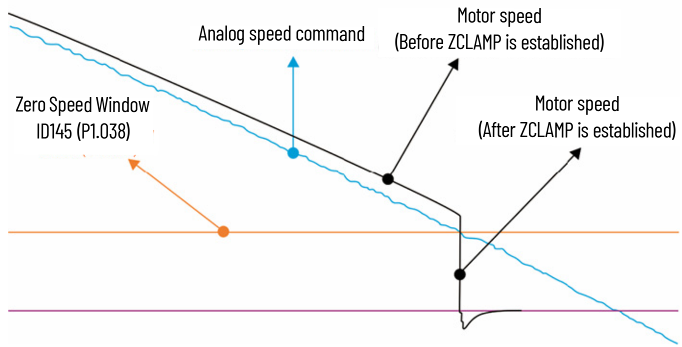
**Table 90 - Relevant Parameter**

| Parameter | Name |
|---|---|
| ID145 (P1.038) | ZeroSpeedWindow |

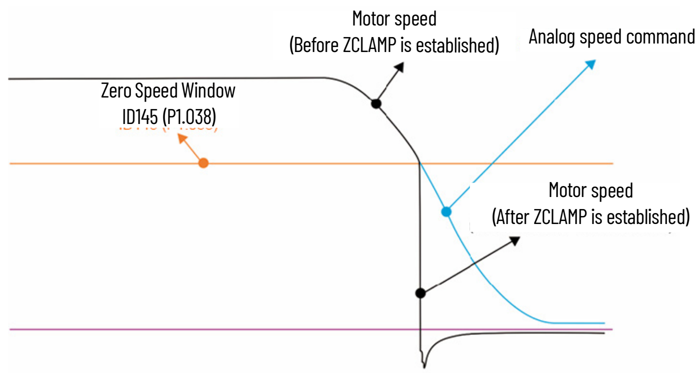
The Zero Speed Threshold function is enabled when the following conditions are met:

- Condition 1: Operation Mode is Speed Control (Operating Mode = S or Sz)
- Condition 2: a digital input configured as Zero Speed Threshold (0x05) and this input is on.
- Condition 3: Motor speed is lower than the value of the parameter ZeroSpeedWindow ID145 (P1.038)
- The analog input is used in this example.
  Analog Input ID167 (P1.064 X = 1)

The Zero Speed Threshold (sometimes called ZClamp) feature uses the analog speed command without acceleration/deceleration to determine if any motor speed limiting should be performed. The motor speed is limited at zero speed when the Zero Speed Threshold conditions are true.



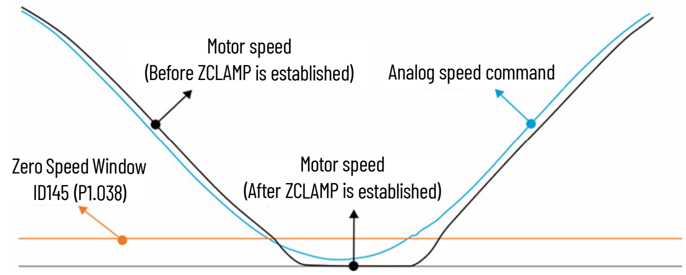

The Zero Speed Threshold (sometimes called ZClamp) feature uses the preset speed commands without acceleration/deceleration to determine if any motor speed limiting should be performed. The motor speed is limited at zero speed when the Zero Speed Threshold conditions are true.

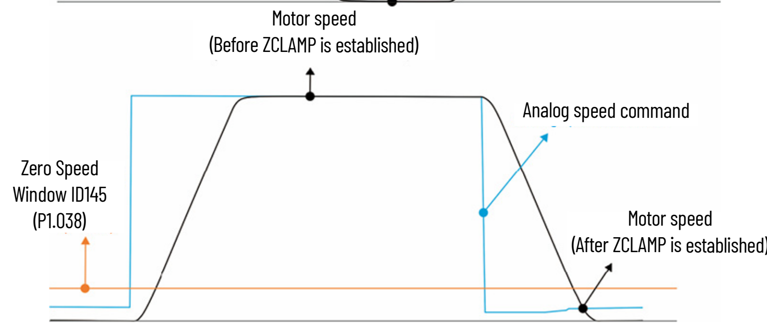


These two examples show the Zero Speed Threshold using the different speed command conditions.

- 1: Command source is analog voltage.

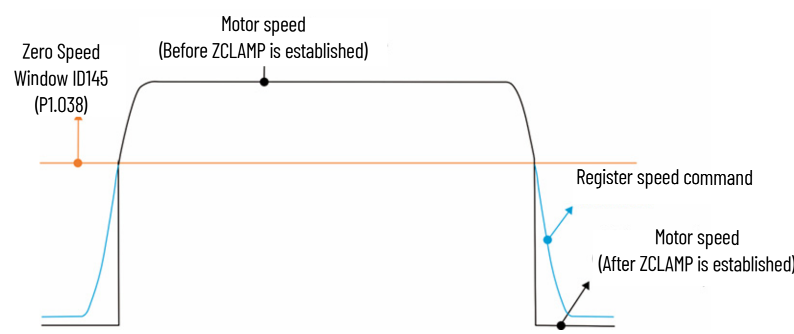
  The Zero Speed Threshold feature uses the analog speed command without acceleration/deceleration to determine if this function is enabled. When the Zero Speed Threshold conditions are met, the motor speed decelerates to 0 rpm by S-curve deceleration. If not, the motor follows the analog speed command through S-curve.




- 1: Command source is register.

  The Zero Speed Threshold feature uses the register speed command with acceleration/deceleration to determine if this function should be enabled. When the Zero Speed Threshold conditions are met, the motor speed is set to 0 rpm.




For more information on the Zero Speed Threshold feature, see the Description of Digital Input Functions on page 425.

## Torque Mode

Torque commands can come from the analog input terminals(COMMAND1-Torque, 18, Analog GND, 13). The analog voltage (+/-10V) represents a bi-directional torque signal and is configured with the Analog I/O page in KNX5100C software.

Torque commands can come from preset torque registers with digital I/O to select different torque values, the binary weighted DIs represent which preset torques are selected. These presets can be used with both the T (Torque Control) and Tz operating mode.

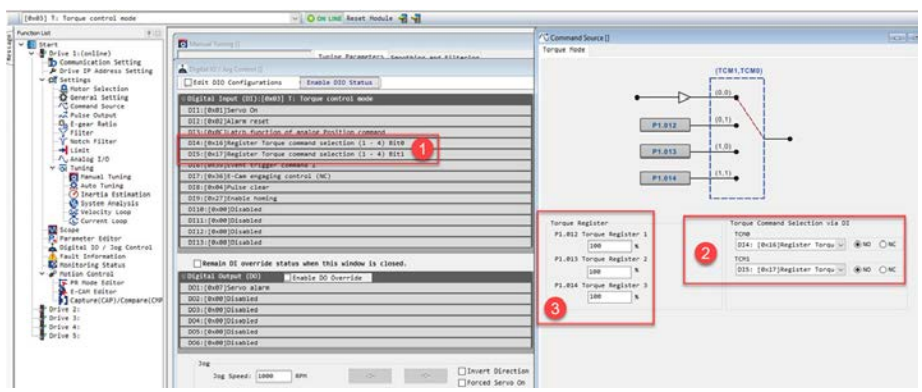
When using IO Mode, the raC_*xxx*_K5100_MAT Add-On Instruction is used to provide a constant torque to the motor.

### Selection of Torque Command

The torque command origin depends on the Operation Mode setting. Torque Control mode, Tz mode, and I/O mode can all generate torque commands.

When Torque Control mode is used, an analog voltage is used to generate the torque command. Presets are also available in Torque Control mode. When the binary weighted torque preset of 0 is used for the preselected torque, the analog torque terminals are used for the torque command. When Tz mode is used, the analog torque terminals are ignored.

*Configure and Select the Preset Torques*




From the KNX5100C software, you can configure the following.

1. From Function List>Digital I/O/Jog Control, edit the DIO configuration to add the torque command selection bits (bits 0 and 1)
2. From Function List>Analog I/O, use the pull-down menu for TCM0/TCM1 to associate the Digital I/O with the appropriate binary weighting.
3. Enter the Preset Torques to use for your application.

   Notice that you can change the Preset Torques by using the ID128, ID129, and ID130 (P1.012, P1.013, and P1.014) respectively.

This table shows the binary weighting representation:

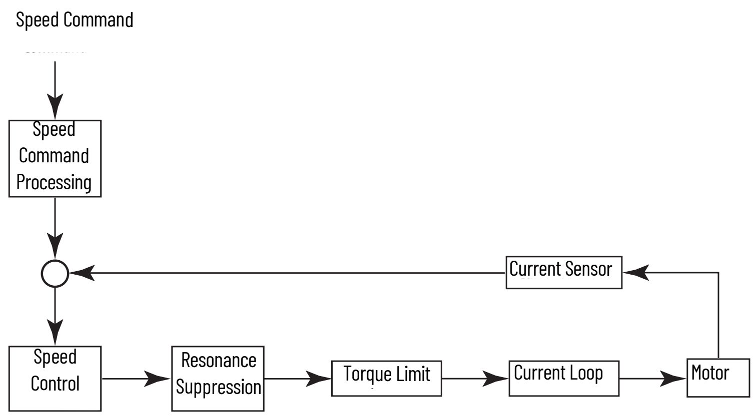
| Torque Command | TCM0 | TCM1 |
|---|---|---|
| Analog Input Torque | 0 | 0 |
| Torque Register 1 | 0 | 1 |
| Torque Register 2 | 1 | 0 |
| Torque Register 3 | 1 | 1 |

## Control Structure of Torque Mode

**Table 91 - Relevant Parameters**

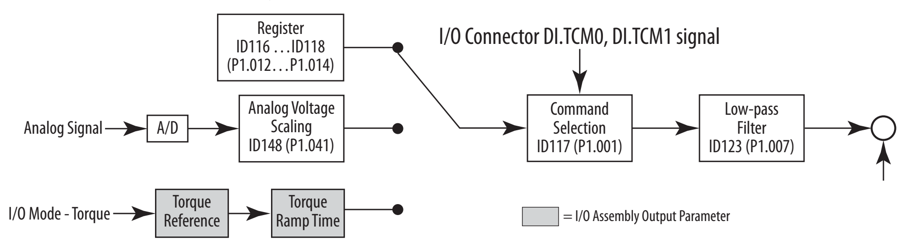
| Parameter | Name |
|---|---|
| ID117 (P1.001) | ControlMode |
| ID123 (P1.007) | TorqueCmdLowPassFilterTime |
| ID148 (P1.041) | AnalogToTorqueScale |

The following diagram shows the basic control structure of torque mode:




The torque command unit is to specify the torque command source, including the parameter Analog Voltage Scaling ID148 (P1.041) and S-curve setting. The torque control unit manages the gain parameters of the servo drive and calculates the current for servo motor in time; this can only set by commands.

The structure of a torque command unit is as follows.




The upper path is the command from the preset torque register, while the middle path is the external analog command. The command is selected according to the status of the DI.TCM0 and DI.TCM1 signals, and with the Operation Mode set to T or Tz.

The lower path is used when the operation mode is IO mode. The intention is to use the raC_*xxx*_K5100_MAT add-on instruction.

## Scaling of Analog Command (Torque Mode)

The motor torque command is controlled by the analog voltage difference between the T_REF and GND analog signals. The torque slope and its range can be adjusted by the Analog to Torque Scale parameter.

**Table 92 - Relevant Parameter**

| Parameter | Name |
|---|---|
| ID148 (P1.041) | AnalogToTorqueScale |

Motor torque command is based on the following equation:

$$\text{Torque control command} = \frac{\text{External analog input voltage} \times \text{ID148 (P1.041) setting value}}{10} = \text{Unit } \%$$

If the ID148 (P1.041) parameter is set at its default setting of 100 and the external analog input voltage is 10V, the torque command is 100% of the rated torque.

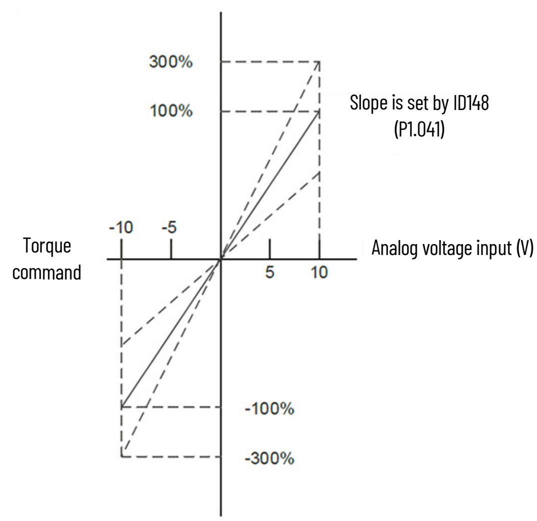
$$\text{Torque control command} = \frac{10\text{V} \times 100}{10} = 100\%$$

If the ID148 (P1.041) parameter is set to 300 and the external analog input voltage is 10V, the torque command is 300% of the rated torque.

$$\text{Torque control command} = \frac{10\text{V} \times 300}{10} = 300\%$$

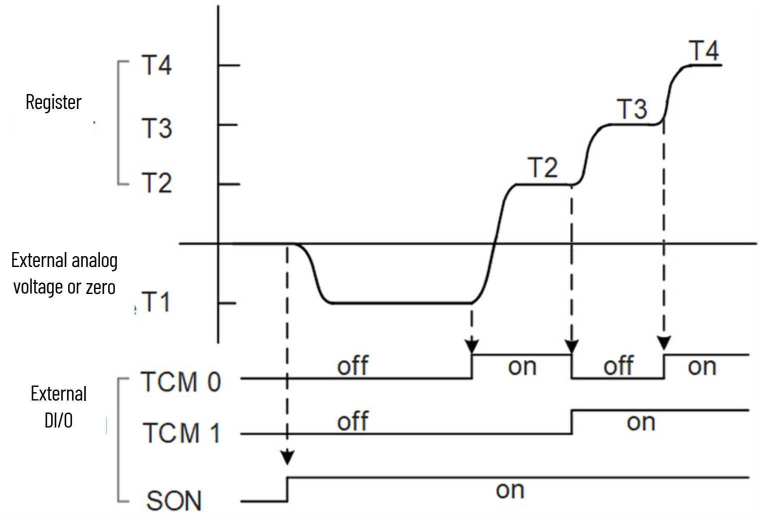
If the ID148 (P1.041) parameter is set at its default setting of 100 and the external analog input voltage is 5V, the torque command is 50% of the rated torque.

$$\text{Torque control command} = \frac{5\text{V} \times 100}{10} = 50\%$$




In Speed, PT and PR Modes set the torque limit corresponding to 10V (max. voltage) for analog torque limit.

## Torque Mode Timing




- Off signifies the contact is open while on signifies the contact is closed.
- When it is in Tz mode, the torque command T1 equals 0; when it is in T mode, the torque command T1 is the external analog voltage input.
- In the servo-on (SON) state, the command is selected according to the state of DI.TCM0 and DI.TCM1 inputs.

# Filter

The Position, Speed, and Torque modes use different filters to remove unwanted resonance from the drive (these filter types are available for use in different drive modes). To configure filters, see Configure Filter on page 167 and Configure Notch Filter on page 169.

## Position Mode

These filters are used in Position mode.

### *S-curve Filter (Position Mode)*

S-curve filter smooths the motion command in position mode. With this filter, speed/acceleration can be continuous and jerk is reduced, and a smoother mechanical operation can be achieved. If the load inertia increases, the operation of the motor will be influenced by friction and inertia when it starts or stops rotating. Setting a larger acceleration/deceleration constant of S-curve (TSL) and acceleration/deceleration time (numbers 0…15) in ID312…ID327 (P5.020…P5.035) can increase the smoothness of operation. When the position command source is pulse, its speed and angular acceleration are continuous, thus, S-curve filter is not a must.

### *Low Pass Filter (Position Mode)*

Low pass filter for commands is typically used to filter out unwanted high-frequency response or noise so that the speed becomes smoother.

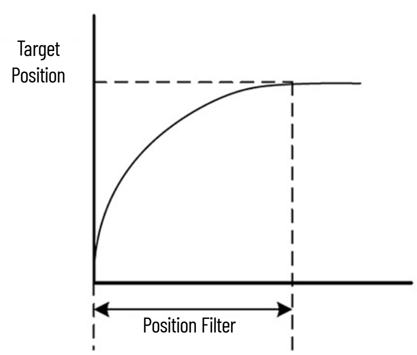



**Table 93 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID124 (P1.008) | PositionCmdLowPassFilterTime |

**IMPORTANT** The filter functions are disabled when the parameter values are set to 0.

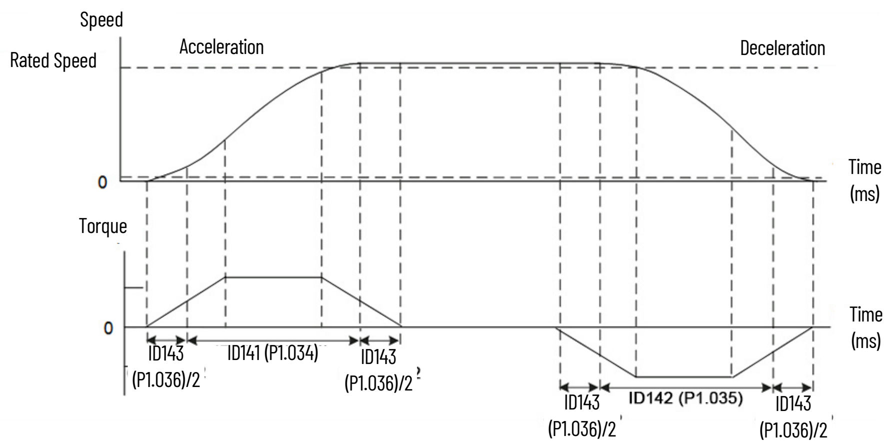
## Speed Mode

These filters are used in Speed mode.

*S-curve Filter (Speed Mode)*

During acceleration or deceleration, the S-curve filter applies the three-stage acceleration curve and tailors a smoother motion trajectory. It is used to avoid jerk (the differentiation of acceleration), resonance as well as noise caused by abrupt speed variation. You can use the parameter ID141 (P1.034), Acceleration Time Constant of S-Curve Velocity Profile (TACC), to adjust the slope changed by acceleration; the parameter ID142 (P1.035), Deceleration Time Constant of S-curve Velocity Profile (TDEC), to adjust the slope changed by deceleration, and the parameter ID143 (P1.036), Smoothing Time of S-curve (TSL), to improve the status of motor activation and stop. The drive can calculate the total time for executing the command.

T (ms) signifies the operation time and S (rpm) signifies the absolute speed command, which is the absolute value of initial speed minus end speed.



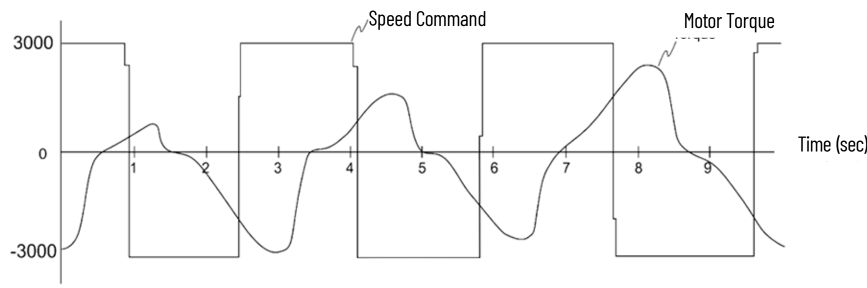

| **IMPORTANT** | These three parameters can be set individually and even when the parameter ID143 (P1.036), Smoothing Time of S-curve, is set to 0 (disabled), the S-curve still has acceleration/deceleration of a trapezoidal profile. |
|---|---|

| Error Compensation Function | When ID143 (P1.036) = 0 | When ID143 (P1.036) = 1 | When ID143 (P1.036) >1 |
|---|---|---|---|
| Smoothing function of S-curve | Disable | Disable | Enable |
| Following error compensation function | Disable | Enable | Determine by ID 241 (P2.068.X)(1) |

(1) For ID241 (P2.068) following error compensation, 0: Disable or 1: Enable.

*Analog Speed Command Filter*

Analog speed command filter provided by the drive helps to smooth motion to the motor when the analog input signal (speed) changes rapidly.



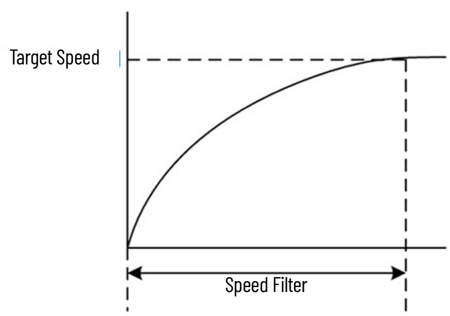

The above diagram is the curve of speed command and motor torque when analog speed command filter is applied. In the diagram above, the slopes of speed command in acceleration and deceleration are different. You can adjust the time setting by using parameters SCurveAccelTime ID141 (P1.034), SCurveDecelTime ID142 (P1.035), and SCurveSmoothTime ID143 (P1.036) as required for your cycle profile.

*Low Pass Filter (Speed Mode)*

Parameter ID122 (P1.006) filters out unwanted high-frequency resonances or noise so that the speed becomes smoother.

**Table 94 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID122 (P1.006) | VelocityCmdLowPassFilterTime |
| ID164 (P1.059) | VelocityCmdMovingFilterTime |




VelocityCmdLowPassFilterTime ID122 (P1.006) is a low-pass filter, while VelocityCmdMovingFilterTime ID164 (P1.059) is a moving filter. The Moving filter applies smoothing at the beginning and end of the Acceleration cycle, the Low Pass applies smoothing at the end of the cycle.

If the Operation Mode contains a position loop, use the VelocityCmdLowPassFilterTIme ID122 (P1.006). If the Operation mode is Speed Control (or Sz), then use VelocityCmdMovingFilterTime ID164 (P1.059).

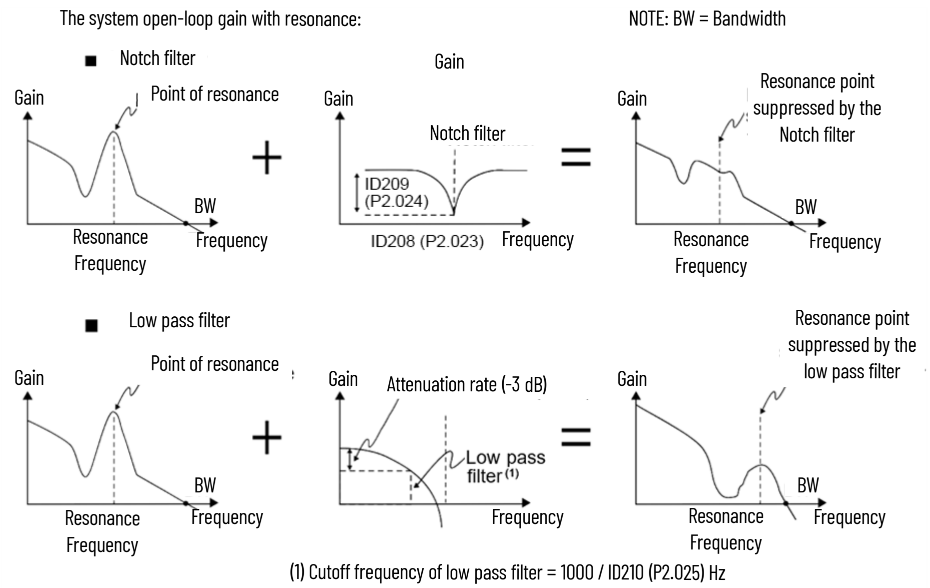
*Resonance Suppression (Notch Filter, Speed Mode)*

When resonance occurs, it can be naturally occurring resonance present on the mechanism or can be as a result of increasing the control loop gains beyond the limits of the mechanism. Mitigating these two factors can improve the situation. In addition, parameter Low-pass Filter ID210 (P2.023) and 5 notch filters (see Table 95 on page 253) are provided to suppress the resonance if the control parameters remain unchanged.

**Table 95 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID208 (P2.023) | NotchFilter1Frequency |
| ID209 (P2.024) | NotchFilter1Depth |
| ID226 (P2.043) | NotchFilter2Frequency |
| ID227 (P2.044) | NotchFilter2Depth |
| ID228 (P2.045) | NotchFilter3Frequency |
| ID229 (P2.046) | NotchFilter3Depth |
| ID254 (P2.095) | NotchFilter1QValue |

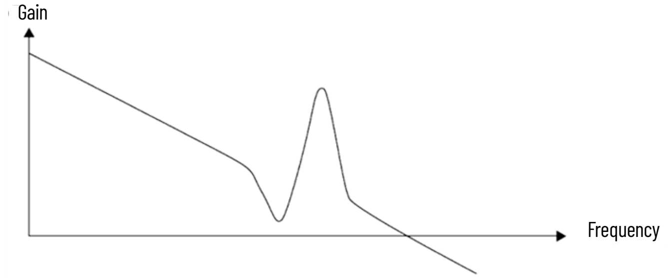
The drive provides two types of resonance suppression, one is a notch filter and the other is a low pass filter. See the following diagrams for the results of suppression by each type.



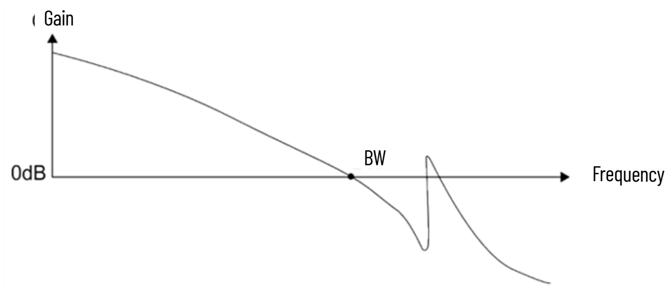

As shown in the previous two examples, if the value of parameter ResonanceSuppressionLowPassFilterTime ID210 (P2.025) is increased from 0, the bandwidth (BW) becomes smaller. Although it solves the problem of resonance, it also reduces the response bandwidth and phase margin, so either the control loop gains have to be lowered, or the system can become unstable.

If the resonance frequency is known, you can mitigate the suppression by using the Notch filter, which is better than the low pass filter in this case. If the resonance frequency drifts along with time or other causes and the drifting amount is too great, using a notch filter is not recommended.

The following figure shows the system open-loop gain with resonance suppression.




When the value of parameter ResonanceSuppressionLowPassFilterTime ID210 (P2.025) is increased from 0, the system bandwidth becomes smaller. Although it solves the problem of resonance frequency, the system bandwidth and phase margin are reduced.




If the resonance frequency is given, the notch filter can mitigate the resonance directly. Frequency of the notch filter is 50…5000 Hz and the suppression attenuation is 0…40 dB. If the resonance frequency does not fall within these values, using the low pass filter to reduce the resonance is suggested.

*Auto-resonance Suppression Mode*

**Table 96 - Relevant Parameter**

| Parameter | Name |
|---|---|
| ID230 (P2.047) | ResonanceSuppressionConfig |

Settings:


- X: Auto-resonance Suppression Function

  0 = Disable - After this function is disabled, the existing suppression values remain with their last value.

  1 = Enable - When this setting is true, the drive determines the following:

  - If the servo is stable and resonance is suppressed and no other resonance is present; then the servo saves the resonance suppression data and changes Auto Suppression function = 0. If there is still a resonance or the drive is unstable, set this value back to 1 and the drive executes this process again.

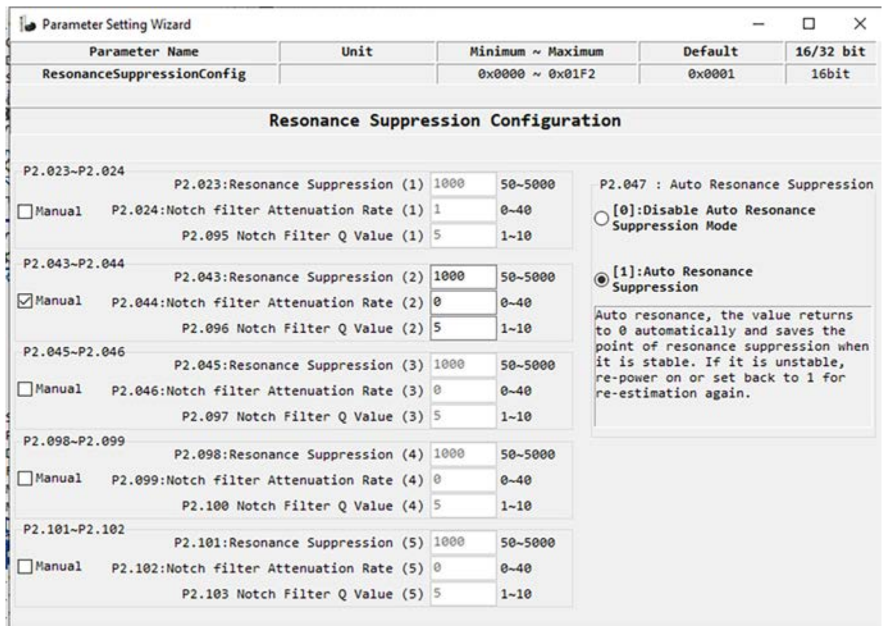
- ZY: Fixed Resonance Suppression Parameter

  In auto resonance suppression, you can set the notch filters that require manual resonance suppression.

| Bit | Function | Description |
|---|---|---|
| 0 | Notch 1 auto/manual setting | • 0: Auto resonance suppression<br>• 1: Manually set the first set of resonance suppression |
| 1 | Notch 2 auto/manual setting | • 0: Auto resonance suppression<br>• 1: Manually set the second set of resonance suppression |
| 2 | Notch 3 auto/manual setting | • 0: Auto resonance suppression<br>• 1: Manually set the third set of resonance suppression |
| 3 | Notch 4 auto/manual setting | • 0: Auto resonance suppression<br>• 1: Manually set the fourth set of resonance suppression |
| 4 | Notch 5 auto/manual setting | • 0: Auto resonance suppression<br>• 1: Manually set the fifth set of resonance suppression |

- U = Reserved

**Figure 98 - Auto-resonance Suppression Mode**




*For example:*
If the user sets the parameter ResonanceSuppression Config ID230 (P2.047) to 0x0021, which is Notch Filter 2 enabled; shown in Figure 98 with the auto resonance suppression enabled, the servo searches for the resonance and suppresses it. When Y is set to 0010 (decimal 2), you can manually set the second set of resonance suppression. Thus, if the servo finds two resonant frequencies, then the servo writes data of the first point to the first set of resonance suppression parameters. Then, data of the second point is written to the third set of resonance suppression parameters. Therefore, the first and second resonant frequencies are attenuated.

*Auto-resonance Detection Level*

**Table 97 - Relevant Parameter**

| Parameter | Name |
|---|---|
| ID231 (P2.048) | ResonanceDiagnosticLevel |

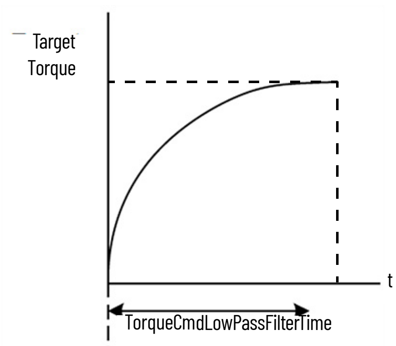
The smaller this parameter value is, the more sensitive the drive is to resonance. When the value of parameter ID231 (P2.048) is bigger, then the resonance sensitivity is lower.

## Torque Mode Low Pass Filter

Low pass filter for commands is typically used to filter out unwanted highfrequency response or noise so that the torque command becomes smoother.

**Table 98 - Relevant Parameter**

| Parameter | Name |
|---|---|
| ID123 (P1.007) | TorqueCmdLowPassFilterTime |



## Speed and Torque Limit Functions

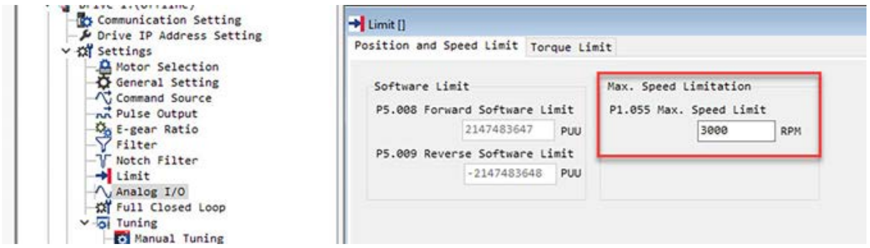
The Kinetix 5100 drive can apply speed and torque limits depending on the Operation Mode of the drive.

### Speed Limits

The Speed Limits are used to limit the maximum motor speed for the application (Max. Speed Limit) and to provide a limited speed in Torque mode

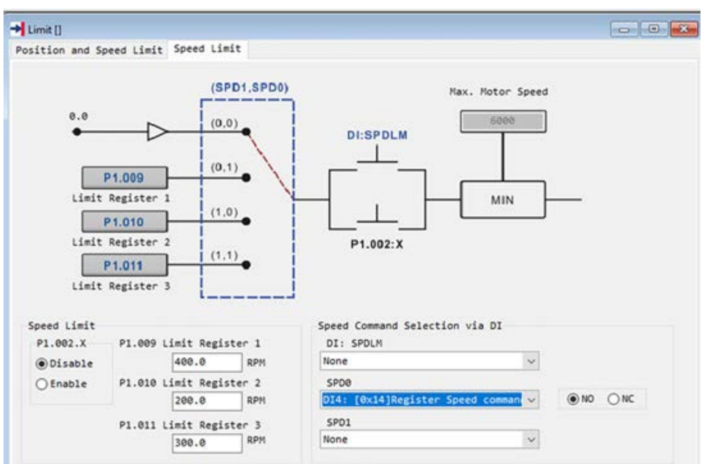
- Operation Mode: Position Mode (PR/PT) and Speed Mode (S/Sz)

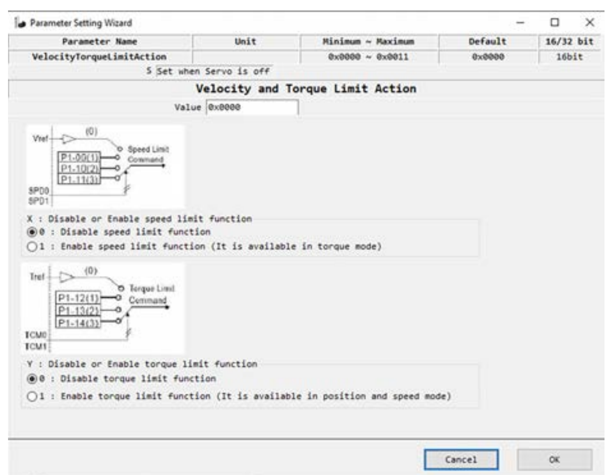
  Max. Speed Limit ID160 (P1.055)




- Operation Mode: Torque (T/Tz)

  The Speed can be limited while in Torque mode. The VelocityTorqueLimitAction ID118 (P1.002) is used to enable the limit and the preset registers contain the speed limited values.




You can change the speed limit:

- One time - The Speed Limit remains active indefinitely. First, choose Enable with ID118 (P1.002.X). This speed change does not require a digital input (SPDLM=None) and only requires enabling X.1 in VelocityTorqueLimitAction ID118 (P1.002). The preset speed is chosen with Digital Inputs SPD0/1.
- More than once - The Speed Limit is changed by using a Digital Input. (DI.Speed Limit/SPDLM) - First, choose Disable with ID118 (P1.002.X). This limiting is flexible so that the speed limit can be changed while the torque limit is active. The preset speeds are selected using the binary weighted value of Digital Inputs SPD0/1. The speed limit is applied when DI.Speed Limit/SPDLM is ON.

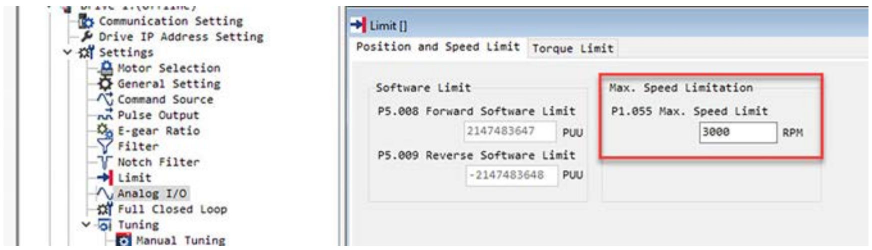
The overall speed limit is still active. That means Max. Speed Limit ID160 (P1.055) is still observed.

## Apply a Speed Limit

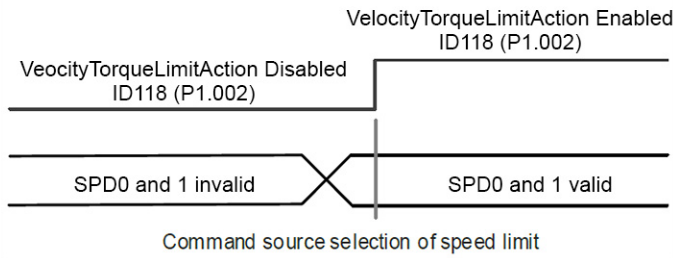
**Table 99 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID118 (P1.002) | VelocityTorqueLimitAction |
| ID125 (P1.009) | PresetVelocityCmd_Limit_1 |
| ID126 (P1.010) | PresetVelocityCmd_Limit_2 |
| ID127 (P1.011) | PresetVelocityCmd_Limit_3 |
| ID160 (P1.055) | MaximumSpeed |

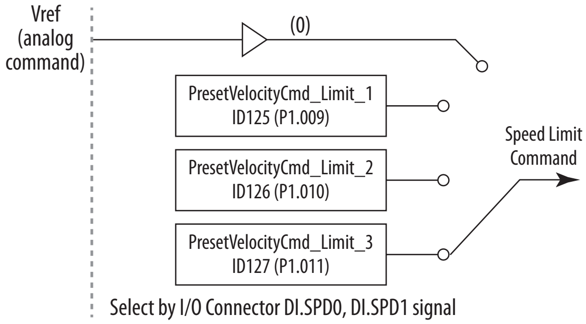
The maximum speed in each mode is determined by the internal parameter ID160 (P1.055). This bi-directional speed limit is applied at the end of the profile generation, so it limits speed regardless of mode or command source.




Speed limit is applicable only in torque mode (T) for controlling the motor maximum speed. If using external analog voltage in torque mode, DI signals are available and can be set to SPD0…SPD1 for motor speed limit selection (internal parameters). You can calibrate the analog input max value to motor rpm max speed. When parameter ID118 (P1.002) is set to 1, the speed limit function is enabled. See the following timing diagram.




To set the speed limit, see the following diagram.

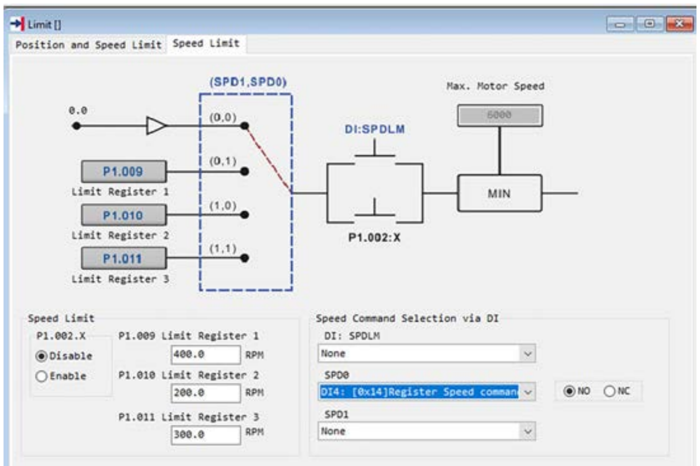


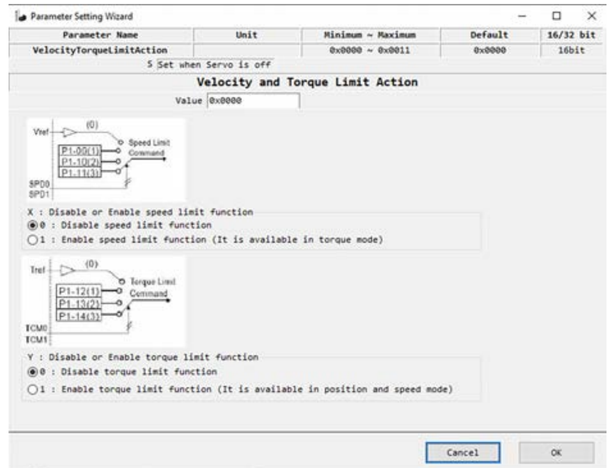
## Torque Limits

The Torque Limits are used to limit the maximum motor torque for the application.

- Operation Mode: Position Mode (PR/PT) and Speed Mode (S/Sz)

  In these modes, you can use the speed and torque limiting to control the motor.



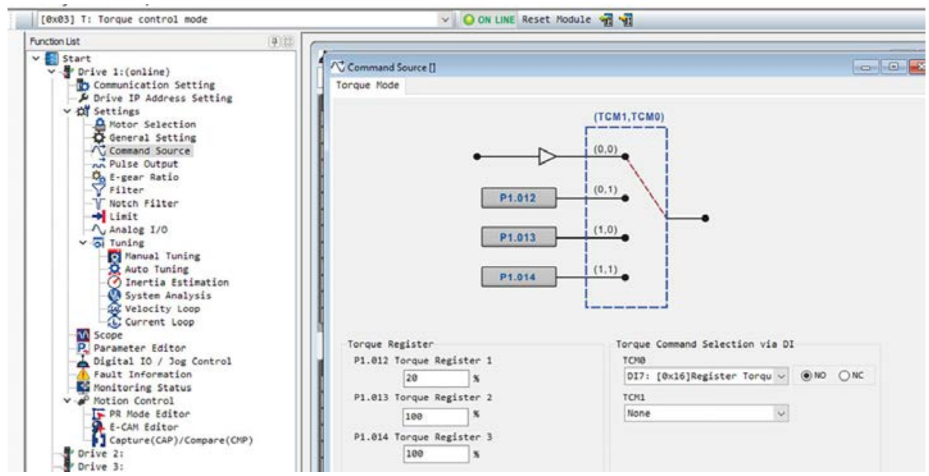



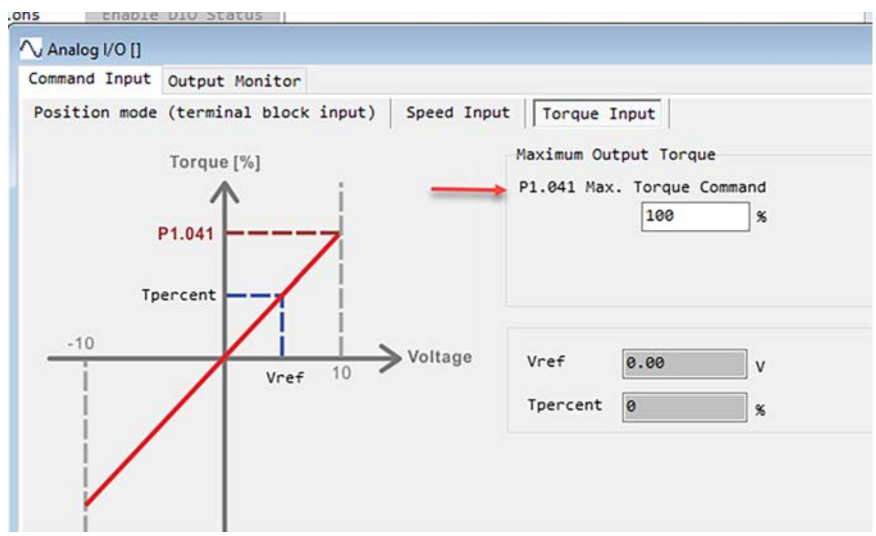

You can change the speed limit (used with torque limiting). The torque configurations are in the following images:

- One time - In this case, the Speed Limit is used with Torque Limiting. First, choose Enable with ID118 (P1.002.Y). This torque limit does not require a digital input (TRQLM=None) and only requires enabling Y.1 in VelocityTorqueLimitAction ID118 (P1.002). The preset torque is chosen with Digital Inputs TCM0/1.
- More than once - By using a Digital Input. (DI.Torque Limit/TRQLM) - First, choose Disable with ID118 (P1.002.Y). This torque limiting is flexible so that the torque limit can be changed. The preset torques are selected using the binary weighted value of Digital Inputs TCM0/1. The torque limit is applied when DI.Torque Limit/TRQLM is ON.

- Operation Mode: Torque Mode (T/Tz)

  The torque limit can be changed using the preset torque registers and the TCM0/1 Digital Inputs. Once the motor is enabled, the torque limit is active. You can use the speed limit (described above) to control the speed limit while in torque mode. When the digital inputs for TCM0/1 are changed, the torque limits are changed dynamically.




This table shows the binary weighting representation:

| Speed Command | TCM0 | TCM1 |
|---|---|---|
| Analog Input Torque | 0 | 0 |
| Torque Register 1 | 0 | 1 |
| Torque Register 2 | 1 | 0 |
| Torque Register 3 | 1 | 1 |

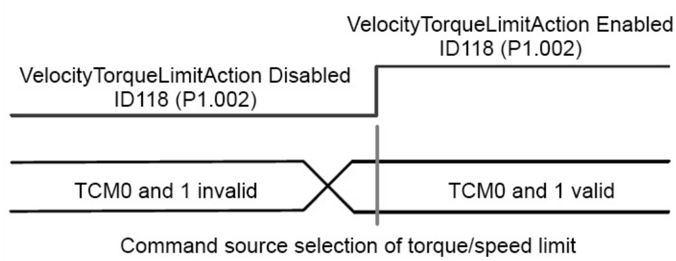
## Apply the Torque Limit

**Table 100 - Relevant Parameters**

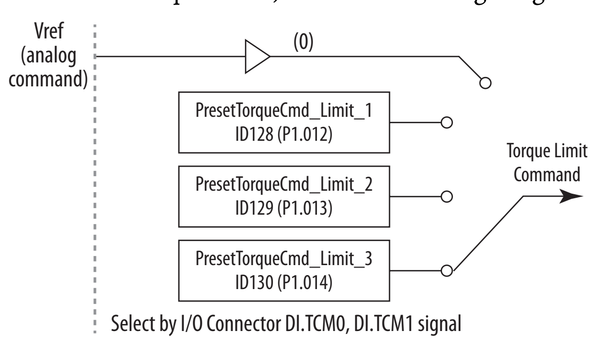
| Parameter | Name |
|---|---|
| ID118 (P1.002) | VelocityTorqueLimitAction |
| ID128 (P1.012) | PresetTorqueCmd_Limit_1 |
| ID128 (P1.013) | PresetTorqueCmd_Limit_2 |
| ID130 (P1.014) | PresetTorqueCmd_Limit_3 |

The issuing method of torque limit command and torque command are identical. The command source can be external analog voltage, which used with Max Torque Command ID148 (P1.041) or internal parameters ID128…ID130 (P1.012…P1.014).

Torque limit can be used in position mode (PT, PR) or speed mode (S). It is used for limiting the motor torque output. When the command in position mode is issued by external pulse or the command in speed mode is issued by external analog voltage, DI signals are available and can be set to TCM0…TCM1 to determine the torque limit command (internal parameters). If there are not enough DI signals available, you can limit the torque by using the analog voltage command with Max Torque Command ID148 (P1.041). When the parameter ID118 (P1.002) is set to 1, the different torque limiting presets are used. When ID118 (P1.002) is set to 0, then Max Torque Command ID148 (P1.041) value is used to limit torque. See the following timing diagram.




To set the torque limit, see the following diagram.

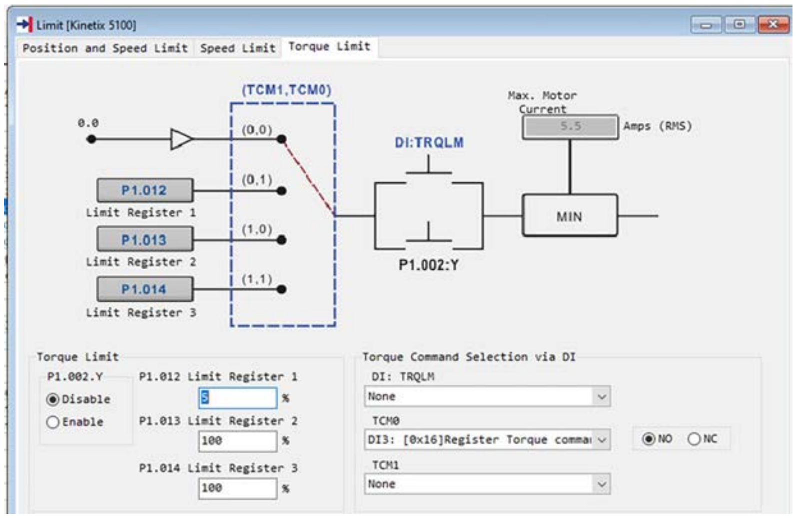


## Enable/Disable Limits by using VelocityTorqueLimitAction

**Table 101 - Relevant Parameters**

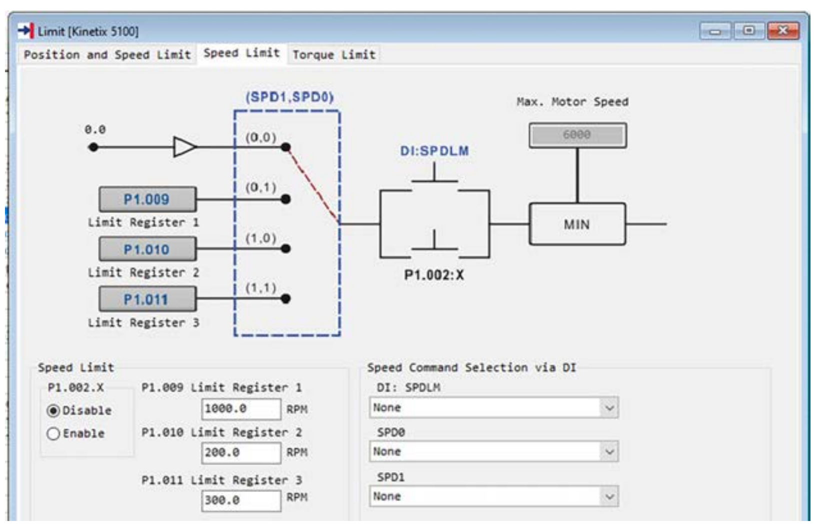
| Parameter | Name |
|---|---|
| ID118 (P1.002) | VelocityTorqueLimitAction |

The VelocityTorqueLimitAction configuration is set by KNX5100C software.




Choose Enable in P1.002.Y to enable or disable the Torque Limit. Once the torque limit is enabled, the torque limit function can be changed:

- One time - This torque change does not require a digital input and just requires enabling Y.1 in VelocityTorqueLimitAction (ID118, P1.002).
- More than once - By using a Digital Input. (DI.Torque Limit) This is flexible so that the torque limit can be modified by changing the torque presets and toggling the digital input.




Choose Enable in P1.002.X to enable or disable the Speed Limit. Once the speed limit is enabled, the speed limit function can be changed:

- One time - This speed change does not require a digital input and just requires enabling X.1 in VelocityTorqueLimitAction (ID118, P1.002).
- More than once - This is flexible so that the speed limit can be modified by changing the speed presets and toggling the digital input.

## Dual and Multi-modes

Eight dual/multiple modes are provided for operation in addition to the single modes. The Dual and Multi-mode functions are chosen by using the Operation Mode setting in KNX5100C setting (Control Mode, ID117, P1.001), and then using Digital Inputs that contain all the mode combinations.

| Mode | Short Name | Setting Code | Description |
|---|---|---|---|
| Dual | PT-S | 06 | PT and S can be switched by using the DI signal, S_P. |
| | PT-T | 07 | PT and T can be switched by using the DI signal, T_P. |
| | PR-S | 08 | PR and S can be switched by using the DI signal, S_P. |
| | PR-T | 09 | PR and T can be switched by using the DI signal, T_P. |
| | S-T | 0A | S and T can be switched by using the DI signal, S_T. |
| | PT-PR | 0D | PT and PR can be switched by using the DI signal, PT_PR. |
| Multi-mode(1) | PT-PR-S | 0E | PT, PR, and S can be switched by using the DI signal, S_P and PT_PR. |
| | PT-PR-T | 0F | PT, PR, and T can be switched by using the DI signal, T_P and PT_PR. |

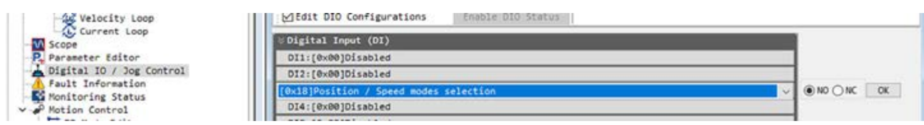
(1) Multiple (multi-) modes are a combination of a dual mode and a single mode.

| | |
|---|---|
| **IMPORTANT** | When dual/multi modes are used, the mode changing is immediate, which can result in unintended motion. |

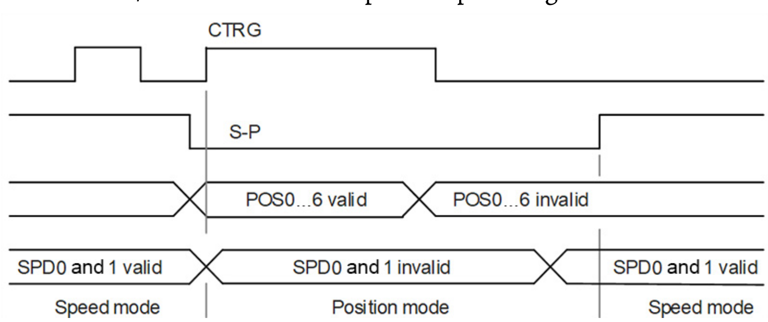
*Speed/Position Dual Mode*

The timing chart shows the behavior of the dual mode operation when switching from Speed mode into Position mode.

- CTRG (Digital Input = CmdTriggered)
- S-P (Digital Input = Position/Speed modes selection, 0 = Position, 1 = Speed as shown)




- POS0…POS6 indicates a valid binary-weighted PR is selected
- SPD0/1 indicate that the preset speed registers are valid




Here is the typical configuration for this operation:

1. Choose the PR/S Operation Mode.
2. Set your Digital I/O (in this example, we are using PR1 and SPD0).
3. Set Position/Speed Mode Selection - this switches between the two modes dynamically.
4. Command Triggered DI (CTRG) is selected.

In Speed Mode, when the transition to Position mode occurs, we require the CTRG (CmdTriggered) input to transition Off to On to begin the selected PR.

In Position Mode, when the transition to Speed mode occurs and the selected speed preset is valid, the motor begins executing the selected preset speed.

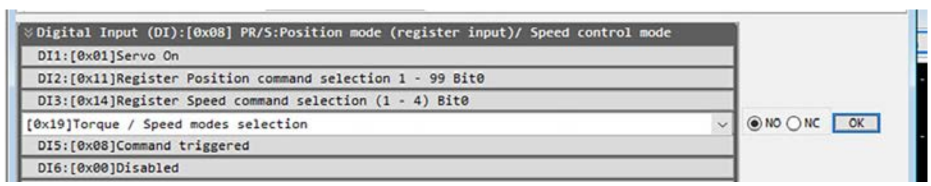
| | |
|---|---|
| **IMPORTANT** | To avoid large speed changes when switching modes, be sure to set the S-curve Smoothing constant to the time your application requires to transition to the worst case preset speed. When modes are changed dynamically, the change to the control loops are immediate. Care must be used so speed/torque limits do not exceed application requirements. |


For more information, see Position Control on page 230 and Speed Mode on page 240.

*Speed/Torque Dual Mode*

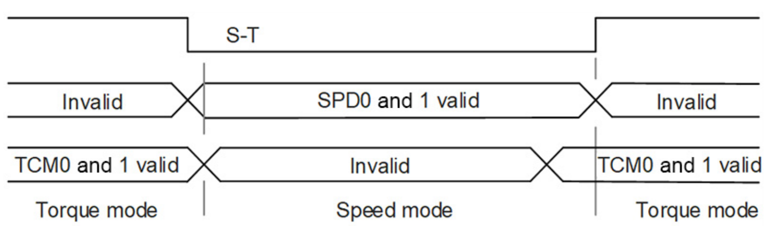
The timing chart below shows the behavior of the dual mode operation when switching from Speed mode into Torque Mode.

- S-T (Digital Input = Torque/Speed modes selection, 0=Torque, 1=Speed as shown




- TCM0/TCM1 indicate that the preset torque register values are valid
- SPD0/1 indicate that the preset speed registers are valid

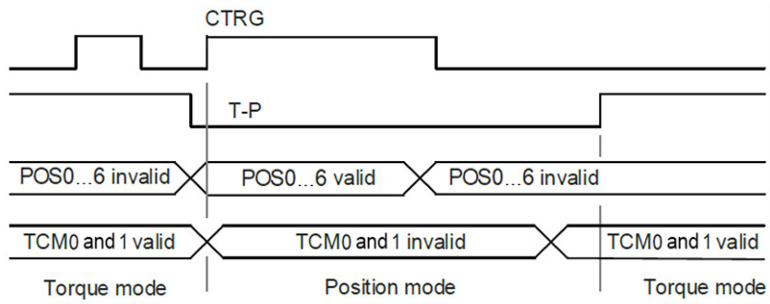
| | |
|---|---|
| **IMPORTANT** | To avoid large speed changes when switching modes, be sure to set the S-curve Smoothing constant to the time your application requires to transition to the worst case preset speed. When modes are changed dynamically, the change to the control loops are immediate. Care must be used so speed/torque limits do not exceed application requirements. |



*Torque/Position Dual Mode*

The timing chart below shows the behavior of the dual mode operation when switching from Torque mode into Position Mode.

- CTRG (Digital Input = CmdTriggered)
- T-P (Digital Input = Torque/Position modes selection, 0 = Torque, 1 = Position)
- POS0…POS6 indicates a valid binary-weighted PR is selected
- TCM0/1 indicate that the preset torque registers are valid




| | |
|---|---|
| **IMPORTANT** | When modes are changed dynamically, the change to the control loops are immediate. Care must be used so speed/torque limits do not exceed application requirements. |

For more information, see Position Control on page 230 and Torque Mode on page 246.

## IO Mode

| | |
|---|---|
| **IMPORTANT** | The induction and linear motors are not supported in IO Mode. |

When the Kinetix 5100 Operating Mode is configured as IO Mode, the operation and status of the drive comes from a Logix controller capable of a Class 1 Ethernet/IP connection. An example of this operation is a CompactLogix controller (for example, a 1769-L18). This controller uses Studio 5000 Logix Designer® application for programming with a Kinetix 5100 drive pre-defined Add-On Profile to exchange data between the drive and controller.

When the Kinetix 5100 is using IO Mode, Class 3 explicit messaging cannot be used for that particular drive.

| | |
|---|---|
| **IMPORTANT** | Although the Kinetix 5100 drive uses Motion Add-On Instructions to program and an Add-On Profile (AOP) that looks similar to the Integrated Motion on Ethernet/IP (CIP) drives, the Kinetix 5100 drive does not function the same way. The Kinetix 5100 drive is a standard I/O device on an Ethernet/IP network. It does not operate in the Motion Group and does not use the motion group for synchronization. The Kinetix 5100 drive operates as a Class 1 I/O device on an Ethernet/IP network. This is not a CIP Motion drive. |

The Input and Output assembly are shown for your convenience. While you can directly manipulate these assemblies, they rely on your logic to operate correctly, including timing, pre-existing drive conditions, and so on. It is typical to use the pre-defined Motion Operation Add-On Instructions to perform motion operations. These instructions contain interlocks and condition checking to facilitate the programming effort. See Appendix C for instruction details.

**Table 102 - Kinetix 5100 Output Assembly Data (Instance 104)**

| Byte | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operating Mode | | | | | | | |
| 1 | | | | Start Motion | Fault Reset | Stop Motion | Servo Off | Servo On |
| 2 | | | | | | | | |
| 3 | Homing Method | | | | | | | |
| 4 | Speed Reference (DINT) | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | Accel Reference (DINT) | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | Decel Reference (DINT) | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | Position Reference (DINT) | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | Home Return Speed (DINT) | | | | | | | |
| 21 | | | | | | | | |
| 22 | | | | | | | | |
| 23 | | | | | | | | |
| 24 | Non-cyclic Move Type | | | | | | | |
| 25 | Cyclic Move Type | | | | | | | |
| 26 | Travel Mode | | | | | | | |
| 27 | | | | | | Captured Position Select | Position Command Overlap | Position Command Override |
| 28 | Torque Reference (DINT) | | | | | | | |
| 29 | | | | | | | | |
| 30 | | | | | | | | |
| 31 | | | | | | | | |
| 32 | Torque Ramp Time (DINT) | | | | | | | |
| 33 | | | | | | | | |
| 34 | | | | | | | | |
| 35 | | | | | | | | |
| 36 | Starting Index | | | | | | | |
| 37 | | | | | | | | |
| 38 | | | | | | | | |
| 39 | | | | | | | | |

**Table 103 - Kinetix 5100 Output Assembly Data (Instance 106)**

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|
| 106 | 0 | OperatingMode (SINT) | | | | | | | |
| | 1 | | | | Start Motion | Fault Reset | Stop Motion | ServoOff | ServoOn |
| | 2 | | | | | | | | |
| | 3 | HomingMethod (SINT) | | | | | | | |
| | 4 | SpeedReference (DINT) | | | | | | | |
| | 5 | | | | | | | | |
| | 6 | | | | | | | | |
| | 7 | | | | | | | | |
| | 8 | AccelReference (DINT) | | | | | | | |
| | 9 | | | | | | | | |
| | 10 | | | | | | | | |
| | 11 | | | | | | | | |
| | 12 | DecelReference (DINT) | | | | | | | |
| | 13 | | | | | | | | |
| | 14 | | | | | | | | |
| | 15 | | | | | | | | |
| | 16 | PositionReference (DINT) | | | | | | | |
| | 17 | | | | | | | | |
| | 18 | | | | | | | | |
| | 19 | | | | | | | | |
| | 20 | HomeReturnSpeed (DINT) | | | | | | | |
| | 21 | | | | | | | | |
| | 22 | | | | | | | | |
| | 23 | | | | | | | | |
| | 24 | NonCyclicMoveType (SINT) | | | | | | | |
| | 25 | CyclicMoveType (SINT) | | | | | | | |
| | 26 | TravelMode (SINT) | | | | | | | |
| | 27 | | | | | | Captured Position Select | Position Command Overlap | Position Command Override |
| | 28 | TorqueReference (DINT) | | | | | | | |
| | 29 | | | | | | | | |
| | 30 | | | | | | | | |
| | 31 | | | | | | | | |
| | 32 | TorqueRampTime (DINT) | | | | | | | |
| | 33 | | | | | | | | |
| | 34 | | | | | | | | |
| | 35 | | | | | | | | |
| | 36 | StartingIndex (SINT) | | | | | | | |
| | 37 | | | | | | | | |
| | 38 | | | | | | | | |
| | 39 | | | | | | | | |
| | 40 | CamMasterReference (SINT) (Future) | | | | | | | |
| | 41 | CamExecutionSchedule (SINT) (Future) | | | | | | | |
| | 42 | CamExecutionMode (SINT) (Future) | | | | | | | |
| | 43 | | | | | CamStop Mode (Future) | | | |

**Table 103 - Kinetix 5100 Output Assembly Data (Instance 106) (Continued)**

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|
| 106 | 44 | CamSlaveScaling (DINT) (Future) | | | | | | | |
| | 45 | | | | | | | | |
| | 46 | | | | | | | | |
| | 47 | | | | | | | | |
| | 48 | Reserved | | | | | | | |
| | 49 | | | | | | | | |
| | 50 | | | | | | | | |
| | 51 | | | | | | | | |
| | 52 | CamLockPosition (DINT) (Future) | | | | | | | |
| | 53 | | | | | | | | |
| | 54 | | | | | | | | |
| | 55 | | | | | | | | |
| | 56 | CamMasterLockPosition (DINT) (Future) | | | | | | | |
| | 57 | | | | | | | | |
| | 58 | | | | | | | | |
| | 59 | | | | | | | | |
| | 60 | CamMasterLeadingCounts (DINT) (Future) | | | | | | | |
| | 61 | | | | | | | | |
| | 62 | | | | | | | | |
| | 63 | | | | | | | | |
| | 64 | CamMasterUnlockCounts (DINT) (Future) | | | | | | | |
| | 65 | | | | | | | | |
| | 66 | | | | | | | | |
| | 67 | | | | | | | | |
| | 68 | CamMasterCyclicLeadingCounts (DINT) (Future) | | | | | | | |
| | 69 | | | | | | | | |
| | 70 | | | | | | | | |
| | 71 | | | | | | | | |
| | 72 | Reserved | | | | | | | |
| | 73 | | | | | | | | |
| | 74 | | | | | | | | |
| | 75 | | | | | | | | |
| | 76 | GearRatioSlaveCounts (DINT) | | | | | | | |
| | 77 | | | | | | | | |
| | 78 | | | | | | | | |
| | 79 | | | | | | | | |
| | 80 | GearRatioMasterCounts (DINT) | | | | | | | |
| | 81 | | | | | | | | |
| | 82 | | | | | | | | |
| | 83 | | | | | | | | |

**Table 104 - Kinetix 5100 Drive Output Assembly Data Description**

| Name | Data Type | Description | Semantics of Values |
|---|---|---|---|
| Operating mode (output) | SINT | This enumerated value indicates the drive's internal mode setting. The drive can operate in different sub-modes while in IO Mode. | • -128…-1: Reserved<br>• 0: Mode not specified<br>• 1: Position mode<br>• 2: Speed mode<br>• 3: Home mode<br>• 4: Torque mode<br>• 5: Gear mode<br>• 6: Index mode<br>• 7: ECAM mode<br>• 8…127: Reserved |
| Servo on | BOOL | A 0-to-1 transition enables the motor. | — |
| Servo off | | A 0-to-1 transition disables the motor. | — |
| Stop motion | | A 0-to-1 transition stops motion on the motor. | — |
| Fault reset | | A 0-to-1 transition clears an active drive fault. | — |
| Start motion | | A 0-to-1 transition means the motion command is issued from the external controller. | — |
| Homing method | SINT | Homing method. | See Table 112 on page 295. |
| Speed reference | DINT | The commanded speed for the motor. | • Units are 0.1 RPM<br>• -80000…+80000<br>• 1…20000 (home mode) |
| Acceleration reference | | The commanded acceleration rate for the motor. | Units are 0.1 RPM/sec |
| Deceleration reference | | The commanded deceleration rate for the motor. | Units are 0.1 RPM/sec |
| Position reference | | The commanded position used for indexing. | User units as defined by the scaling relationship from the E-Gear ratio in KNX5100C software. |
| Home return speed | | The return speed when home mode is the operating mode. | 1…5000 units are 0.1 RPM (rotary motors) |
| Non-cyclic move type | SINT | Enumerated value used to determine the noncyclic move type. | • -128…-1: Reserved<br>• 0: Absolute<br>• 1: Relative<br>• 2: Incremental<br>• 3: High-speed capture<br>• 4…127: Reserved |
| Cyclic move type | | Enumerated value used to determine the cyclic move type. | • -128…-1: Reserved<br>• 0: Rotary positive<br>• 1: Rotary negative<br>• 2: Rotary shortest path<br>• 3…127: Reserved |
| Travel mode | | Enumerated value used to determine the travel constraints of the axis. | • -128…+1: Reserved<br>• 2: Non-cyclic move<br>• 3…9: Reserved<br>• 10: Cyclic move<br>• 11…127: Reserved |
| Position command override | BOOL | When executing a motion command, the next movement can override the previous movement. | • 0: Does not override previous movement<br>• 1: Can override previous movement |
| Position command overlap | | The end of the current movement can be overlapped by the next movement. | • 0: Does not overlap the next movement<br>• 1: Overlaps the next movement |
| Captured position select | BOOL | Selects between the high speed digital inputs used to capture position feedback. | Vendor specific.<br>0: DI9 is selected<br>1: DI10 is selected |

### Table 104 - Kinetix 5100 Drive Output Assembly Data Description (Continued)

| Name | Data Type | Description | Semantics of Values |
|---|---|---|---|
| Torque reference | DINT | Represents the output torque level when the Operation Mode is Torque Mode (3). This value is percent of motor rated torque. | -4000…4000 enumeration is 0.1x |
| Torque ramp time | | Represents the time to reach the torque reference. This units are ms. | 1…65500 |
| Starting index | SINT | The first index (position register) that the drive should execute. | • -128…-1: Reserved<br>• 0: PR 0<br>• 1…99: PR1…PR99<br>• 100…127: Vendor specific |

### Table 105 - Kinetix 5100 Input Assembly Data (Instance 154)

| Byte | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Diagnostic Active | Connection Faulted | Run Mode |
| 1 | Diagnostic sequence count | | | | | | | |
| 2 | Pad bytes for LINT alignment | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | Uncertain | Fault | |
| 9 | At Reference | Stopped | Homed Status | Command in Progress | Ready | Active | Warning Present | |
| 10 | Reserved | | | | | | | |
| 11 | Operating Mode | | | | | | | |
| 12 | Active Index | | | | | | | |
| 13 | Reserved | | | | | | | |
| 14 | | | | | | | | |
| 15 | Motor Type | | | | | | | |
| 16 | Actual Speed (DINT) | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | Fault Code (UINT) | | | | | | | |
| 21 | | | | | | | | |
| 22 | Warning Code (UINT) | | | | | | | |
| 23 | | | | | | | | |
| 24 | Actual Position (DINT) | | | | | | | |
| 25 | | | | | | | | |
| 26 | | | | | | | | |
| 27 | | | | | | | | |
| 28 | Actual Torque (DINT) | | | | | | | |
| 29 | | | | | | | | |
| 30 | | | | | | | | |
| 31 | | | | | | | | |
| 32 | Parameter Monitor 1 Value (DINT) | | | | | | | |
| 33 | | | | | | | | |
| 34 | | | | | | | | |
| 35 | | | | | | | | |

**Table 105 - Kinetix 5100 Input Assembly Data (Instance 154) (Continued)**

| Byte | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 36 | Parameter Monitor 2 Value (DINT) | | | | | | | |
| 37 | | | | | | | | |
| 38 | | | | | | | | |
| 39 | | | | | | | | |
| 40 | Parameter Monitor 3 Value (DINT) | | | | | | | |
| 41 | | | | | | | | |
| 42 | | | | | | | | |
| 43 | | | | | | | | |
| 44 | Parameter Monitor 4 Value (DINT) | | | | | | | |
| 45 | | | | | | | | |
| 46 | | | | | | | | |
| 47 | | | | | | | | |
| 48 | Parameter Monitor 5 Value (DINT) | | | | | | | |
| 49 | | | | | | | | |
| 50 | | | | | | | | |
| 51 | | | | | | | | |

**Table 106 - Kinetix 5100 Drive Input Assembly Data Description**

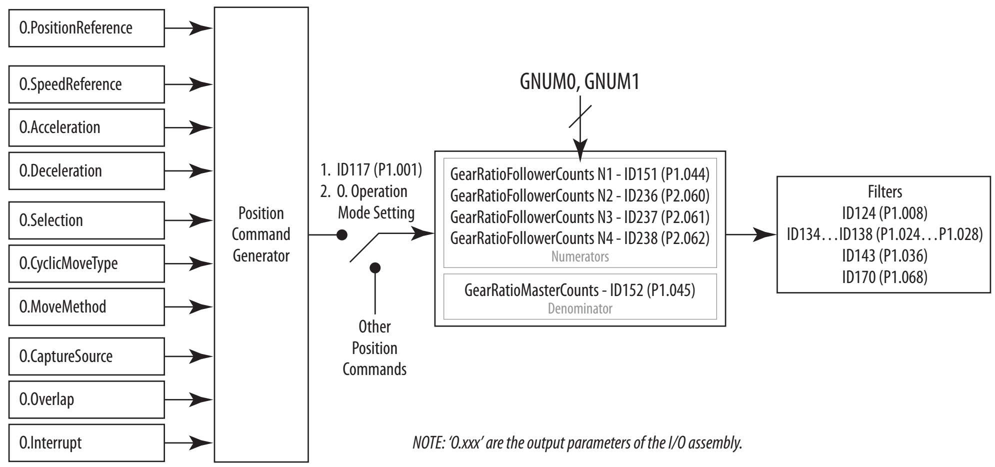
| Name | Data Type | Description | Semantics of Values |
|---|---|---|---|
| Run mode | BOOL | Indicates whether the drive is in run mode | • 0: Drive is idle<br>• 1: Drive is in run mode |
| Connection faulted | | Indicates whether the connection is faulted | • 0: Connection is not faulted<br>• 1: Connection is faulted |
| Diagnostic active | | Indicates whether the diagnostic is active | • 0: Diagnostic is not active<br>• 1: Diagnostic is active |
| Diagnostic sequence count | SINT | The sequence count for the diagnostic | — |
| Fault | BOOL | Indicates whether the drive is in a faulted state | • 0: No Fault<br>• 1: Faulted |
| Uncertain | | Indicates whether the data validity is questionable | • 0: Data is valid<br>• 1: Data validity is questionable |
| Warning present | | Indicates whether the drive is in a warning state | • 0: No warnings<br>• 1: Drive is in a warning state |
| Active | BOOL | Indicates whether the motor is enabled | • 0: Motor is not enabled<br>• 1: Motor is enabled |
| Ready | | Indicates whether the motor is ready to be enabled | • 0: Motor is not ready<br>• 1: Motor is ready |
| Command in progress | | Indicates whether the drive received the command from the controller | Indicates the new command has been received by the K5100 drive. It toggles between 0 and 1 after a new command has been received by the K5100 drive. When this bit toggles it stays at the toggled state until a new command is received. |
| Homed status | | Indicates whether the drive completed the home operation | 1: Drive completed the home operation |
| Stopped | | Indicates whether the motor is stopped | 1: Motor is stopped |
| At reference | | Motor actual at reference (position, speed, torque) based on mode | 1: Motor actual at reference (position, speed, torque) based on mode |

**Table 106 - Kinetix 5100 Drive Input Assembly Data Description (Continued)**

| Name | Data Type | Description | Semantics of Values |
|---|---|---|---|
| Operating mode (input) | SINT | Indicates the drive Operation Mode | Its value may be:<br>• -128…+1: Reserved<br>• 0: Mode not specified<br>• 1: Position mode<br>• 2: Speed mode<br>• 3: Home mode<br>• 4: Torque mode<br>• 5: Gear mode<br>• 6: Index mode<br>• 7…127: Reserved |
| Active index | SINT | Indicates the currently executing index (PR) | Currently executing index:<br>• -128…+1: Reserved<br>• 0: PR 0: Homing<br>• 1…99: PR 1…PR 99<br>• 100…127: Reserved |
| Motor type | SINT | Indicates which type of motor is connected to the drive | • 0: No motor connected<br>• 1: Rotary motor connected<br>• 2: Linear motor connected |
| Actual speed | DINT | Motor actual velocity | The value is RPM |
| Fault code | UINT | Fault code | See View Status and Faults on page 440 |
| Warning code | UINT | Warning code | See View Status and Faults on page 440 |
| Actual position | DINT | Motor Actual Position | PUU (counts or user units) |
| Actual torque | DINT | Actual Motor Torque | % motor rated torque |
| Parameter monitor 1 value | DINT | Parameter monitor selection 1 | 0 - no parameter is selected<br>0x0001…0xFFFF - returned value mapped from KNX5100C Function List>Parameter Editor>StatusMonitor ID060 |
| Parameter monitor 2 value | DINT | Parameter monitor selection 2 | 0 - no parameter is selected<br>0x0001…0xFFFF - returned value mapped from KNX5100C Function List>Parameter Editor>StatusMonitor ID061 |
| Parameter monitor 3 value | DINT | Parameter monitor selection 3 | 0 - no parameter is selected<br>0x0001…0xFFFF - returned value mapped from KNX5100C Function List>Parameter Editor>StatusMonitor ID062 |
| Parameter monitor 4 value | DINT | Parameter monitor selection 4 | 0 - no parameter is selected<br>0x0001…0xFFFF - returned value mapped from KNX5100C Function List>Parameter Editor>StatusMonitor ID063 |
| Parameter monitor 5 value | DINT | Parameter monitor selection 5 | 0 - no parameter is selected<br>0x0001…0xFFFF - returned value mapped from KNX5100C Function List>Parameter Editor>StatusMonitor ID064 |

## IO Mode - Position

When the IO Mode is used and the drive internal sub-mode is Position Mode (1), the drive command is an index or constant speed operation. Typically, the Motion Add-On Instruction are used to perform the index (raC_*xxx*_K5100_MAM) or Jog (raC_*xxx*_K5100_MAJ) operation. The control structure of position mode is as follows.

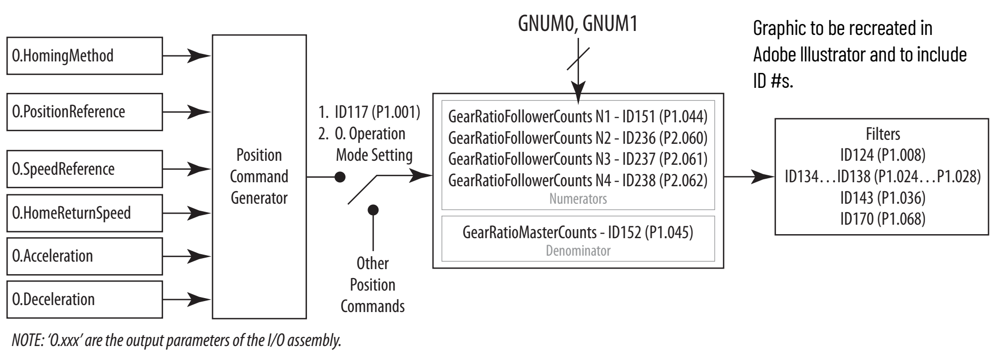



See Appendix C, Use Add-On Instructions on page 479, for more information.

## IO Mode - Home

When the IO Mode is used and the drive internal sub-mode is Home Mode (3), the drive command is a homing operation. Typically, the Motion Add-On Instruction are used to perform the home operation (raC_*xxx*_K5100_MAH).

The control structure of home mode is as follows.



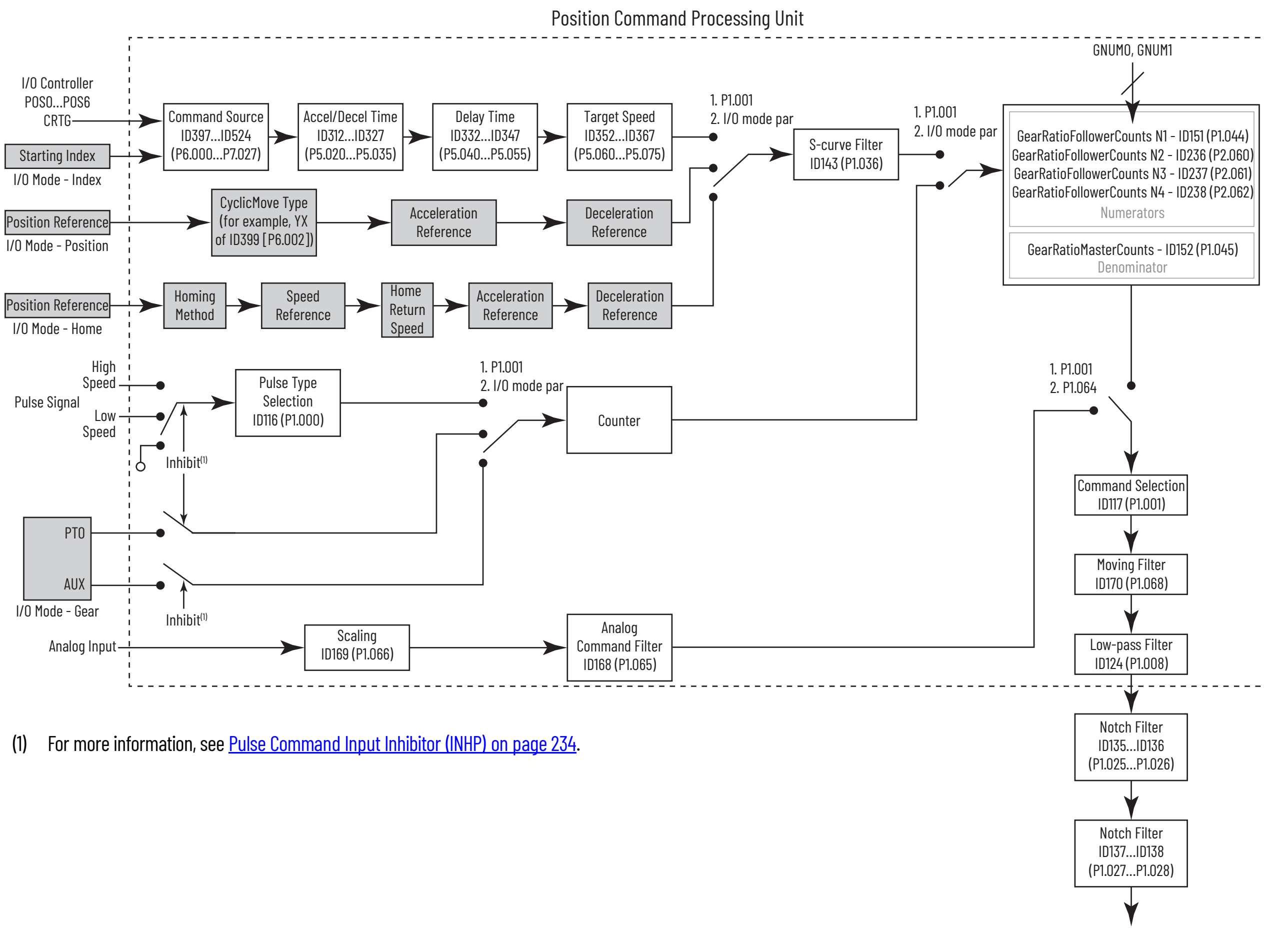

See Appendix C, Use Add-On Instructions on page 479, for more information.

See Homing on page 292 for more information.

## IO Mode - Gear

When the IO Mode is used and the drive internal sub-mode is Gear Mode (5), the drive command is a fixed pulse-pulse operation (Gearing). This mode uses a pulse-pulse following between this drive (slave) and a master that delivers pulses via the PT terminals or AUX feedback input. Typically, there is additional configuration in the KNX5100C software and then the Motion Add-On Instruction is used to perform the gearing operation (raC_*xxx*_K5100_MAG).

The control structure of gear mode is as follows.

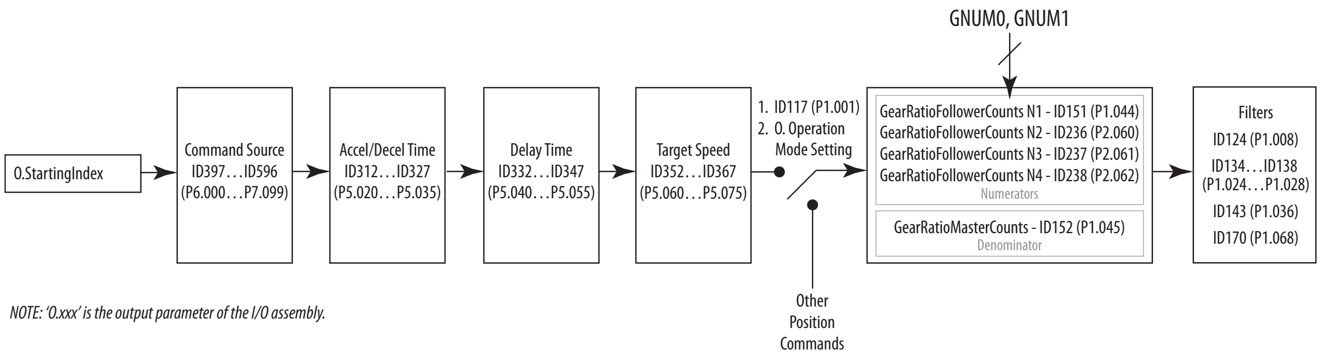



(1) For more information, see Pulse Command Input Inhibitor (INHP) on page 234.

## IO Mode - Index

When the IO Mode is used and the drive internal sub-mode is Index Mode (6), the drive uses a PR (Position Register) that you specify and is stored in the drive to execute. Typically, the Motion Add-On Instruction is used to perform the PR, or index selection (raC_*xxx*_K5100_MAI). For more about PR Mode, see Chapter 11, Motion Control in PR Mode.

The control structure of the index mode is as follows.

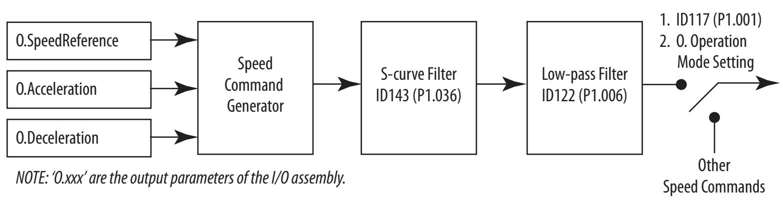



NOTE: 'O.xxx' is the output parameter of the I/O assembly.

## IO Mode - Speed

When the IO Mode is used and the drive internal sub-mode is Speed Mode (2), the drive executes a constant speed profile. Typically, the Motion Add-On Instruction is used to perform the constant speed profile (raC_*xxx*_K5100_MAJ).

The control structure of speed mode is as follows.

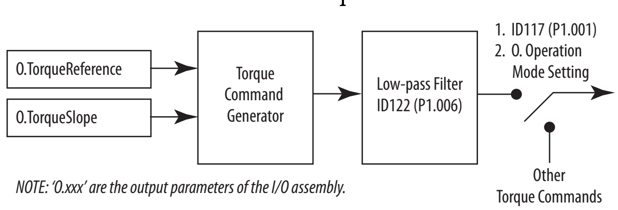



NOTE: 'O.xxx' are the output parameters of the I/O assembly.

## IO Mode - Torque

When the IO Mode is used and the drive internal sub-mode is Torque Mode (4), the drive outputs a constant torque. Typically, the Motion Add-On Instruction is used to perform the constant torque output (raC_*xxx*_K5100_MAT).

The control structure of torque mode is as follows.



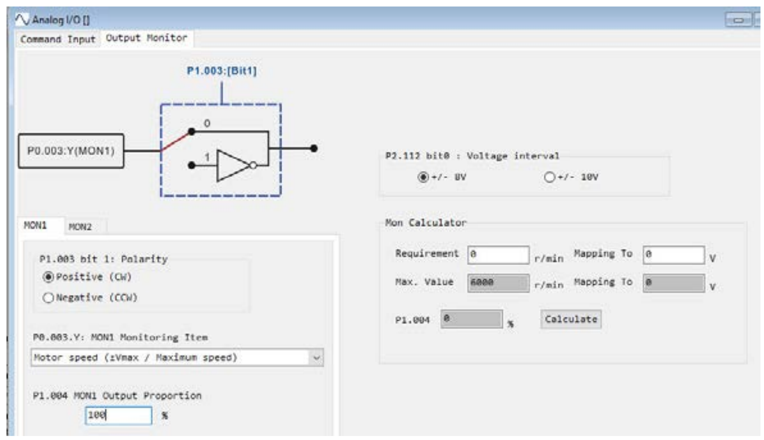

NOTE: 'O.xxx' are the output parameters of the I/O assembly.

## Analog Outputs and Monitoring

There are two analog outputs available on the I/O Connector pins 15(AOUT2), 16(AOUT1), and 19(AGND). These outputs can be scaled based on the output voltage and value used. You can use the MON1 and MON2 analog outputs at the same time.

**Table 107 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID103 (P0.003) | AOMonitorSelection |
| ID119 (P1.003) | EncoderOutputPolarity |
| ID120 (P1.004) | AnalogOutput1Scale |
| ID121 (P1.005) | AnalogOutput2Scale |
| ID290 (P4.020) | AnalogOuput1Offset |
| ID291 (P4.021) | AnalogOuput2Offset |




To configure the Analog Output, follow these steps.

1. From KNX5100C software, choose Function List > Drive > Settings > Analog I/O > Output Monitor.
2. Choose the output voltage used for the Analog Output.
3. Choose the Polarity of the Analog Output.
4. From the pull-down menu, assign a drive parameter to the analog output.

   If required, you can scale the drive parameter to provide better output granularity.
5. Use the Mon Calculator to scale the drive parameter with the analog output scale.

   When you enter the Requirement Mapping to XX Volts, click the Calculate to record the scaling into ID120 (P1.004).

   You must disable the drive and download any changes to the drive.

For example:
By using the steps above, this example shows the selection of Motor RPM with Analog Output1 (MON1) to specify a motor speed of 1000 rpm to correspond to an analog output of 8V for a motor with a maximum speed of 5000 rpm, use the following equation:

$$\text{ID120 (1.004)} = \frac{\text{Required speed}}{\text{Max speed}} \times 100\% = \frac{1000\ \text{rpm}}{5000\ \text{rpm}} \times 100\% = 20\%$$

To acquire the corresponding voltage output for the current motor speed, use the following equations:

*For a motor current speed of 300 rpm:*

$$MON1 = 8V \times \frac{\text{Current speed}}{\text{Max speed} \times \frac{P1.004}{100}} \times 100\% = 8V \times \frac{300\text{ rpm}}{5000\text{ rpm} \times \frac{20}{100}} \times 100\% = 2.4V$$

*For a motor current speed of 900 rpm:*

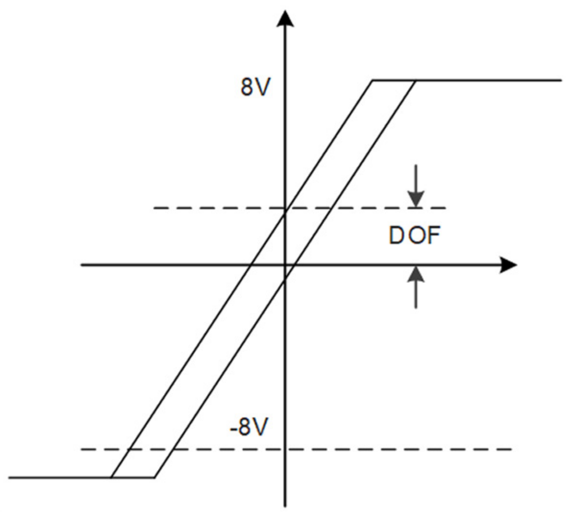
$$MON1 = 8V \times \frac{\text{Current speed}}{\text{Max speed} \times \frac{P1.004}{100}} \times 100\% = 8V \times \frac{900\text{ rpm}}{5000\text{ rpm} \times \frac{20}{100}} \times 100\% = 7.2V$$

### *Voltage Drift*

**Table 108 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID290 (P4.020) | AnalogOuput1Offset |
| ID291 (P4.021) | AnalogOuput2Offset |

If analog voltage drift occurs, the voltage level defined as zero volts is different from the measured zero volts point. To compensate for this offset, AnalogOutput1Offset DOF1 ID290 (P4.020) and AnalogOutput2Offset DOF2 ID291 (P4.021) can be used to calibrate the offset voltage output.



# Notes:

Chapter 11

# Motion Control in PR Mode



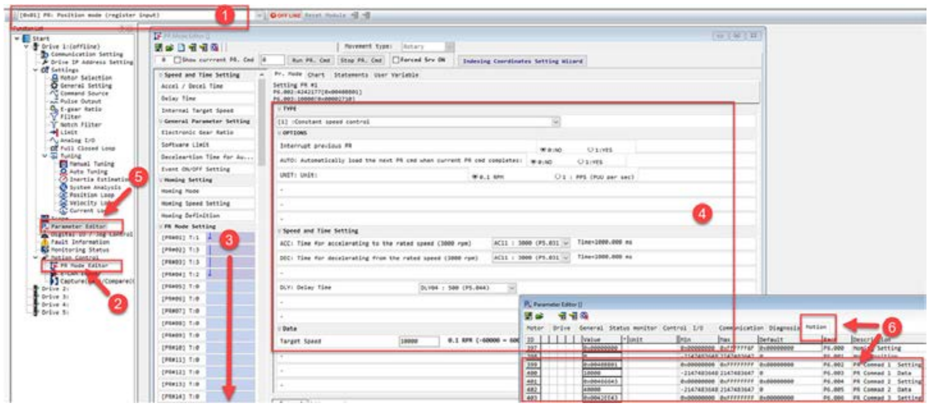
This chapter provides information about how to use the PR (Position Register) Operation Mode. In this mode, commands are executed based on the internal registers (called PRs) of the servo drive. Various commands are available, including Homing, Speed, Position, Jump, Write, Index Position, and Arithmetic operation. This chapter contains detailed description of each command.

This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

# Detailed Operation in PR Mode

In PR Mode, the internal registers (PR) of the Kinetix 5100 drive generate commands. The drive provides 100 PR (Position Registers) that allow different commands to be executed by the drive. The figure below shows the location of the key functions of PR Mode in the KNX5100C software.

**Figure 99 - PR Mode Operation**




| Item | Description |
|---|---|
| 1 | Operation Mode – set for PR Mode (Position Mode – Register Input). |
| 2 | PR Mode Editor - choose Function List>Settings>Motion Control>PR Mode Editor. |
| 3 | PR Mode Setting menu - the individual PR (Registers) – PR#01…PR#99 are shown. |
| 4 | PR#01 - the PR# dialog box shows the settings for the PR type that is chosen.<br>PR#00 is used as the Homing Configuration, so it cannot be used for any other purpose. |
| 5 | Parameter Editor - choose Function List>Settings>Parameter Editor to view or as an alternate method to set the move data. |
| 6 | Within the Parameter Editor, choose the Motion tab, here the PR Settings and PR Data is shown. Now, an external controller can use explicit messaging to read/write this data. |

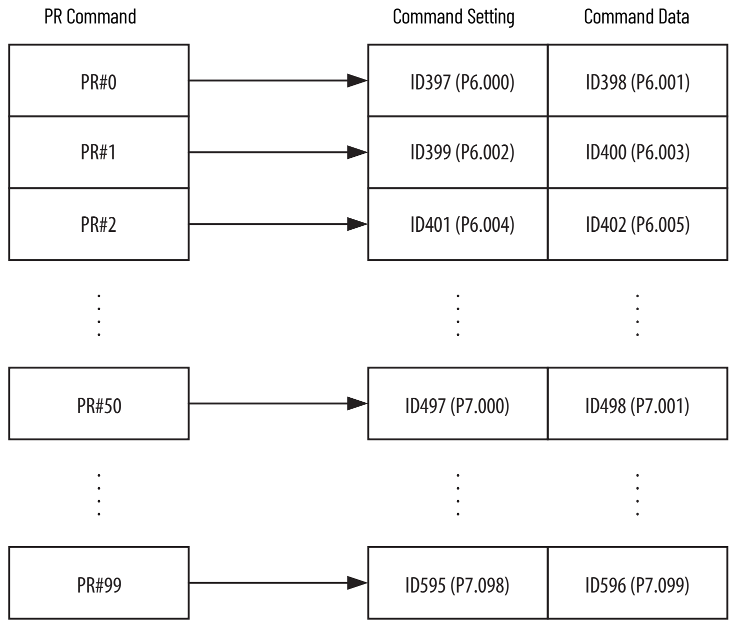
## Parameter Editor

The Home and PR values (Settings and Data) can be accessed by using parameters ID397…ID596 (P6.000…P7.099). These are grouped in pairs as shown in Figure 100.

1. Open the Parameter Editor; unction List>Settings>Parameter Editor.
2. Choose the Motion tab.

   This tab shows the locations for the individual PR settings.
3. Change the parameters by using explicit read/write Ethernet/IP messaging with an external controller.

**Figure 100 - Setting Parameters for Each PR Command**



## PR Mode Definitions

When an individual PR is selected (Figure 99, step ) and the dialog box appears (Figure 99, step ) in KNX5100C software. The TYPE selection chooses which OPTION values that are visible.

**Table 109 - PR Mode Definitions - Part 1**

| Type | Description |
|---|---|
| [0] NA | – |
| [1] Constant speed control | See Constant Speed Control on page 318 |
| [2] Point-to-Point Command | See Position Control Command on page 320 |
| [3] Point-to-Point Command<br>(Proceed to the next command when completed) | – |
| [7] Jump to the specified command | See Jump Command on page 323 |
| [8] Write to Parameters or Data Array | See Write Command on page 325 |
| [0xA] Index Position Control | See Index Position Command on page 327 |
| [0xB] Statement | See Arithmetic Operation Commands on page 332 |

Some of the Options shown are only visible when the TYPE is selected.

**Table 110 - PR Mode Definitions - Part 2**

| OPTIONS | SEMANTICS | DESCRIPTION | Constant Speed Control | Point to Point Command | Point to Point (proceed to next) | Jump to specified command | Write to parameters/ data array | Index Position Control | Statement |
|---|---|---|---|---|---|---|---|---|---|
| Interrupt previous PR<br>See Command Interrupts Execution on page 356 | 0=NO, 1=YES | When this PR is executed, it will interrupt (stop) any currently executing PR | X | X | X | X | X | X | X |
| Overlap Next PR<br>See Overlap Command Execution on page 362 | 0=NO, 1=YES | Will overlap the next PR with the currently executing PR | | X | X | | | X | |
| AUTO | 0=NO, 1=YES | Automatically load the next PR cmd when the current PR cmd completes | X | | | | X | X | |
| UNIT | 0=0.1 RPM, 1= PPS (PUU/sec) | | X | | | | | | |
| Speed factor | 0=0.1RPM, 1=0.01RPM | | | | | | | X | |
| CMD: Position command types | 00: Absolute Position<br>01: REL Relative Position<br>02: INC Incremental Position<br>03: CAP High Speed Position Capturing | | | X | | | | | |
| Direction | 0=forward, 1=reverse, 2=shortest direction | | | | | | | X | |
| ROM | 0=NO, 1=YES | Write to EERPOM when uploading a parameter | | | | | X | | |

### *PR Command Setting*

If you need to read/write the PR Command (including indexing) Setting values, the decoding of these hex values is shown below.

You can use an external controller capable of Class 3 Ethernet/IP messaging to perform explicit read/writes for changing the index settings, which involves changes to the control setting. This parameter ID399 (P6.002) for PR1 contains a High and Low word that can be changed from Hex into Decimal. This section shows how to ‘decode’ the settings so you can change any indexing value.

Settings:

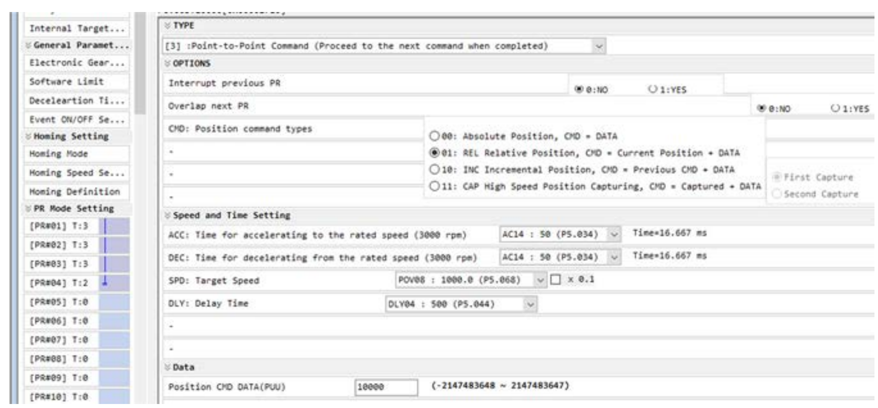
Format of this parameter: (High word h) DCBA: (Low word L) UZYX


| | | | |
|---|---|---|---|
| **A** | SPD, Target speed index | **X** | TYPE, Command type |
| **B** | DLY, Delay time index | **Y** | OPT, Option |
| **C** | AUTO | **Z** | ACC, Acceleration time index |
| **D** | Reserved | **U** | DEC, Deceleration time index |

The High/Low word values correspond to the following individual selections shown by using the actual Index selection in KNX5100C software. Notice that the drive uses pull-down selections for different index dynamics like speed, acceleration, and deceleration. Figure 101 shows a Point-To Point Command (indexing) and how these decoded values relate to the KNX5100C software.

We show how to decode the Control Setting so we can modify ID399 (P6.002) by using an explicit write. This approach to reading/writing index values works well for a single index approach. It also implies that you use all the possible Speed/Accel/Decel/Delay that are pre-loaded in the drive and then the control setting selects your dynamics by using the pull-down value.

**Figure 101 - Point-to-Point Index Setting in KNX5100C Software**



Definitions of the words are as follows:

- YX: option; command type - the X, Y rows line up to show what options are available for the Command Type

| **Y: OPT, Option** | | | | **X: TYPE, Command Type** |
|---|---|---|---|---|
| **Bit 3** | **Bit 2** | **Bit 1** | **Bit 0** | |
| - | UNIT | AUTO | INS | 1: Constant speed control |
| CMD | | OVLP | INS | 2: Point-to-point command |
| | | | | 3: Point-to-point command (Proceed to the next command when completed) |
| - | - | - | INS | 7: Jump to the specified PR command |
| - | ROM | AUTO | INS | 8: Write to parameter or Data Array |
| DIR | | OVLP | INS | A: Index position control |
| - | - | - | - | B: Statement / arithmetic operation |

  - DIR sets the rotation direction (Bit3, Bit2).

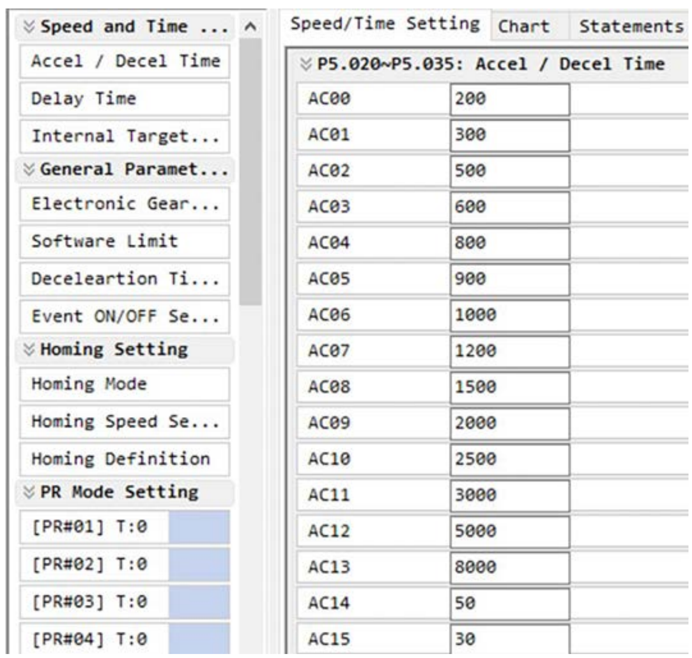
    00: Forward
    01: Backward
    10: Shortest distance
    11: Reserved
  - ROM lets the drive write parameters to both RAM and EEPROM at the same time. This function can only write parameters.
  - INS: executing this PR command interrupts the previous PR command.
  - OVLP: allow overlapping of the next PR command. Overlapping is not allowed in Speed mode. When overlapping Position mode, DLY has no function.
  - AUTO: once current PR command is finished, automatically load the next command.
  - CMD is the position command selection (Bit3, Bit2).

    00: ABS, Absolute Position, CMD = DATA
    01: REL, Relative Position, CMD = Current Position + DATA
    10: INC, Incremental Position, CMD = Previous CMD + DATA
    11: CAP, High Speed Position Capturing, CMD = Captured Position + DATA
  - UNIT is the speed unit selection: 0 signifies 0.1 rpm and 1 signifies pulse per second (PPS).

- UZ: DEC, deceleration time; ACC, acceleration time

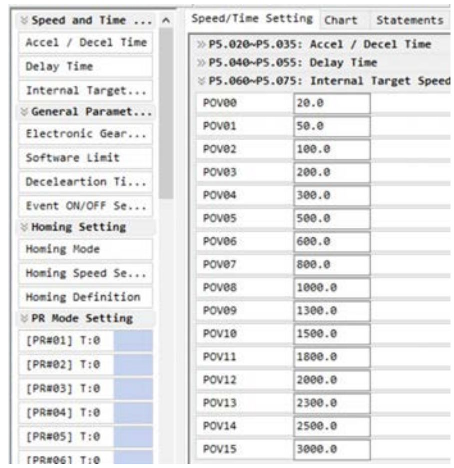
| U: DEC, Deceleration Time | Z: ACC, Acceleration Time | Corresponding Parameter | Default Value (ms) |
|---|---|---|---|
| 0 | 0 | ID312 (P5.020) | 200 |
| 1 | 1 | ID313 (P5.021) | 300 |
| 2 | 2 | ID314 (P5.022) | 500 |
| 3 | 3 | ID315 (P5.023) | 600 |
| 4 | 4 | ID316 (P5.024) | 800 |
| 5 | 5 | ID317 (P5.025) | 900 |
| 6 | 6 | ID318 (P5.026) | 1000 |
| 7 | 7 | ID319 (P5.027) | 1200 |
| 8 | 8 | ID320 (P5.028) | 1500 |
| 9 | 9 | ID321 (P5.029) | 2000 |
| 10 | 10 | ID322 (P5.030) | 2500 |
| 11 | 11 | ID323 (P5.031) | 3000 |
| 12 | 12 | ID324 (P5.032) | 5000 |
| 13 | 13 | ID325 (P5.033) | 8000 |
| 14 | 14 | ID326 (P5.034) | 50 |
| 15 | 15 | ID327 (P5.035) | 30 |

Accel/Decel are used from the same pull-down menu as follows:



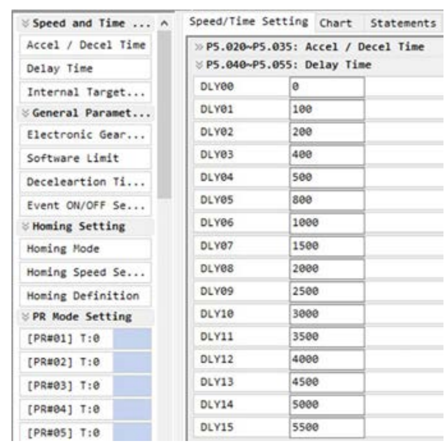
- A: SPD, target speed index

| A | Corresponding parameter | Default value (ms) |
|---|---|---|
| 0 | ID352 (P5.060) | 20 |
| 1 | ID353 (P5.061) | 50 |
| 2 | ID354 (P5.062) | 100 |
| 3 | ID355 (P5.063) | 200 |
| 4 | ID356 (P5.064) | 300 |
| 5 | ID357 (P5.065) | 500 |
| 6 | ID358 (P5.066) | 600 |
| 7 | ID359 (P5.067) | 800 |
| 8 | ID360 (P5.068) | 1000 |
| 9 | ID361 (P5.069) | 1300 |
| 10 | ID362 (P5.070) | 1500 |
| 11 | ID363 (P5.071) | 1800 |
| 12 | ID364 (P5.072) | 2000 |
| 13 | ID365 (P5.073) | 2300 |
| 14 | ID366 (P5.074) | 2500 |
| 15 | ID367 (P5.075) | 3000 |




- B: DLY, delay time index

| B | Corresponding parameter | Default value (ms) |
|---|---|---|
| 0 | ID332 (P5.040) | 0 |
| 1 | ID333 (P5.041) | 100 |
| 2 | ID334 (P5.042) | 200 |
| 3 | ID335 (P5.043) | 400 |
| 4 | ID336 (P5.044) | 500 |
| 5 | ID337 (P5.045) | 800 |
| 6 | ID338 (P5.046) | 1000 |
| 7 | ID339 (P5.047) | 1500 |
| 8 | ID340 (P5.048) | 2000 |
| 9 | ID341 (P5.049) | 2500 |
| 10 | ID342 (P5.050) | 3000 |
| 11 | ID343 (P5.051) | 3500 |
| 12 | ID344 (P5.052) | 4000 |
| 13 | ID345 (P5.053) | 4500 |
| 14 | ID346 (P5.054) | 5000 |
| 15 | ID347 (P5.055) | 5500 |




- C: AUTO: once current PR command is finished, automatically load the next command. This function is only enabled when X = A indexing position control.

  Description of each bit:

| | | |
|---|---|---|
| **Bit 2** | AUTO | 0: disable auto function<br>1: once current PR command is finished, automatically load the next command |
| **Bit 0, Bit 1** | Reserved | - |

If we chose our values from Figure 101 on page 283:

**Table 111 - High/Low Word Values**

| High Word | Value |
|---|---|
| A | 8 (1000 RPM) |
| B | 4 (500 ms delay) |
| C | 0 (Do not load next command) |
| D | 0 |
| HEX | 0 0 4 8 |

| Low Word | Value |
|---|---|
| X | 3 (Point to Point Command-Proceed to next PR) |
| Y | 0 1 0 0 (REL, OVLP, INS) – this is 4 in decimal |
| Z | E (Accel of 50) – this is 14 in decimal |
| U | E (Decel of 50) – this is 14 in decimal |
| HEX | E E 4 3 |

This becomes: 0 0 4 8 E E 4 3 which is 4,779,587 Decimal, this value is what we write to ID399 (P6.002). This value is the PRCmdxSetting.

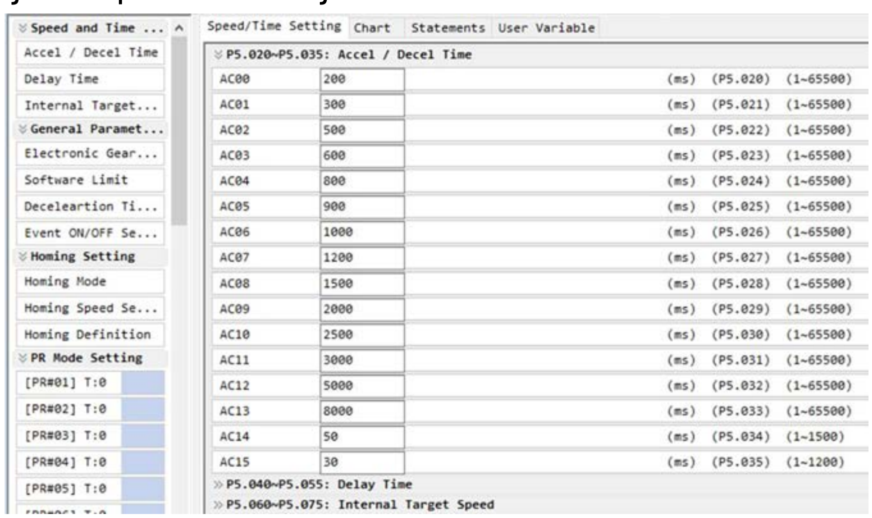
*PR Command Data Setting*

The PRCmdXData parameters define either the target position of the related PR command or the target PR command for the jump command.

## Shared PR Parameters

The drive dynamics and delays are shared by PR programs. The Speed, Acceleration, Deceleration, and Delays that are chosen by pull-down menus use a common value that is made in the PR Mode Editor>Speed and Time Setting menu.

**Figure 102 - Speed and Time Setting**




**ATTENTION:** Damage to machine can occur. Changing a setting that is used by multiple PR commands will affect all PR commands using that setting.

For example, if multiple PR commands apply the target speed setting of PresetVelocity0 ID352 (P5.060), and that preset rpm value is changed, that PR command target speed is also changed. The Accel/Decel times that are used for a Position Command are calculated based on reaching 3000 rpm. So, changing this preset velocity also affects the Accel and Decel times for any profile that uses the same Preset Velocity.

**EXAMPLE** If acceleration time is set to 50 ms, this means when the target speed of motion command is 3000 rpm, then the required duration is 50 ms.
If the target speed of the motion command is 1500 rpm, then the acceleration time is 25 ms.

**Figure 103 - Shared Parameter Data of PR Commands**

PR Command Setting: ACC:1 | DEC:4 | DLY:2 | SPD:5

Acceleration / Deceleration Time (ACC/DEC)

| | | |
|---|---|---|
| 0 | ID312 (P5.020) | 200 |
| 1 | ID313 (P5.021) | 300 |
| 2 | ID314 (P5.022) | 500 |
| 3 | ID315 (P5.023) | 600 |
| 4 | ID316 (P5.024) | 800 |
| 5 | ID317 (P5.025) | 900 |
| 6 | ID318 (P5.026) | 1000 |
| … | … | |
| 14 | ID326 (P5.034) | 50 |
| 15 | ID327(P5.035) | 30 |

Delay Time (DLY)

| | | |
|---|---|---|
| 0 | ID332 (P5.040) | 0 |
| 1 | ID333 (P5.041) | 100 |
| 2 | ID334 (P5.042) | 200 |
| 3 | ID335 (P5.043) | 400 |
| 4 | ID336 (P5.044) | 500 |
| 5 | ID337 (P5.045) | 800 |
| 6 | ID338 (P5.046) | 1000 |
| … | … | |
| 14 | ID346 (P5.054) | 5000 |
| 15 | ID347(P5.055) | 5500 |

Target Speed (SPD)

| | | |
|---|---|---|
| 0 | ID352 (P5.060) | 20.0 |
| 1 | ID353 (P5.061) | 50.0 |
| 2 | ID354 (P5.062) | 100.0 |
| 3 | ID355 (P5.063) | 200.0 |
| 4 | ID356 (P5.064) | 300.0 |
| 5 | ID357 (P5.065) | 500.0 |
| 6 | ID358 (P5.066) | 600.0 |
| … | … | |
| 14 | ID366 (P5.074) | 2500.0 |
| 15 | ID367(P5.075) | 3000.0 |

See Speed and Time Settings on page 336 for information about configuring the speed and time settings for these shared parameters.

## Monitoring Variables in PR Mode

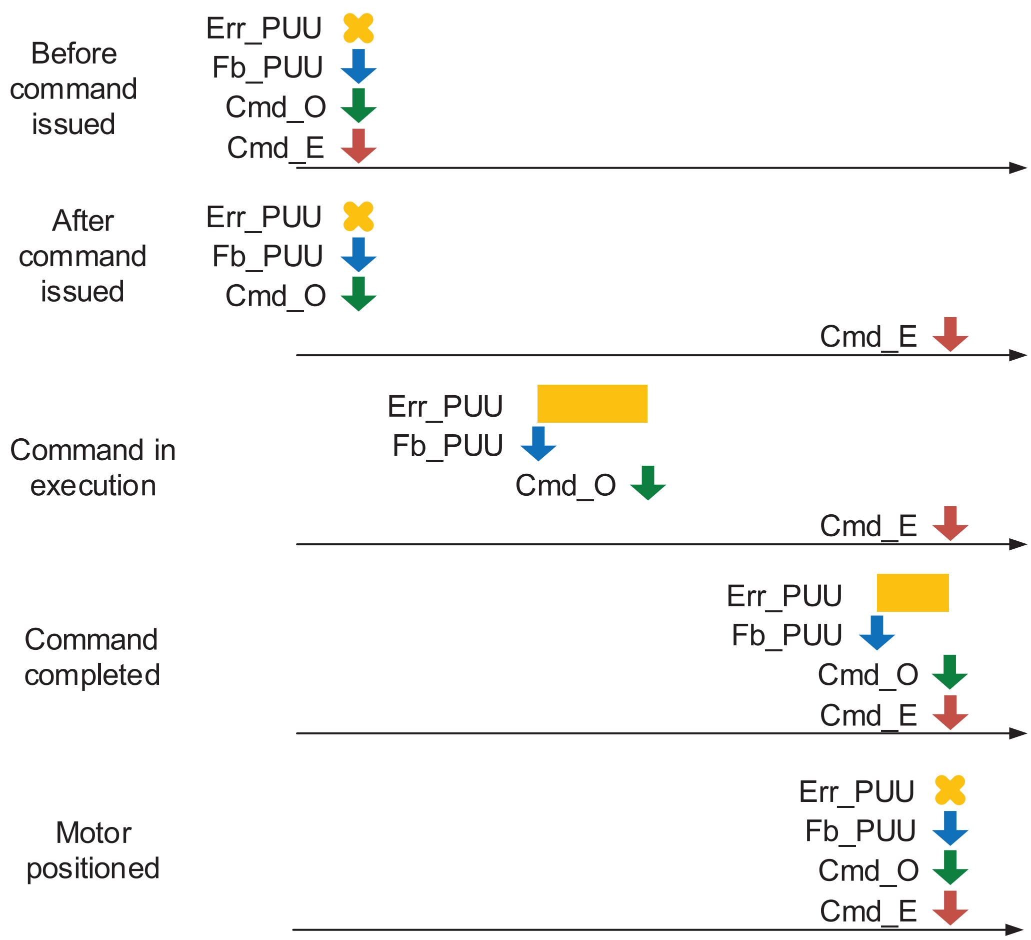
The Kinetix 5100 drive provides different options to monitor the drive indexing operation in PR Mode. The Monitoring Status, Scope function, or most accurate is the Digital Inputs/Outputs. You can use these options to create timing information that can help understand how the drive indexing is operating.

PR Mode provides the following four monitoring variables for servo command and feedback.

- Command position (PUU): The target position of the motion command generated per scan cycle during servo operation (updated every 1 ms), simplified as Cmd_O (Command Operation).
- PR command end register: The target position of the PR command, simplified as Cmd_E (Command End). When a command is triggered, the servo drive calculates the target position and then updates the PR command end register.
- Feedback position (PUU): The feedback position (coordinates) for the motor, simplified as Fb_PUU (Feedback PUU).
- Position error (PUU): The deviation between the command position (PUU) and the feedback position (PUU), simplified as Err_PUU (Error PUU).

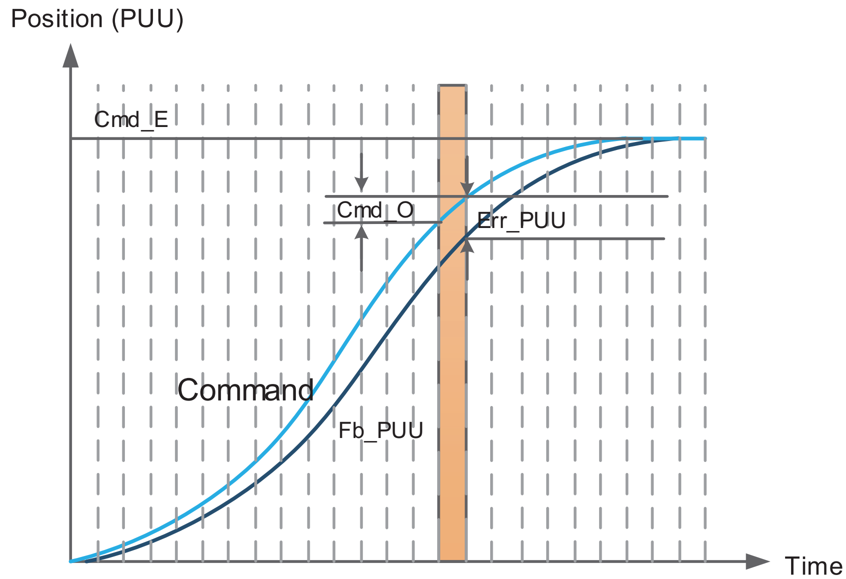
How these four monitoring variables work is shown in Figure 104. After the drive sets a Position command, the drive sets the position of Cmd_E once the target position data is acquired. The motor moves to the target position based on the PR command setting. Cmd_O calculates the command position data in each fixed cycle (1 ms) and sends it to the servo drive, where it is treated as a dynamic command. Fb_PUU is the motor feedback position and Err_PUU is the deviation of Cmd_O minus Fb_PUU.

**Figure 104 - Timing Diagram of PR Mode Monitoring Variables**




The detailed command behavior of each stage is illustrated in Figure 105. Cmd_E is the endpoint specified by the command; this value is determined once the PR command is triggered. Fb_PUU is the feedback position, which is the motor actual position. For example, Cmd_O is the target of this command section and Err_PUU is the deviation between target position and feedback position.

Figure 105 - Monitoring Variables' Status When Executing a Command IN PR Mode




Use digital input (DI) and digital output (DO) signals to monitor PR commands as shown in Figure 106. When the motion command is triggered by DI.CTRG [0x08], the servo drive operates based on the command from the internal register. Once the execution is completed, DO.Cmd_OK [0x15] turns on. And when the motor is within its target position window, which is set by ID159 (P1.054) InPositionWindow, the DO.TPOS [0x05] is on. Once the PR position command completes and the motor reaches the target position, both DO signals are on and the servo drives outputs the MC_OK [0x17] signal to signify that this PR command is completed.

Figure 106 - Operation of DI and DO Signals in PR Mode

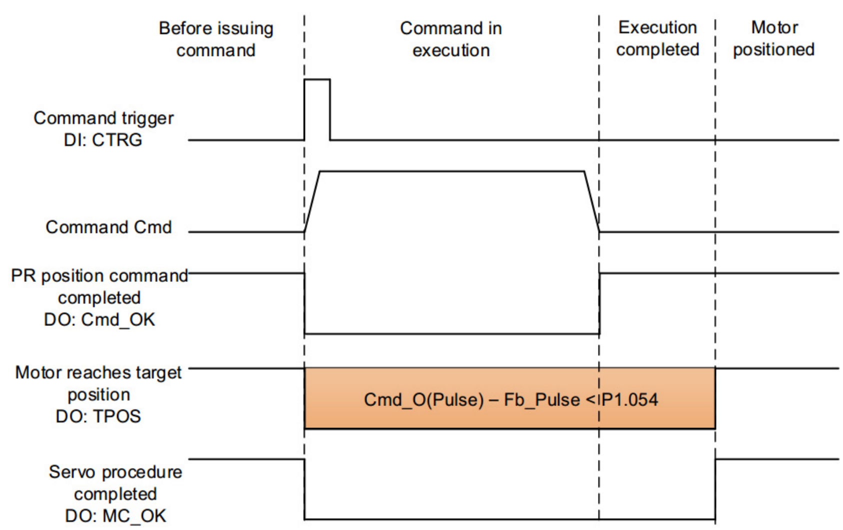
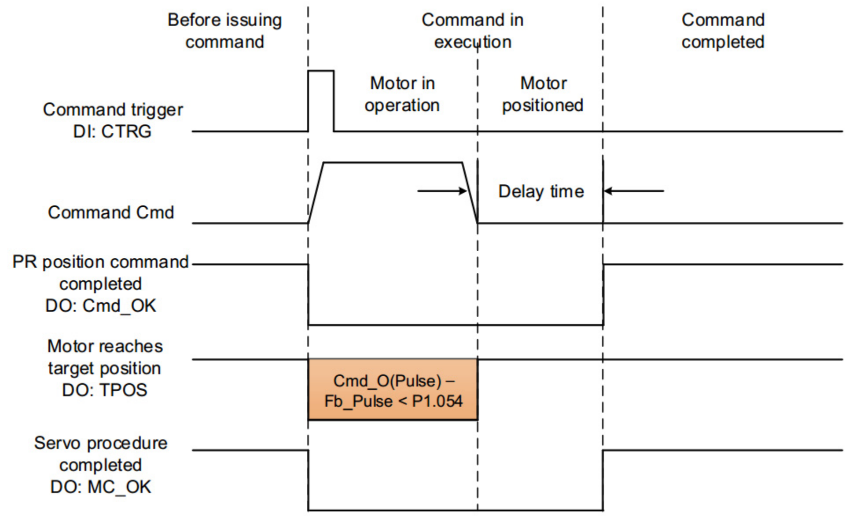


**Figure 107 - Operation of DI and DO Signals in PR Mode(including delay time)**




See Description of System Variable Monitoring on page 432 for more information.

## Homing

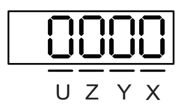
The Kinetix 5100 drive provides flexible homing sequences. The drive provides 11 homing methods in PR Mode. These methods include the use of a home sensor, travel limit switch, motor marker pulse, or collision point (torque limit) and come with sub-selections such as whether to refer to marker pulse and travel limit signal as the trigger. Homing method is specified by HomingMode ID297 (P5.004) and the homing definition is determined by HomingSetting ID397 (P6.000). Simple homing configuration is done by using KNX5100C software. The Homing Settings are accessed using the PR Mode Editor.

In addition to the physical items used with a homing method, an assigned Digital Input (DI.Enable Homing) is used to perform homing. An alternative to assigning this Digital input is to execute PR00. This PR is dedicated to performing the homing operation.

### Setting Homing Mode ID297 (P5.004) - PR Mode

This setting is used with PR mode or by monitoring the Parameter Editor.

Settings:




Definition of each setting value:

<table>
<tr><th>X: Homing Method</th><th>Y: Z Pulse Setting</th><th>Z: Limit setting</th><th>U: Reserved</th></tr>
<tr><td>0: homing in forward direction and define PL as homing origin</td><td rowspan="4">0: return to Z pulse<br>1: go forward to Z pulse<br>2: do not look for Z pulse</td><td rowspan="2">–</td><td rowspan="11">–</td></tr>
<tr><td>1: homing in reverse direction and define NL as homing origin</td></tr>
<tr><td>2: homing in forward direction, ORG: OFF→ON as homing origin</td><td rowspan="6">When encounter limit:<br>0: show error<br>1: reverse direction</td></tr>
<tr><td>3: homing in reverse direction, ORG: OFF→ON as homing origin</td></tr>
<tr><td>4: look for Z pulse in forward direction and define it as homing origin</td><td rowspan="2">–</td></tr>
<tr><td>5: look for Z pulse in reverse direction and define it as homing origin</td></tr>
<tr><td>6: homing in forward direction, ORG: ON→OFF as homing origin</td><td rowspan="2">0: return to Z pulse<br>1: go forward to Z pulse<br>2: do not look for Z pulse</td></tr>
<tr><td>7: homing in reverse direction, ORG: ON→OFF as homing origin</td></tr>
<tr><td>8: define current position as the origin</td><td>–</td><td rowspan="3">–</td></tr>
<tr><td>9: look for the collision point in forward direction and define it as the origin</td><td rowspan="2">0: return to Z pulse<br>2: do not look for Z pulse</td></tr>
<tr><td>A: look for the collision point in reverse direction and define it as the origin</td></tr>
</table>

**IMPORTANT** The Homing Method values shown are for the PR Operation mode. The homing operations are the same as in IO Mode, however, the Homing Method values are different. See raC_xxx_K5100_MAH on page 509.

## Configuring Homing Setting ID397 (P6.000) - PR Mode

Settings:



| | | | |
|---|---|---|---|
| **A** | DEC2: deceleration time selection of second homing | **YX** | CMD: command type |
| **B** | DLY: select 0…F for delay time | **Z** | ACC: select 0…F for acceleration time |
| **C** | – | **U** | DEC1: deceleration time selection of first homing |
| **D** | BOOT | **-** | - |

- A: DEC2: Choose the deceleration time (0…F) selected from the pull-down menu in KNX5100C software.
  Function List>PR Mode Editor>Speed and Time Setting>Accel/Decel Time.
  This time corresponds to AC00 ID312 (P5.020)…AC15 ID327 (P5.035). This deceleration is the second homing speed that is shared with the Motor Stops Deceleration setting, which is part of Deceleration Time for Auto-Protection ID296 (P5.003).
- B: DLY: Choose the delay time (0…F) selected from the pull-down menu in KNX5100C software.
  Function List>PR Mode Editor>Speed and TIme Setting>Delay Time.
  This time corresponds to DLY00 ID312 (P5.020)…DLY15 ID327 (P5.035). This delay is used to delay the start of the homing sequence.
- D: BOOT: (0=Disable, 1=Enable). When enabled, this setting executes the Homing sequence after the drive is powered on and enabled (BOOT+ ServoON).
- YX: CMD: command type

  0x0: Stop: stops the motion once the Homing is completed.

  0x1…0x63: once the Homing sequence is completed, execute the specified PR command (PR#01…PR#99).
- Z: ACC: Choose the acceleration time (0…F) selected from the pull-down menu in KNX5100C software.
  Function List>PR Mode Editor>Speed and Time Setting>Accel/Decel Time.
  These times correspond to AC00 parameter ID312 (P5.020)…AC15 parameter ID327 (P5.035).
- U: DEC1: Choose the deceleration time (0…F) selected from the pull-down menu in KNX5100C software.
  Function List>PR Mode Editor>Speed and Time Setting>Accel/Decel Time.
  This time corresponds with AC00 ID312 (P5.020)…AC15 ID327 (P5.035). This deceleration is the first deceleration used in the homing sequence.

**IMPORTANT** After the Home position is set the motor has to decelerate to a stop. The motor end position depends on the homing speed and deceleration rate used for homing.

If you require to move back to the Home position, change the CMD to a PR that performs an absolute Point-to-Point Index to move the motor back to the Home Position (Origin Definition).

The Home position does not have to be zero.

Homing speed is limited to 200 rpm in rotary motors. Linear motors do not have this restriction.

## Homing Speed and Position

This section describes how the Homing Positon and Homing Speed are used in the Kinetix 5100 drive.

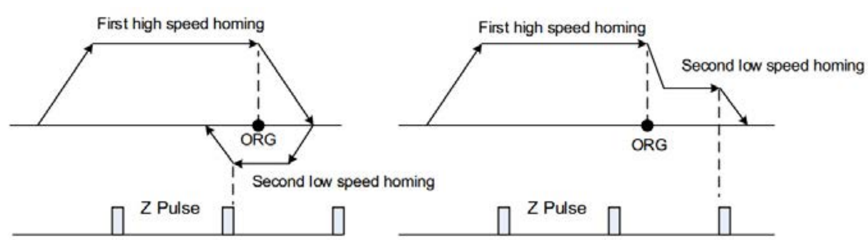
### *Home Position*

Parameter ID398 (P6.001) HomePosition defines the Origin Position (sometimes called the Origin Definition). The range is -2147483648…2147483647.

### *Home Speed*

The homing sequence is shown in Figure 108. The homing procedure uses two speeds, a high speed and a low speed. Homing starts with Acceleration to High Speed Homing (1st speed). Once the ORG switch is detected, the motor is decelerated (using the 1st Deceleration Time). It will use the Low Speed Homing (2nd speed) to complete the homing sequence by moving to a marker pulse. Then uses the second Deceleration time to stop the motor.

**Figure 108 - Speed Settings for Homing**




## Operation of Homing Types

This section describes the homing methods supported by the drive. They can be categorized into six types.

- Homing to Positive Limit (PL)
- Homing to Negative Limit (NL)
- Homing to Forward ORG OFF to ON (Rising Edge condition)
- Homing to Reverse ORG OFF to ON (Rising Edge condition)
- Homing to Forward ORG ON to OFF (Falling Edge condition)
- Homing to Reverse ORG ON to OFF (Falling Edge condition)

These Homing sequences are used in PR and IO modes, although the method for executing the homing is different (KNX5100C software/Logix Designer application), their behavior is the same. When the marker pulse is used, the Home Position physical location is more accurate than using an input signal only (Home Switch/ORG for example).

The homing method value is used when you want to change the homing type with IO mode (Class 1 Ethernet/IP); the raC_*xxx*_K5100_MAH Add-On Instruction uses these methods with Set_HomingMethod value.

Within the Homing section, we reference these acronyms:

- PL - Positive Limit
- NL - Negative Limit
- ORG - Home Switch

**Table 112 - Homing Method Values - IO Mode**

| Value | Description |
|---|---|
| 0 | Homing in forward direction and regard PL as homing origin. Return to Z pulse. |
| 1 | Homing in forward direction and regard PL as homing origin. Go forward to Z pulse. |
| 2 | Homing in forward direction and regard PL as homing origin. Do not look for Z pulse. |
| 3 | Homing in reverse direction and regard NL as homing origin. Return to Z pulse. |
| 4 | Homing in reverse direction and regard NL as homing origin. Go forward to Z pulse. |
| 5 | Homing in reverse direction and regard NL as homing origin. Do not look for Z pulse. |
| 6 | Homing in forward direction, ORG: OFF→ON as homing origin. Return to Z pulse. Shows error when encounter limit. |
| 7 | Homing in forward direction, ORG: OFF→ON as homing origin. Return to Z pulse. Reverse direction when encounter limit. |
| 8 | Homing in forward direction, ORG: OFF→ON as homing origin. Go forward to Z pulse. Shows error when encounter limit. |
| 9 | Homing in forward direction, ORG: OFF→ON as homing origin. Go forward to Z pulse. Reverse direction when encounter limit. |
| 10 | Homing in forward direction, ORG: OFF→ON as homing origin. Do not look for Z pulse. Shows error when encounter limit. |
| 11 | Homing in forward direction, ORG: OFF→ON as homing origin. Do not look for Z pulse. Reverse direction when encounter limit. |
| 12 | Homing in reverse direction, ORG: OFF→ON as homing origin. Return to Z pulse. Shows error when encounter limit. |
| 13 | Homing in reverse direction, ORG: OFF→ON as homing origin. Return to Z pulse. Reverse direction when encounter limit. |
| 14 | Homing in reverse direction, ORG: OFF→ON as homing origin. Go forward to Z pulse. Shows error when encounter limit. |
| 15 | Homing in reverse direction, ORG: OFF→ON as homing origin. Go forward to Z pulse. Reverse direction when encounter limit. |
| 16 | Homing in reverse direction, ORG: OFF→ON as homing origin. Do not look for Z pulse. Shows error when encounter limit. |
| 17 | Homing in reverse direction, ORG: OFF→ON as homing origin. Do not look for Z pulse. Reverse direction when encounter limit. |
| 18 | Look for Z pulse in forward direction and regard it as homing origin. Shows error when encounter limit. |
| 19 | Look for Z pulse in forward direction and regard it as homing origin. Reverse direction when encounter limit. |
| 20 | Look for Z pulse in reverse direction and regard it as homing origin. Shows error when encounter limit. |
| 21 | Look for Z pulse in reverse direction and regard it as homing origin. Reverse direction when encounter limit. |

**Table 112 - Homing Method Values - IO Mode (Continued)**

| Value | Description |
|---|---|
| 22 | Homing in forward direction, ORG: ON→OFF as homing origin. Return to Z pulse. Shows error when encounter limit. |
| 23 | Homing in forward direction, ORG: ON→OFF as homing origin. Return to Z pulse. Reverse direction when encounter limit. |
| 24 | Homing in forward direction, ORG: ON→OFF as homing origin. Go forward to Z pulse. Shows error when encounter limit. |
| 25 | Homing in forward direction, ORG: ON→OFF as homing origin. Go forward to Z pulse. Reverse direction when encounter limit. |
| 26 | Homing in forward direction, ORG: ON→OFF as homing origin. Do not look for Z pulse. Shows error when encounter limit. |
| 27 | Homing in forward direction, ORG: ON→OFF as homing origin. Do not look for Z pulse. Reverse direction when encounter limit. |
| 28 | Homing in reverse direction, ORG: ON→OFF as homing origin. Return to Z pulse. Shows error when encounter limit. |
| 29 | Homing in reverse direction, ORG: ON→OFF as homing origin. Return to Z pulse. Reverse direction when encounter limit. |
| 30 | Homing in reverse direction, ORG: ON→OFF as homing origin. Go forward to Z pulse. Shows error when encounter limit. |
| 31 | Homing in reverse direction, ORG: ON→OFF as homing origin. Go forward to Z pulse. Reverse direction when encounter limit. |
| 32 | Homing in reverse direction, ORG: ON→OFF as homing origin. Do not look for Z pulse. Shows error when encounter limit. |
| 33 | Homing in reverse direction, ORG: ON→OFF as homing origin. Do not look for Z pulse. Reverse direction when encounter limit. |
| 34 | Define current position as the origin. |
| 35 | Look for the collision point in forward direction and regard it as the origin. Return to Z pulse. Shows error when encounter negative limit. |
| 36 | Look for the collision point in forward direction and regard it as the origin. Do not look for Z pulse. |
| 37 | Look for the collision point in reverse direction and regard it as the origin. Return to Z pulse. Shows error when encounter positive limit. |
| 38 | Look for the collision point in reverse direction and regard it as the origin. Do not look for Z pulse. |

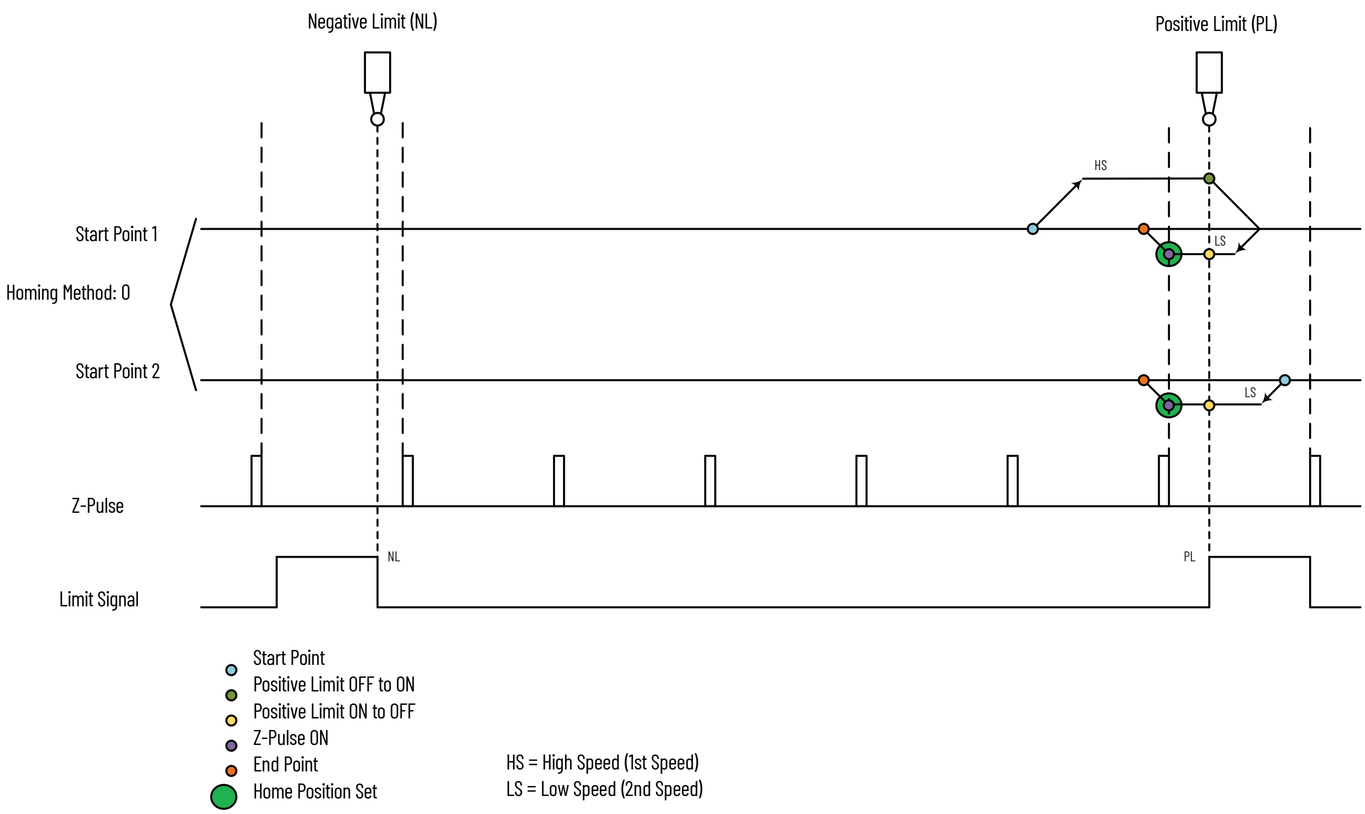
**IMPORTANT** The Homing Method values shown are for the IO Operation mode. The homing operations are the same as in PR Mode, however, the Homing Method values are different.

### *Homing to Positive Limit*

This homing method uses the positive or negative limit (the limit is also called a travel or overtravel), see Figure 109 through Figure 111 for examples. When the limit is detected, you can choose to look for the marker pulse (Z) and set the Home Position when the marker pulse is detected. If no marker pulse is used, the Home Position is set when the limit is detected. Changing the starting position does not change the homing operation.

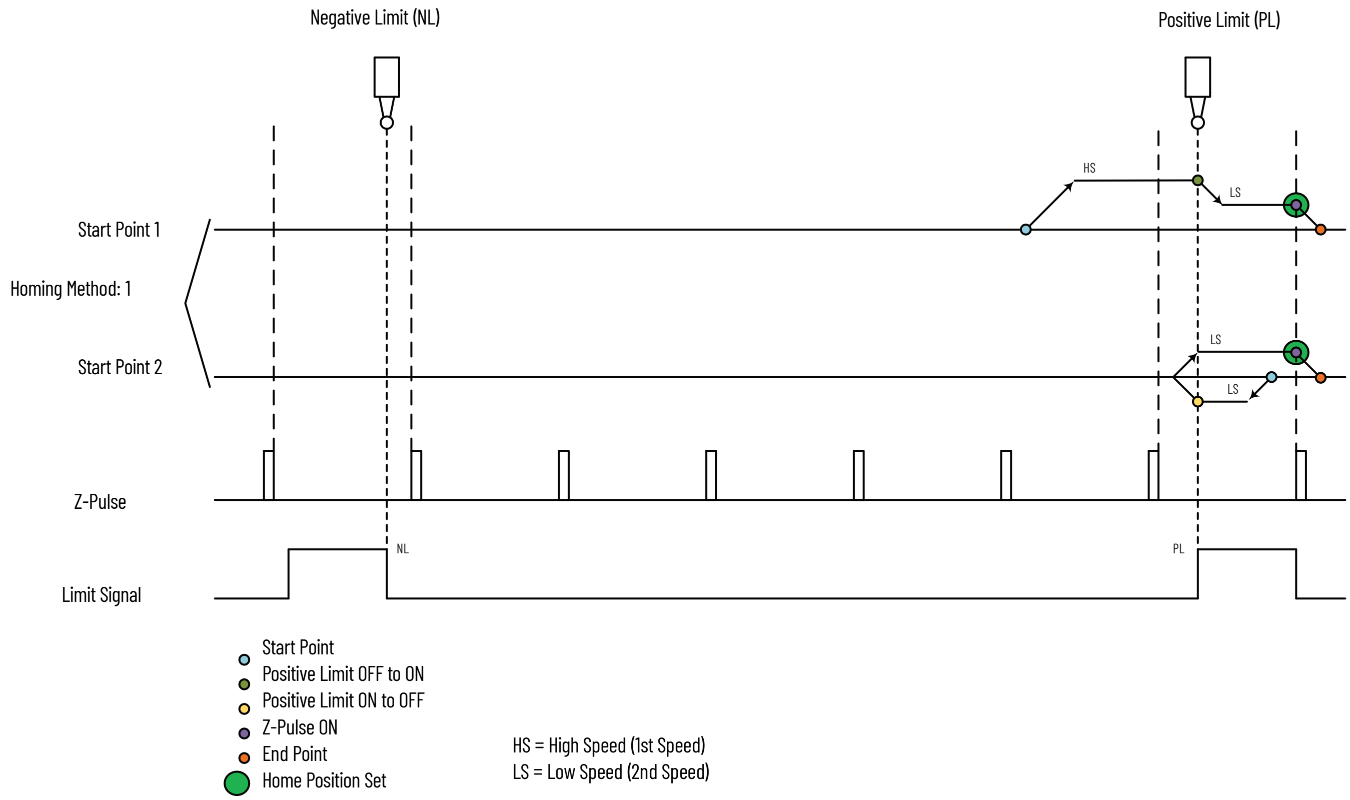
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 0 | Homing in forward direction and regard PL as homing origin, Return to Z pulse.<br>• Return is called 'Move backward' in KNX5100C software<br>• High Speed Homing (HS) (1st speed setting) is /10 - so 1000 = 100 rpm<br>• Low Speed (LS) Homing (2nd speed setting) is /10 - so 200 = 20 rpm<br>• Home Position is set at Green dot |

**Figure 109 - Homing to Positive Limit - Homing Method 0**



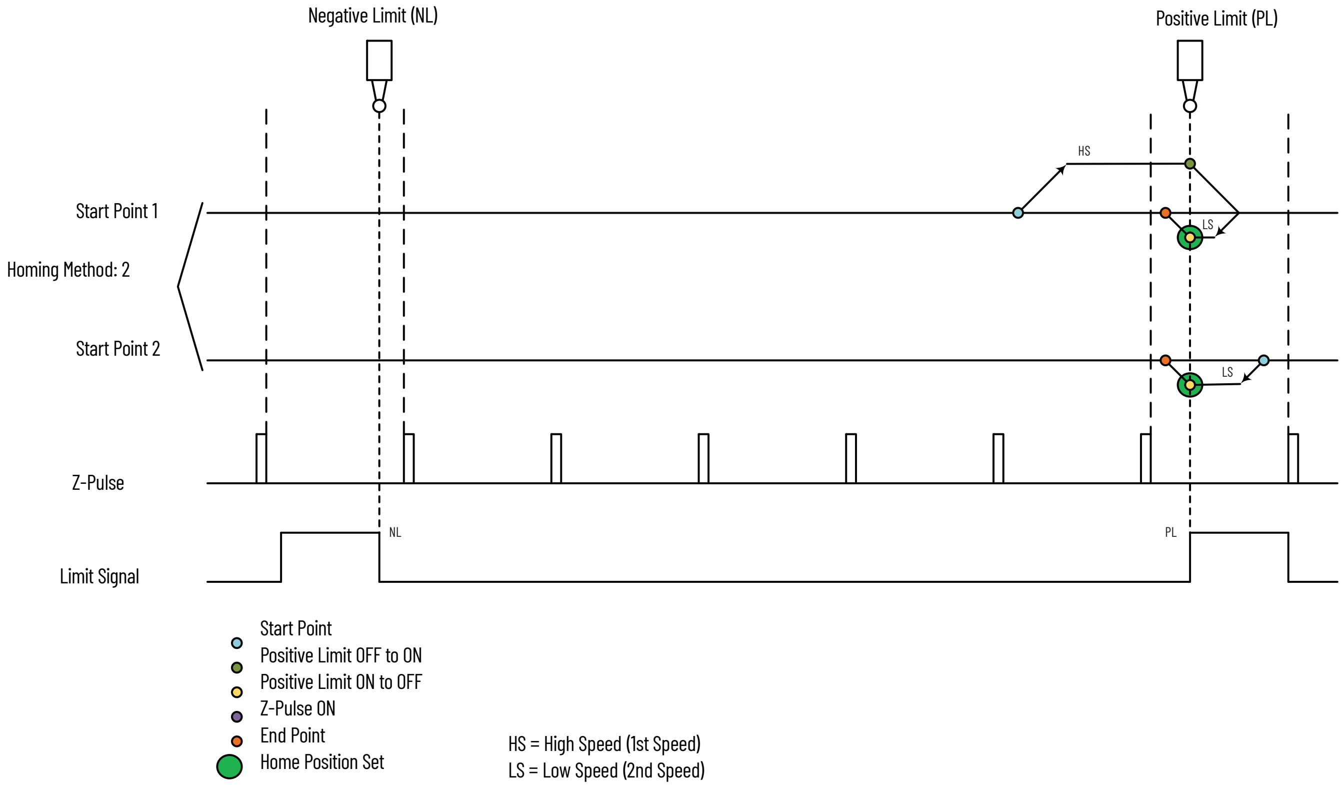
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 1 | Homing in forward direction and regard PL as homing origin, Go forward to Z pulse.<br>• High Speed Homing (1st speed setting) is /10 - so 1000 = 100 rpm<br>• Low Speed Homing (2nd speed setting) is /10 - so 200 = 20 rpm<br>• Home Position is set at Green dot |

**Figure 110 - Homing to Positive Limit - Homing Method 1**



| Homing Method - IO Mode | Homing Method - Description |
| --- | --- |
| 2 | Homing in forward direction and regard PL as homing origin, Do not look for Z pulse.<br>• High Speed Homing (1st speed setting) is /10 - so 1000 = 100 rpm<br>• Low Speed Homing (2nd speed setting) is /10 - so 200 = 20 rpm<br>• Home Position is set at Green dot |

**Figure 111 - Homing to Positive Limit - Homing Method 2**

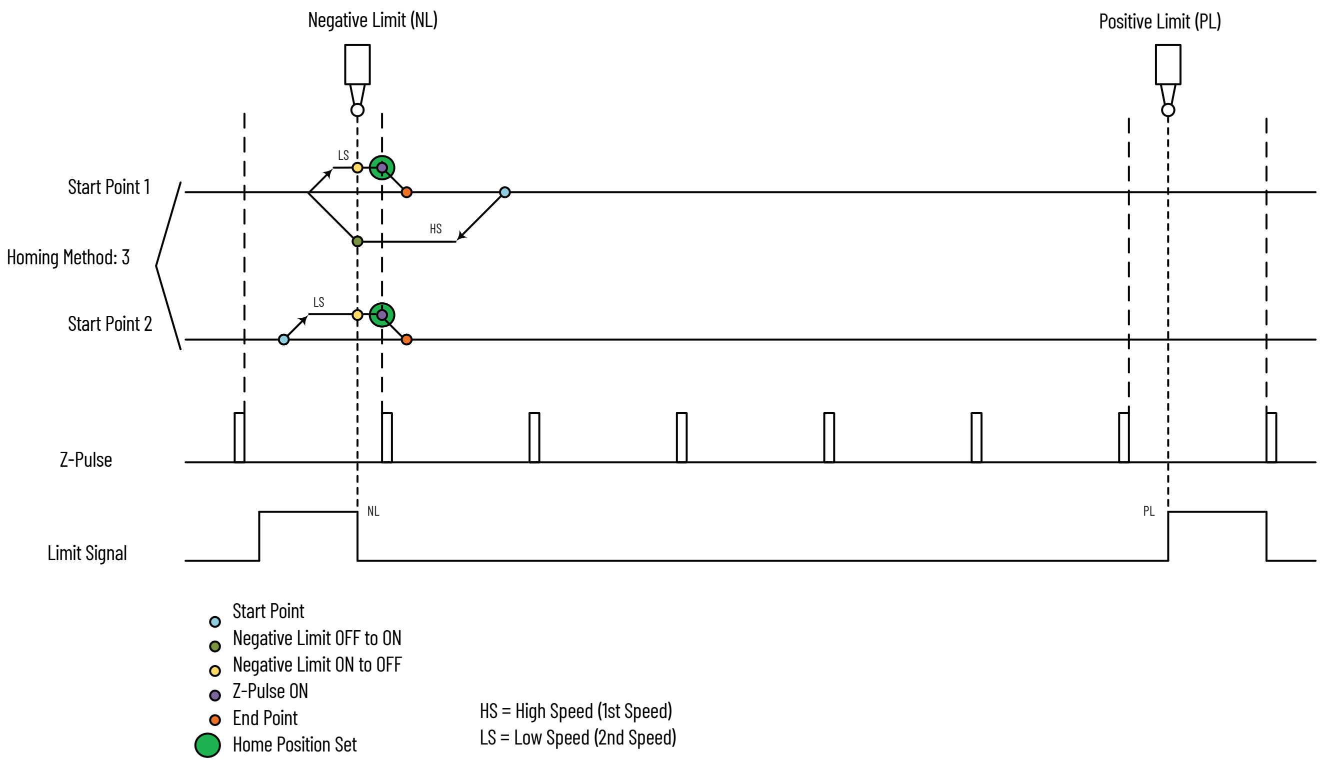


### *Homing to Negative Limit*

This homing method uses the negative limit (the limit is also called a travel or overtravel), see Figure 112 through Figure 114 for examples. When the limit is detected, you can choose to look for the marker pulse (Z) and set the Home Position when the marker pulse is detected. If no marker pulse is used, the Home Position is set when the limit is detected. Changing the starting position does not change the homing operation.

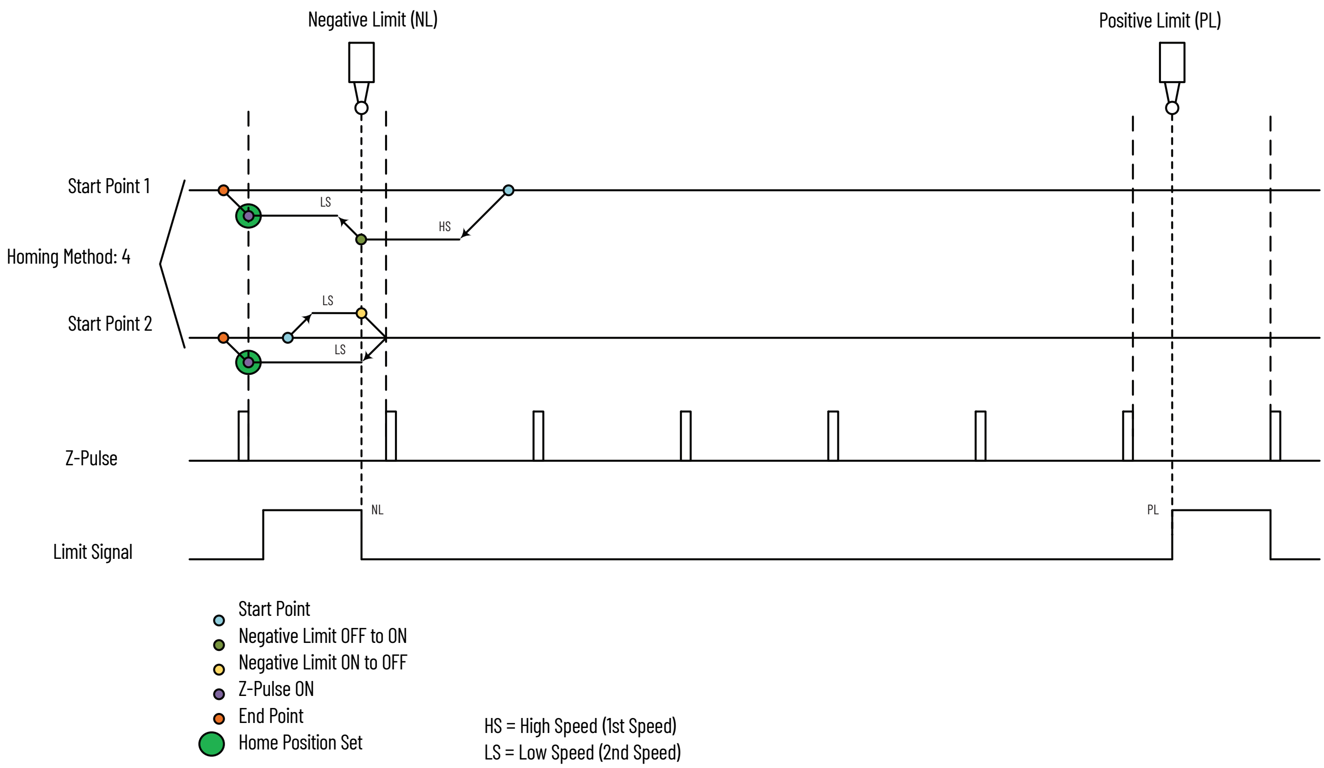
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 3 | Homing in reverse direction and regard NL as homing origin, Return to Z pulse. Home Position is set at Green dot. |

**Figure 112 - Homing to Negative Limit - Homing Method 3**



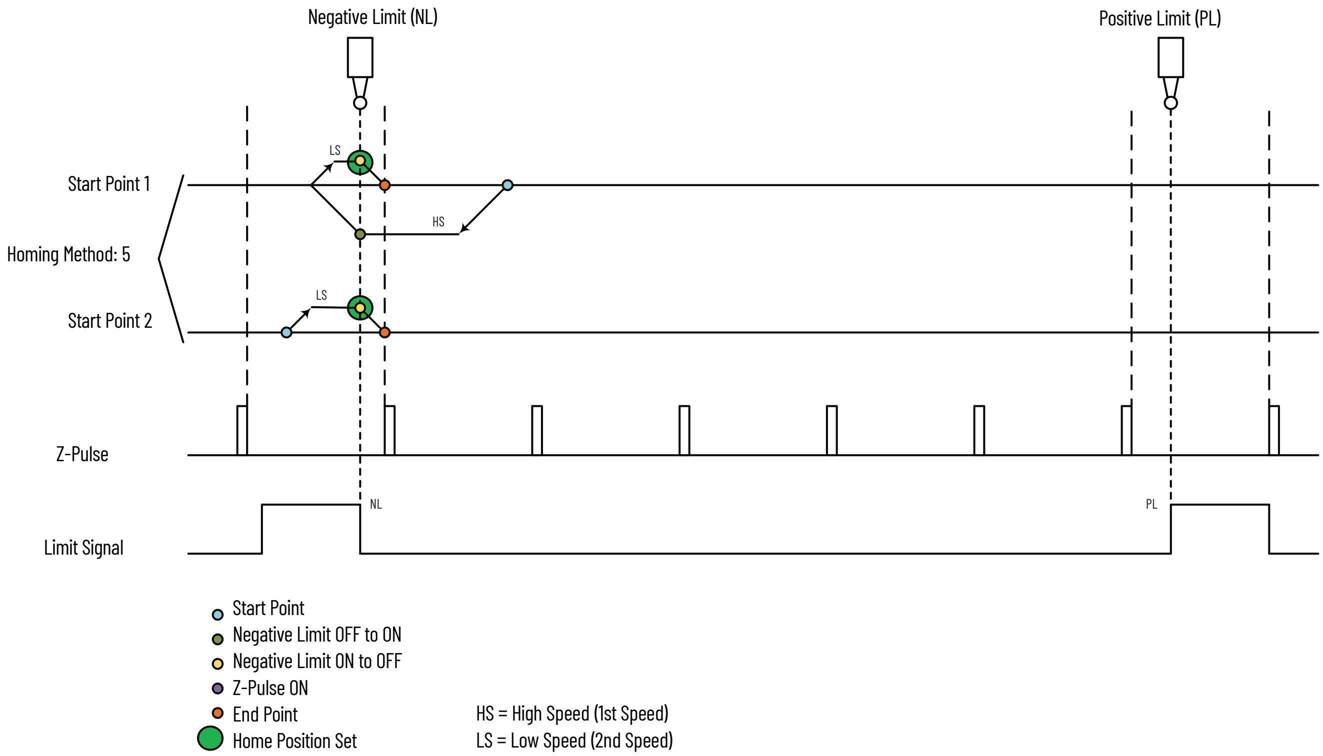
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 4 | Homing in reverse direction and regard NL as homing origin, Go forward to Z pulse. Home Position is set at Green dot. |

Figure 113 - Homing to Negative Limit - Homing Method 4



| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 3 | Homing in reverse direction and regard NL as homing origin, Return to Z pulse. Home Position is set at Green dot. |
| 4 | Homing in reverse direction and regard NL as homing origin, Go forward to Z pulse. Home Position is set at Green dot. |
| 5 | Homing in reverse direction and regard NL as homing origin, Do not look for Z pulse. Home Position is set at Green dot. |

**Figure 114 - Homing to Negative Limit - Homing Method 5**



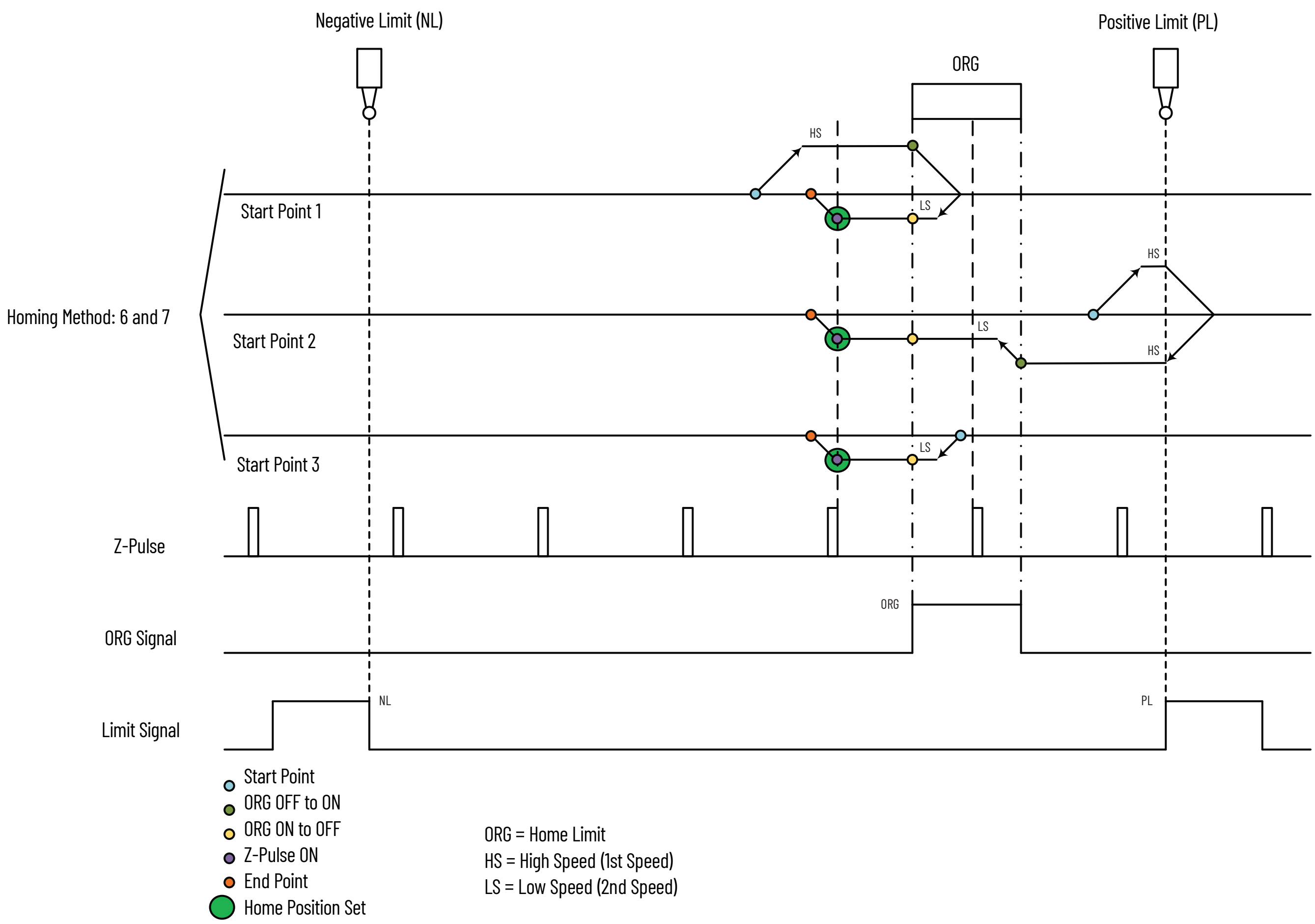
### *Homing to Forward ORG OFF to ON (Rising Edge condition)*

You can use the home sensor (ORG) to set the Home Position. You can use the ORG with (or without) the marker (Z) pulse to set the Home Position.

See Figure 115…Figure 117 for description.

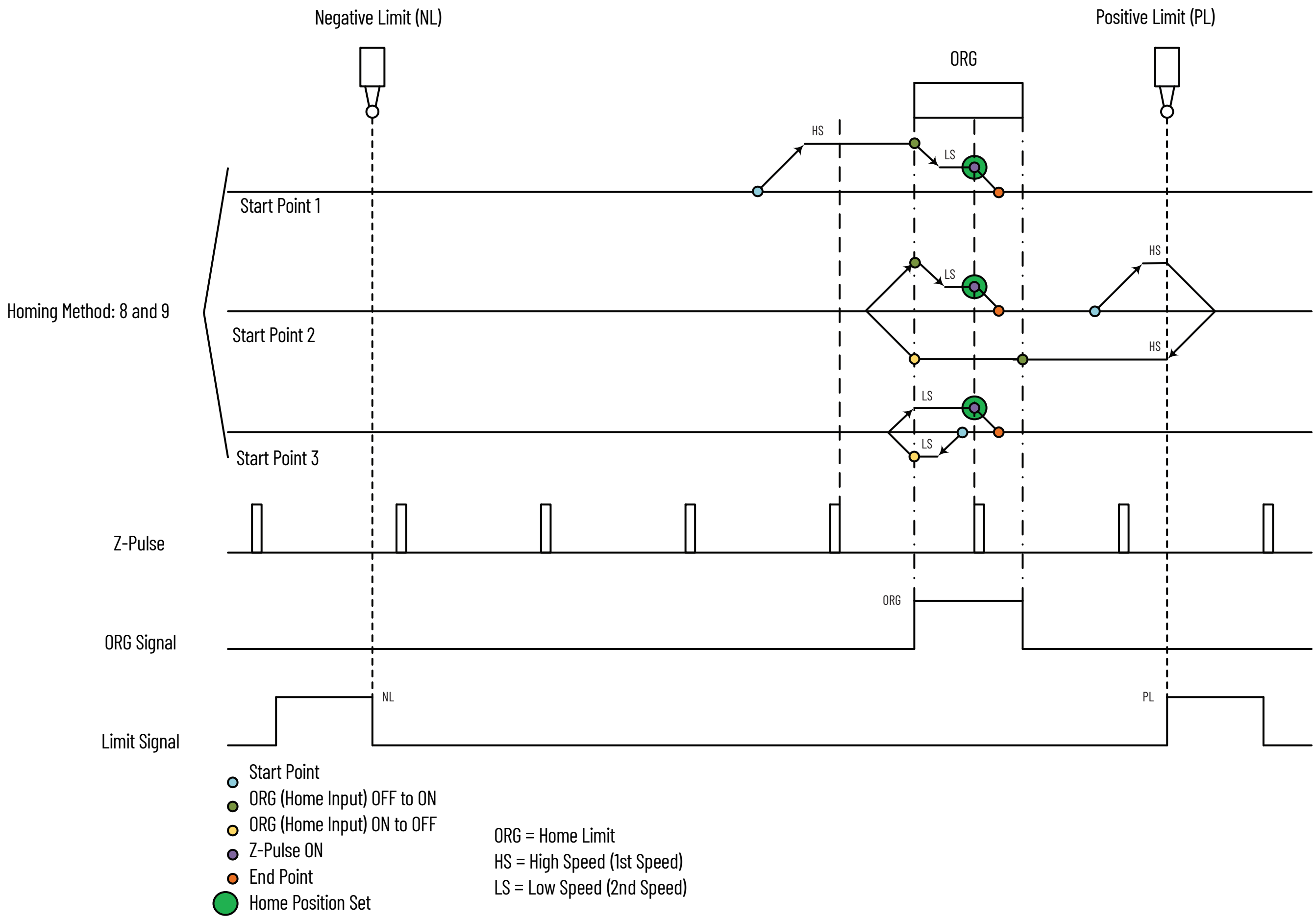
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 6 | Homing in forward direction, ORG: OFF to ON as homing origin, Return to Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 7 | Homing in forward direction, ORG: OFF to ON as homing origin, Return to Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 115 - Homing to Forward ORG OFF to ON (Rising Edge condition) - Homing Method 6 and 7**



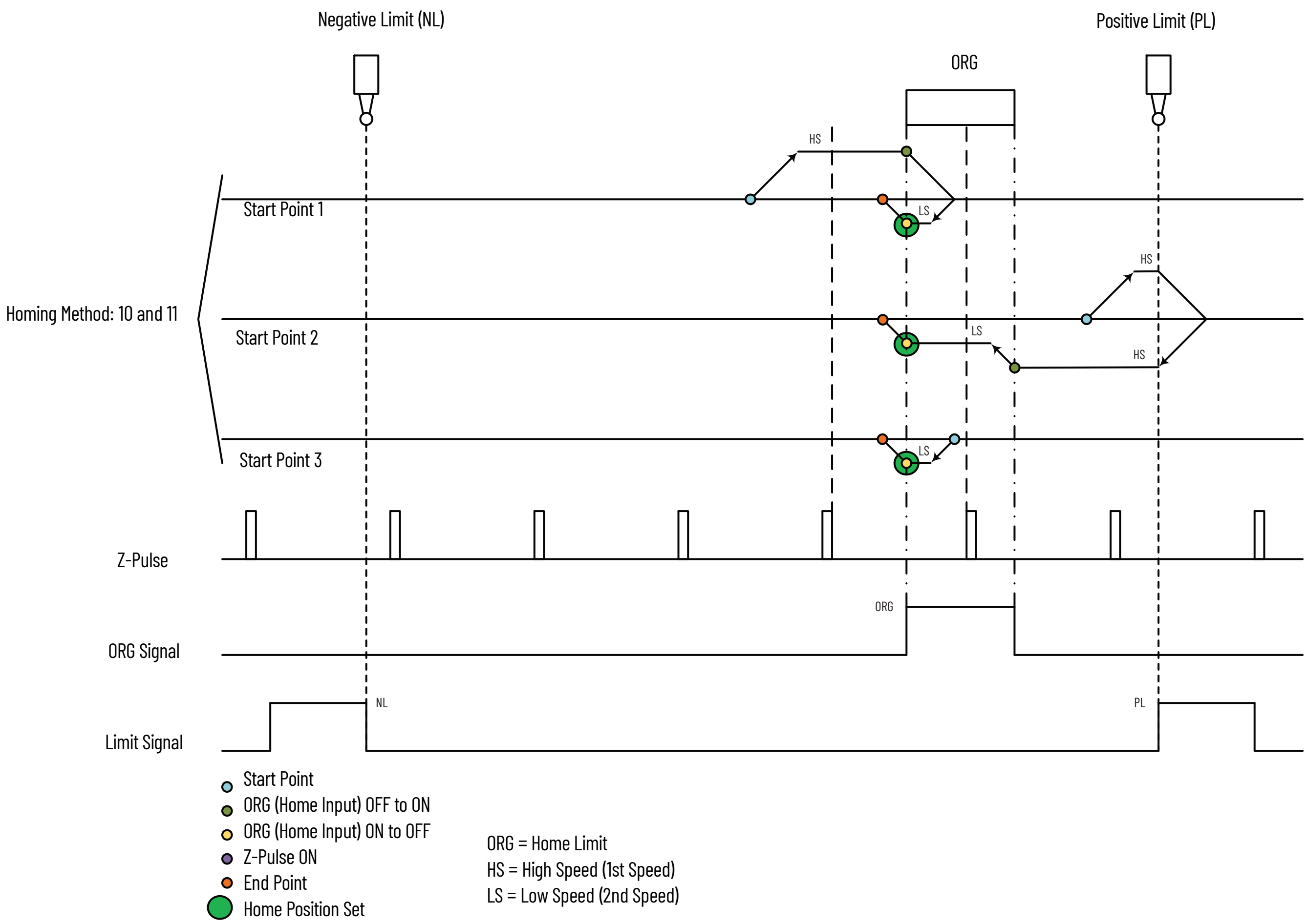
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 8 | Homing in forward direction, ORG: OFF to ON as homing origin, Go forward to Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 9 | Homing in forward direction, ORG: OFF to ON as homing origin, Go forward to Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 116 - Homing to Forward ORG OFF to ON (Rising Edge condition) - Homing Method 8 and 9**



| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 10 | Homing in forward direction, ORG: OFF to ON as homing origin, Do not look for Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 11 | Homing in forward direction, ORG: OFF to ON as homing origin, Do not look for Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 117 - Homing to Forward ORG OFF to ON (Rising Edge condition) - Homing Method 10 and 11**

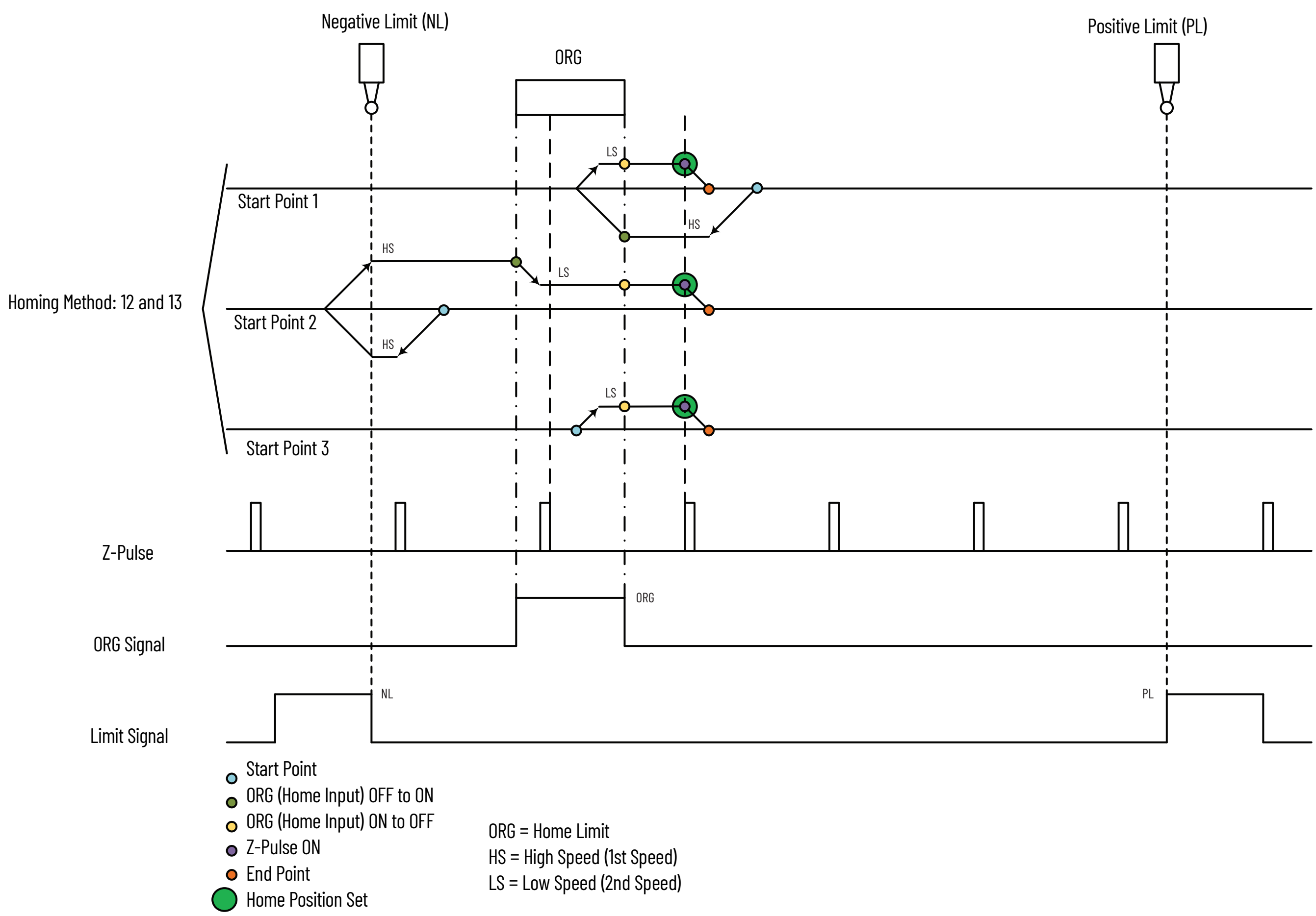


*Homing to Reverse ORG OFF to ON (Rising Edge condition)*

Figure 118...Figure 120 show the different homing methods that use the ORG signal with optional marker (Z) pulse. Notice that in some cases the low speed (LS) moves the motor forward or backward. When the ORG signal is used alone, a second transition of this signal must occur for the homing sequence to complete (End).

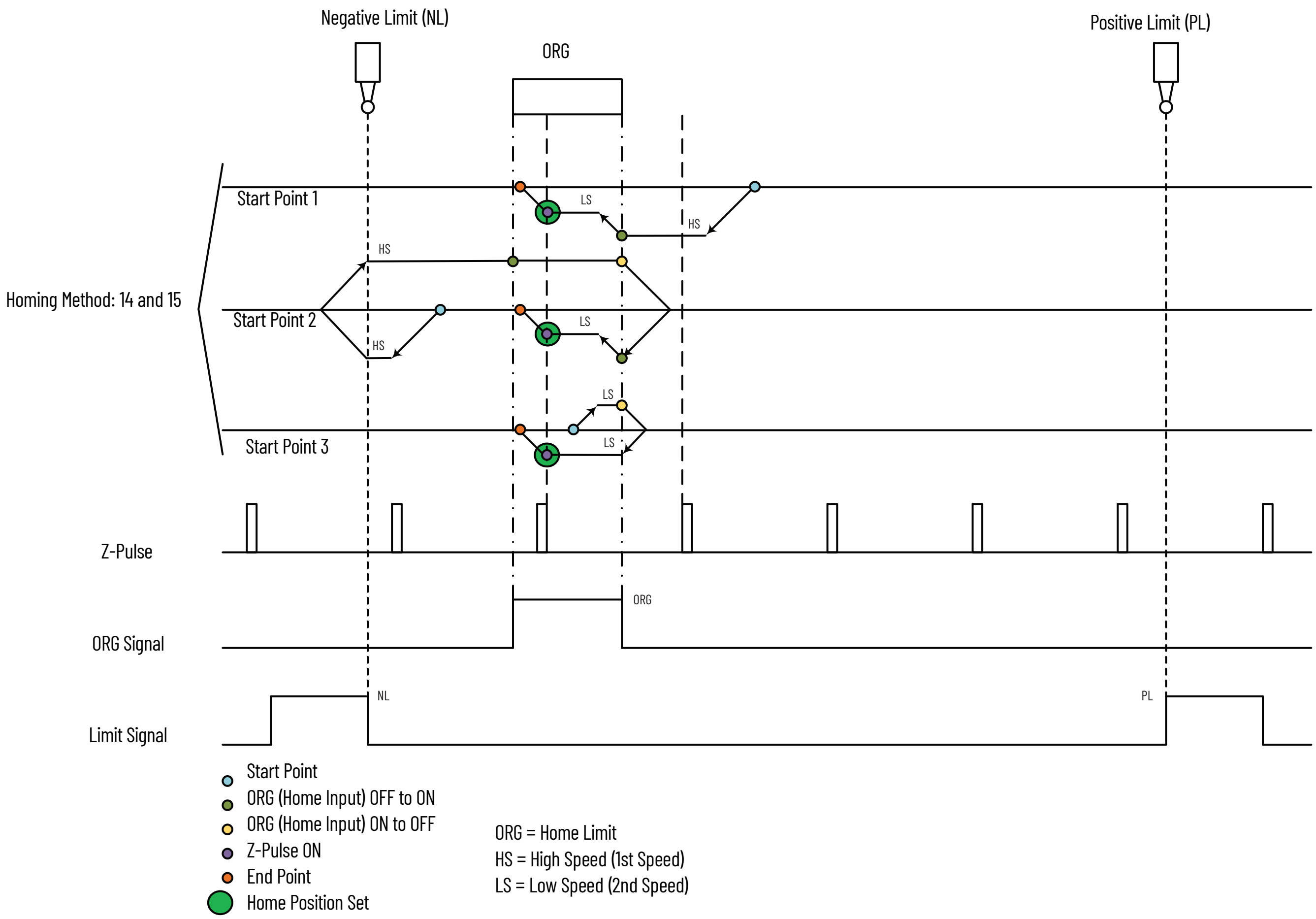
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 12 | Homing in reverse direction, ORG: OFF to ON as homing origin, Return to Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 13 | Homing in reverse direction, ORG: OFF to ON as homing origin, Return to Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 118 - Homing to Reverse ORG OFF to ON (Rising Edge condition) - Homing Method 12 and 13**



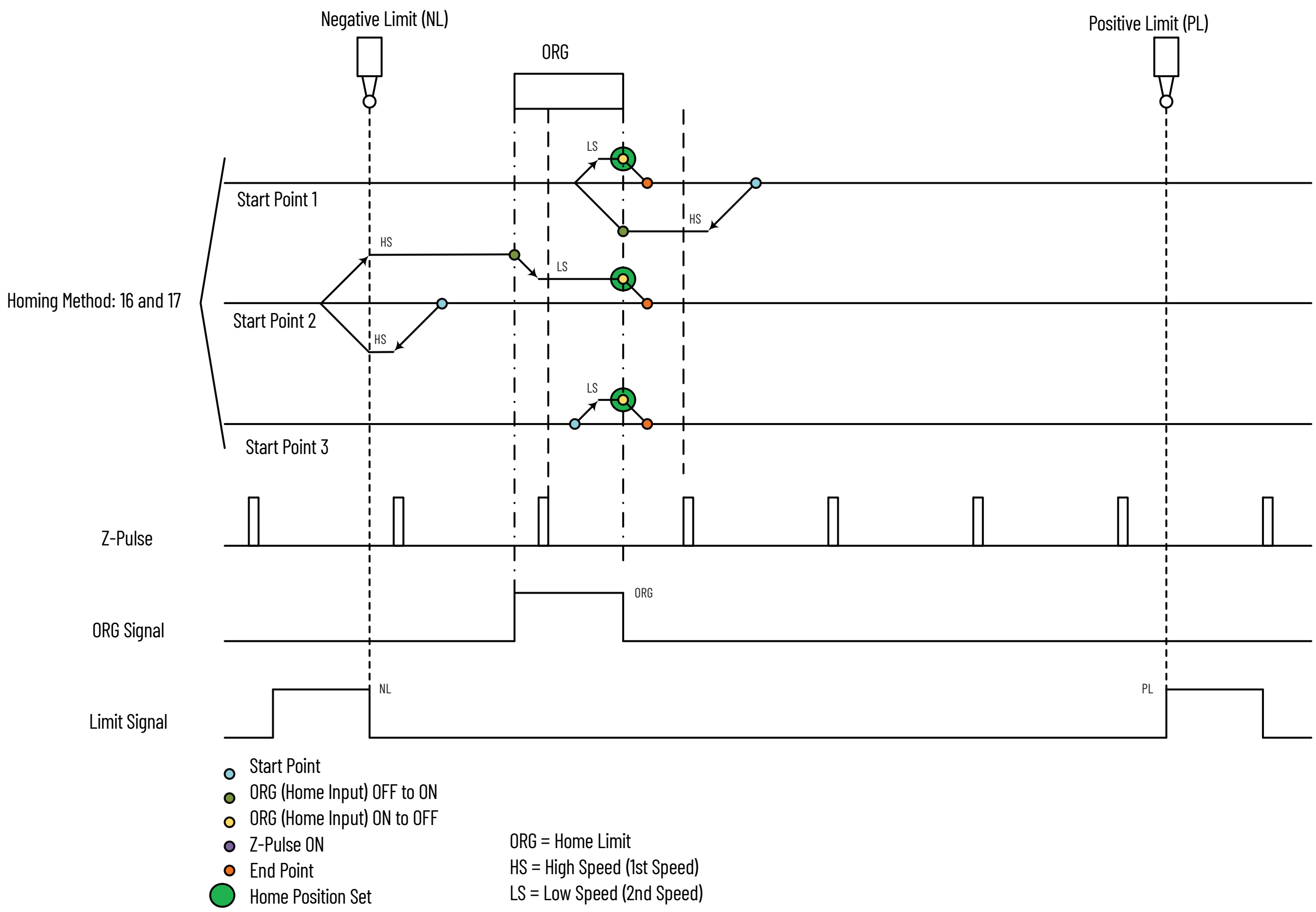
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 14 | Homing in reverse direction, ORG: OFF to ON as homing origin, Go forward to Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 15 | Homing in reverse direction, ORG: OFF to ON as homing origin, Go forward to Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 119 - Homing to Reverse ORG OFF to ON (Rising Edge condition)- Homing Method 14 and 15**



| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 16 | Homing in reverse direction, ORG: OFF to ON as homing origin, Do not look for Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 17 | Homing in reverse direction, ORG: OFF to ON as homing origin, Do not look for Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 120 - Homing to Reverse ORG OFF to ON (Rising Edge condition) - Homing Method 16 and 17**

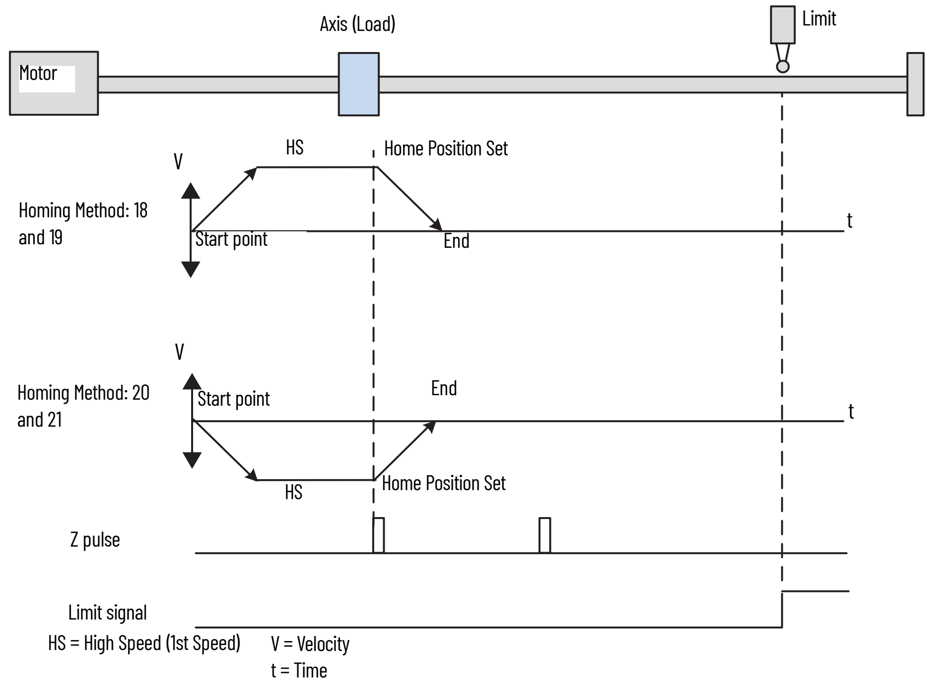


### *Referencing the Z Pulse*

This homing method uses the motor marker pulse (Z) to set the HomingPosition. The marker pulse is on the motor encoder and occurs once per motor rotation.

| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 18 | Look for Z pulse in forward direction and regard it as homing origin, Shows error when encounter limit. |
| 19 | Look for Z pulse in forward direction and regard it as homing origin, Reverse direction when encounter limit. |
| 20 | Look for Z pulse in reverse direction and regard it as homing origin, Shows error when encounter limit. |
| 21 | Look for Z pulse in reverse direction and regard it as homing origin, Reverse direction when encounter limit. |

**Figure 121 - Z Pulse as Reference Point**



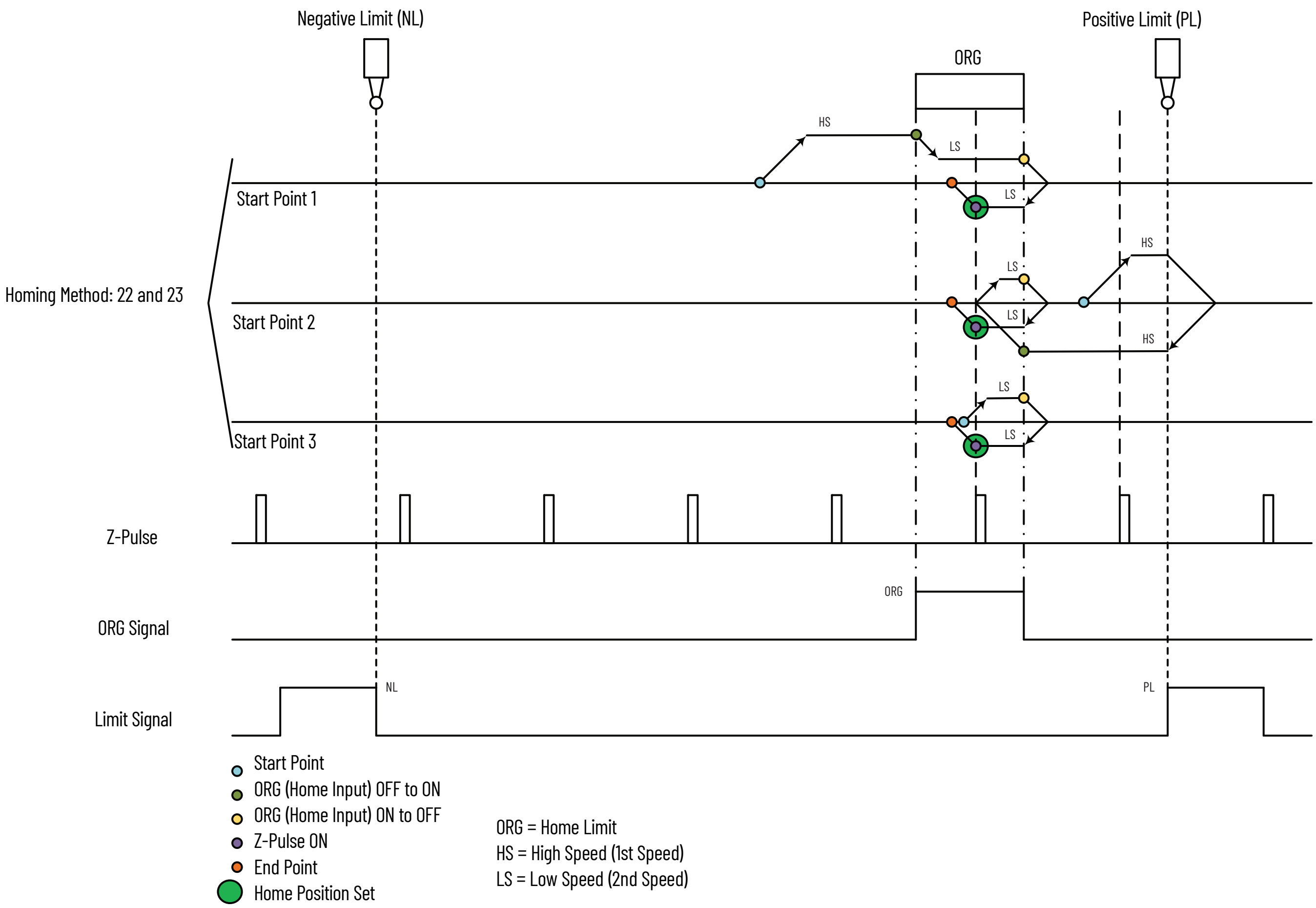
### *Homing to Forward ORG ON to OFF (Falling Edge condition)*

You can use the home sensor (ORG) to set the Home Position. You can use the ORG with the marker (Z) pulse to set the Home Position.

See Figure 122…Figure 124 for description.

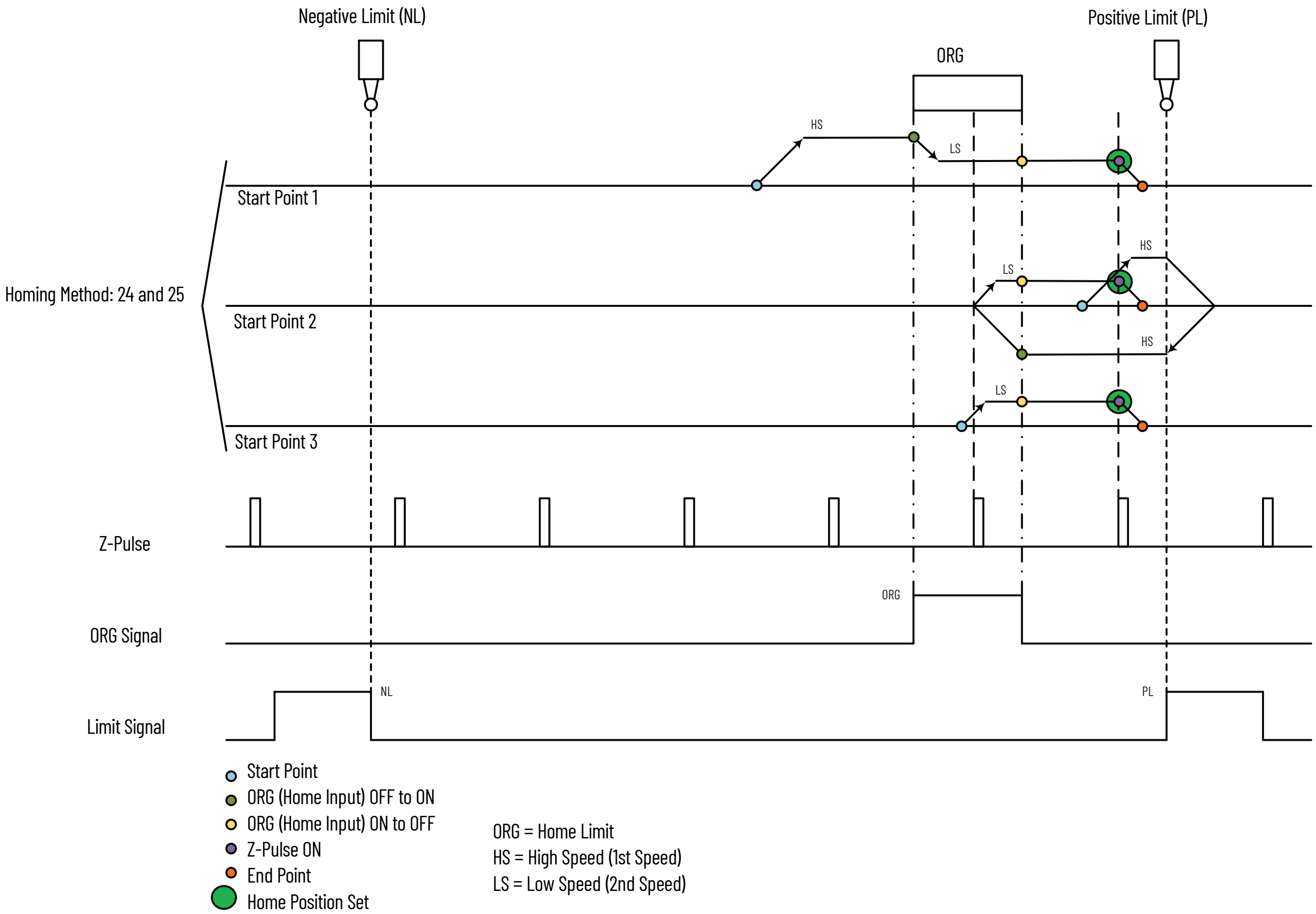
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 22 | Homing in forward direction, ORG: ON to OFF as homing origin, Return to Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 23 | Homing in forward direction, ORG: ON to OFF as homing origin, Return to Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 122 - Homing to Forward ORG ON to OFF (Falling Edge condition) - Homing Method 22 and 23**



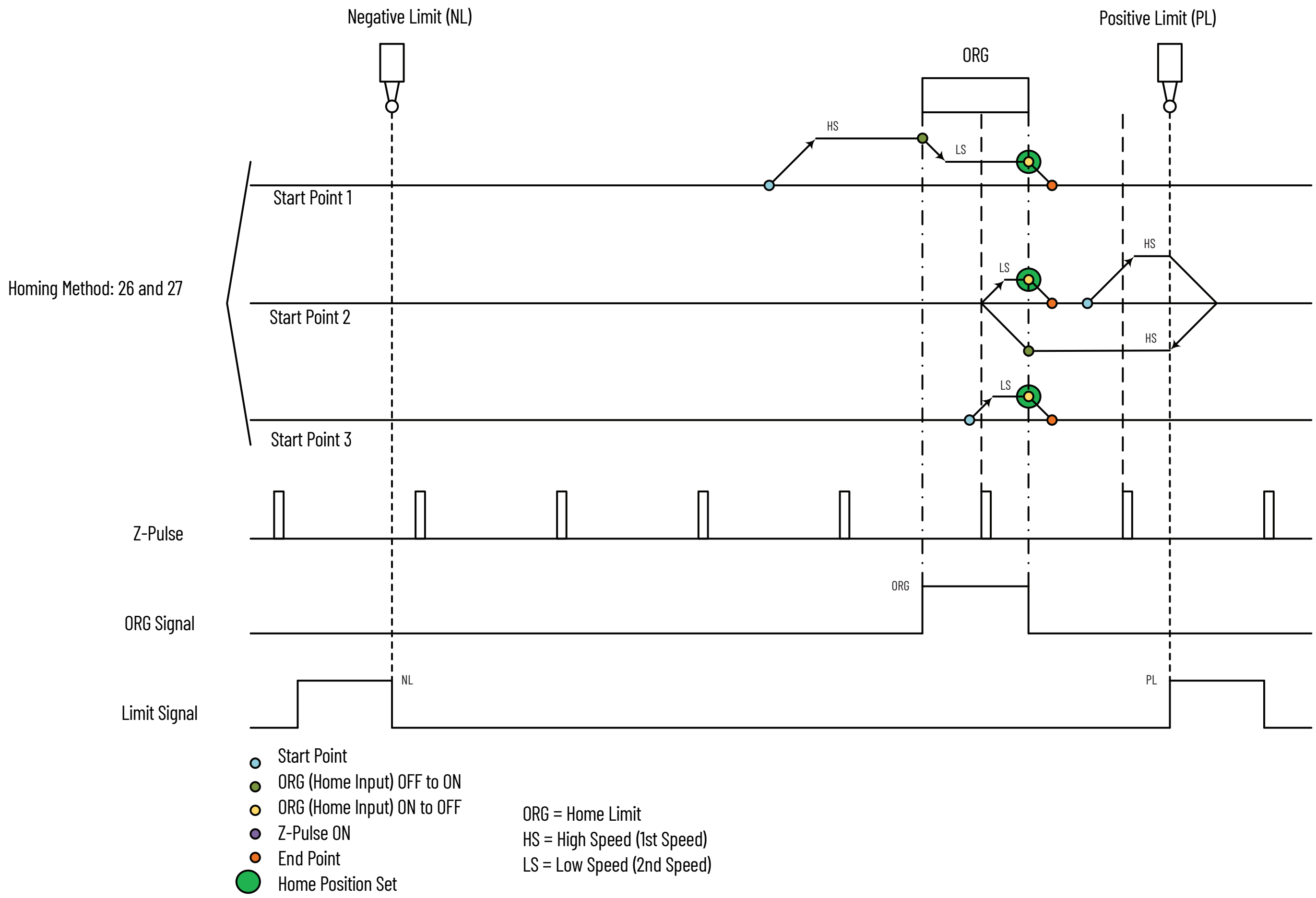
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 24 | Homing in forward direction, ORG: ON to OFF as homing origin, Go forward to Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 25 | Homing in forward direction, ORG: ON to OFF as homing origin, Go forward to Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 123 - Homing to Forward ORG ON to OFF (Falling Edge condition) - Homing Method 24 and 25**



| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 26 | Homing in forward direction, ORG: ON to OFF as homing origin, Do not look for Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 27 | Homing in forward direction, ORG: ON to OFF as homing origin, Do not look for Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 124 - Homing to Forward ORG ON to OFF (Falling Edge condition)- Homing Method 26 and 27**

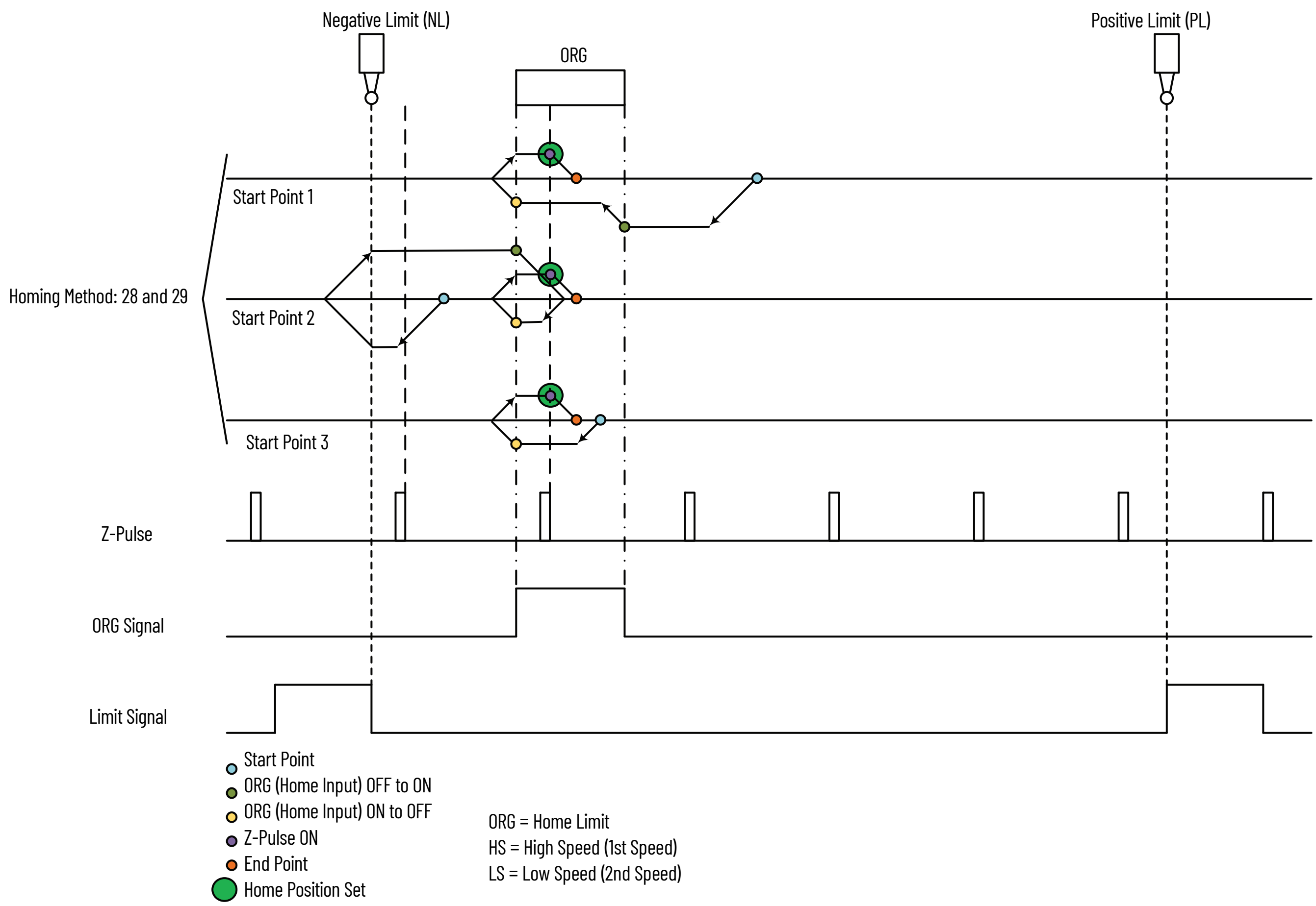


### *Homing to Reverse ORG ON to OFF (Falling Edge condition)*

Figure 125...Figure 127 shows the different homing methods that use the ORG signal (using the falling edge, or ON->OFF transition) with optional marker (Z) pulse. Notice that in some cases the low speed (LS) moves the motor forward or backward. When the ORG signal is used alone, a second transition of this signal must occur for the homing sequence to complete (End).

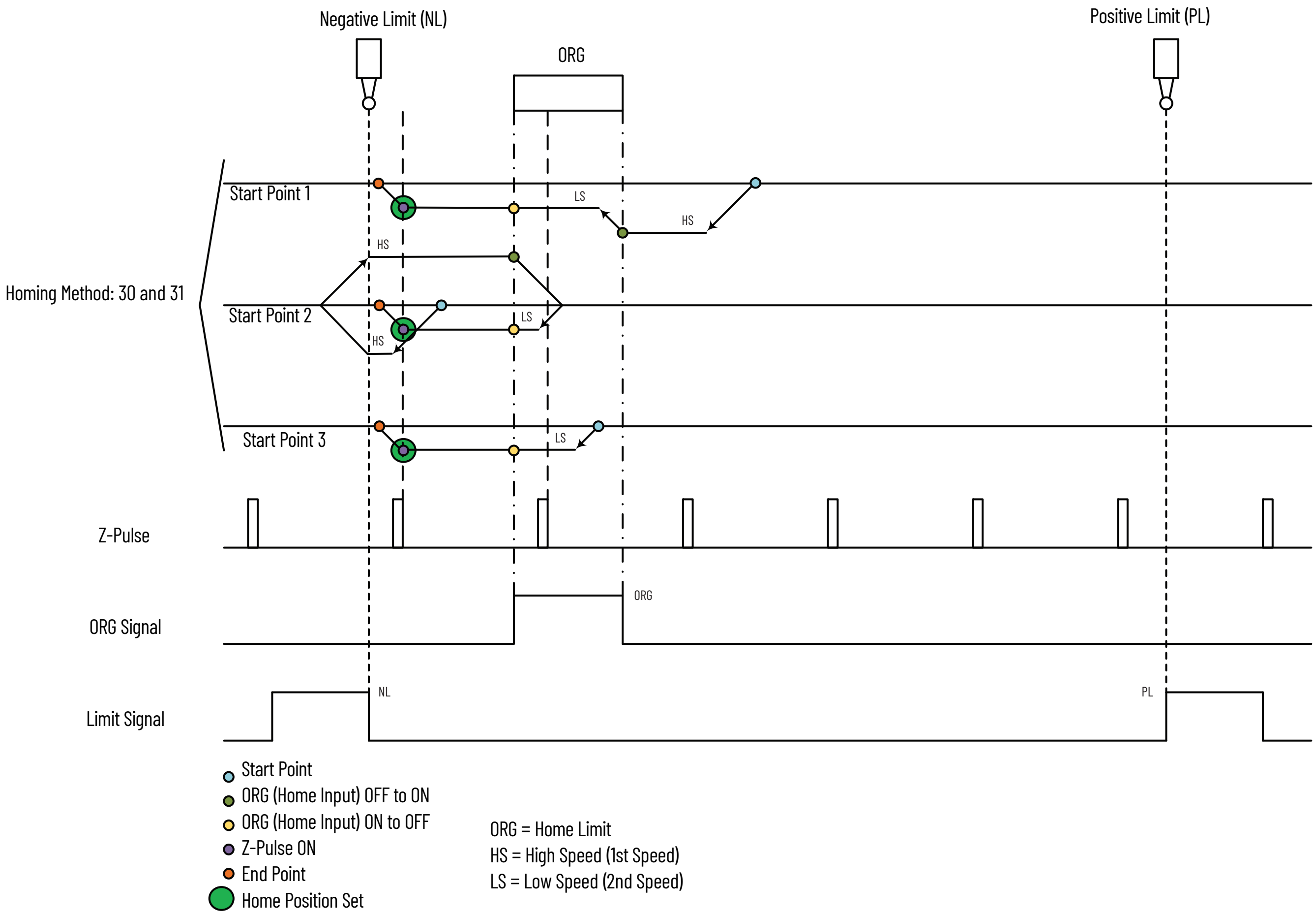
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 28 | Homing in reverse direction, ORG: ON to OFF as homing origin, Return to Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 29 | Homing in reverse direction, ORG: ON to OFF as homing origin, Return to Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 125 - Homing to Reverse ORG ON to OFF (Falling Edge condition) - Homing Method 28 and 29**



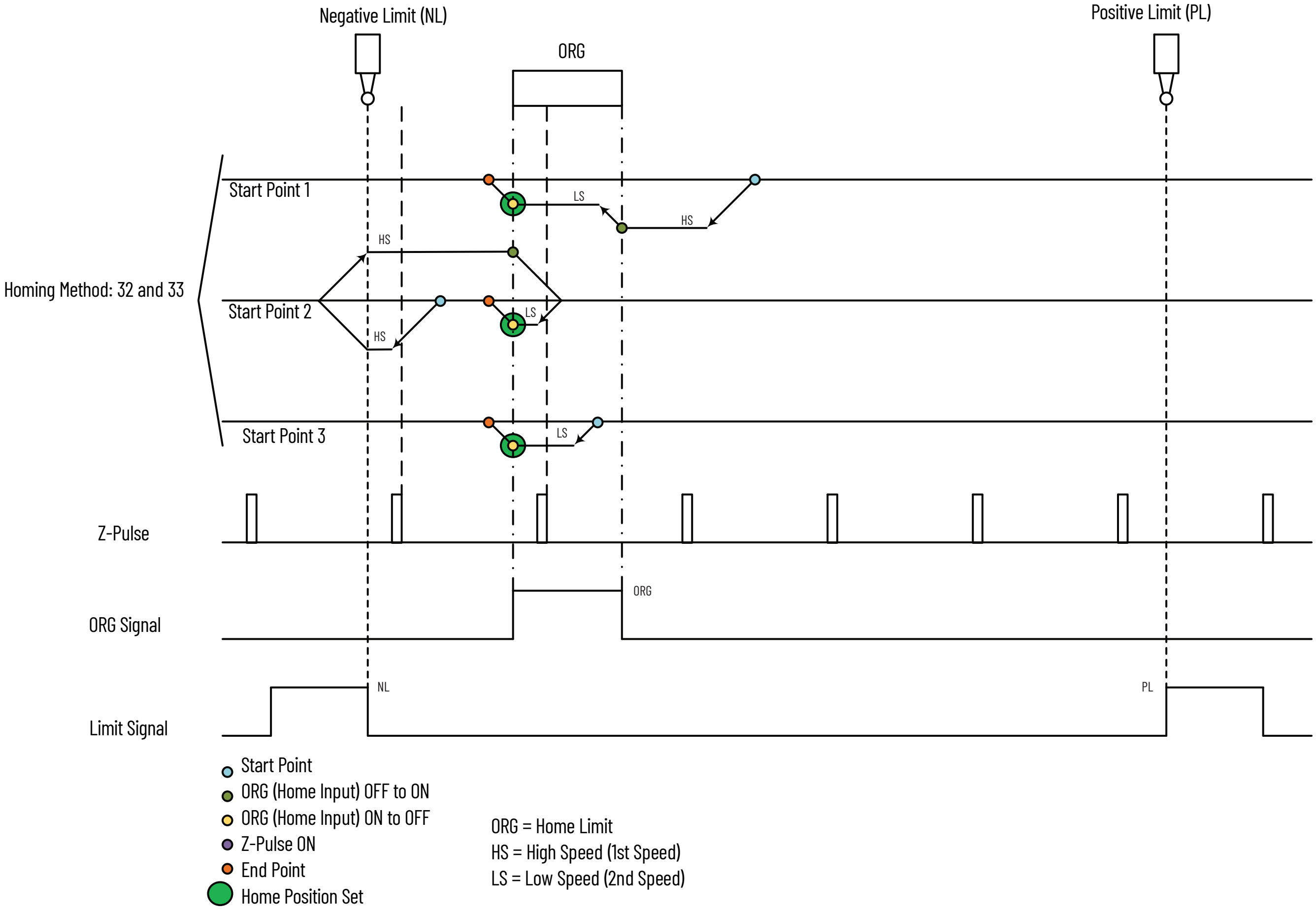
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 30 | Homing in reverse direction, ORG: ON to OFF as homing origin, Go forward to Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 31 | Homing in reverse direction, ORG: ON to OFF as homing origin, Go forward to Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 126 - Homing to Reverse ORG ON to OFF (Falling Edge condition) - Homing Method 30 and 31**



| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 32 | Homing in reverse direction, ORG: ON to OFF as homing origin, Do not look for Z pulse, Shows error when encounter limit. Home Position is set at Green dot. |
| 33 | Homing in reverse direction, ORG: ON to OFF as homing origin, Do not look for Z pulse, Reverse direction when encounter limit. Home Position is set at Green dot. |

**Figure 127 - Homing to Reverse ORG ON to OFF (Falling Edge condition) - Homing Method 32 and 33**

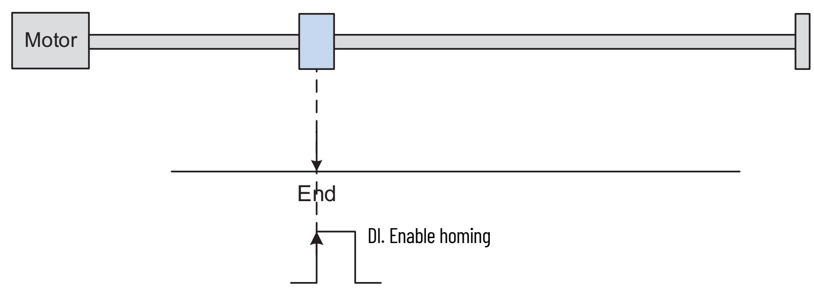


*Referencing the Present Position as the Origin*

This homing method sets the present physical location of the motor as the HomePosition ID 397 (P6.001). The motor does not move using this homing method and the motor must be enabled. When the Operation Mode is IO, this method is used with the raC_*xxx*_K5100_MAH and is Homing Method 34.

| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 34 | Define current position as the origin. |

**Figure 128 - Referencing Current Position as the Origin**




The Digital Input (DI.Enable Homing) must be used to perform this homing.

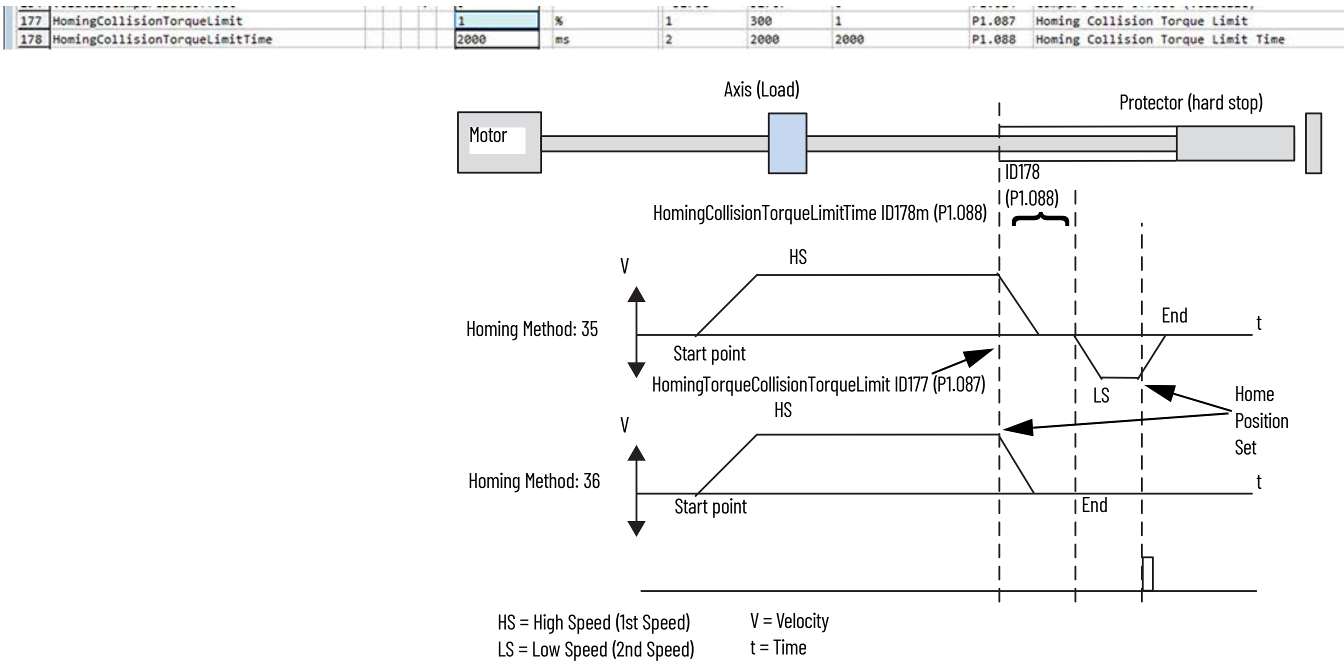
*Referencing the Torque Limit*

This homing method references a user defined motor torque parameter HomingTorqueCollisionTorqueLimit ID177 (P1.087) as a 'hard stop'. When the motor is homing and the actual motor torque equals the HomingTorqueCollisionTorqueLimit; and this condition is true for the HomingCollisionTorqueLimitTime ID178 (P1.088), the optional marker homing is executed and the homing is complete.

Be sure that the torque used for this homing method is within any user defined torque limit or the homing does not complete.

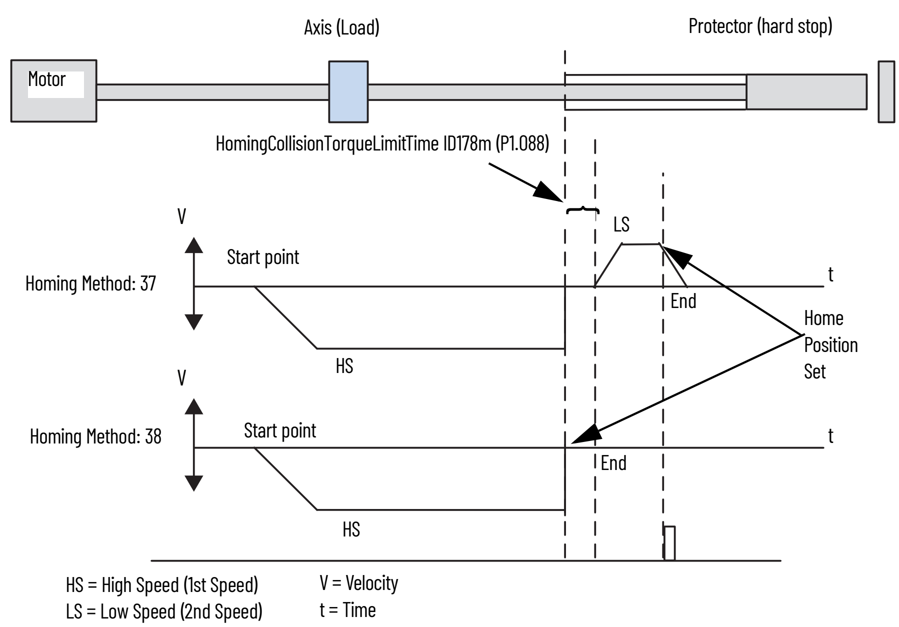
| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 35 | Look for the collision point in forward direction and regard it as the origin. Return to Z pulse. |
| 36 | Look for the collision point in forward direction and regard it as the origin. Do not look for Z pulse. |

**Figure 129 - Torque Limit as Reference Point - Forward Direction**




| Homing Method - IO Mode | Homing Method - Description |
|---|---|
| 37 | Look for the collision point in reverse direction and regard it as the origin. Return to Z pulse. |
| 38 | Look for the collision point in reverse direction and regard it as the origin. Do not look for Z pulse. |

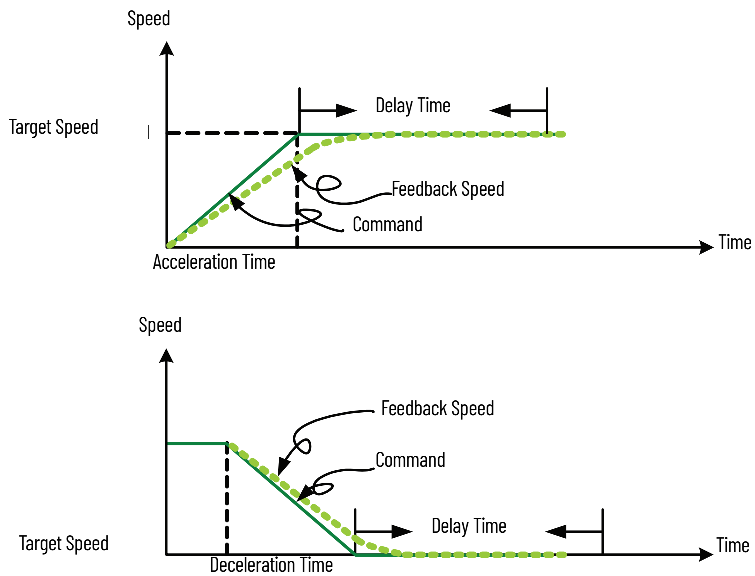
**Figure 130 - Torque Limit as Reference Point - Reverse Direction**



## Constant Speed Control

When the Kinetix 5100 drive is in PR Operation Mode, you can use the Constant Speed control function. The parameters available for PR Mode with speed control are acceleration/deceleration time, delay time, and target speed.

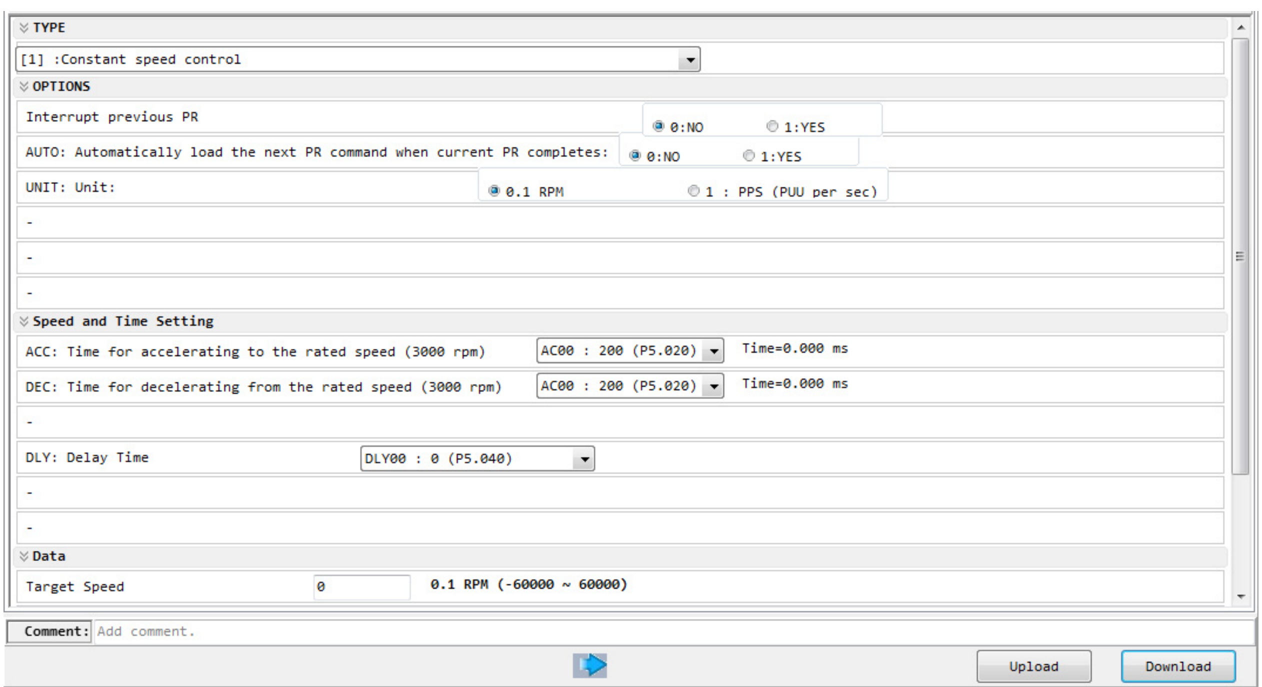
**Figure 131 - Parameter for PR Mode Speed Control**




The constant speed control command type is a simple command. See PR Mode Definitions on page 282 to see the different options available with this command.

The constant speed control is useful when it is triggered by using an event input to interrupt a currently executing PR. Use the interrupt to change the speed of a currently executing constant speed command.

**Figure 132 - PR Mode Speed Screen**



These settings are the functions of each bit when a speed command is applied by using the PRCmdXSetting parameter ID339…ID595 (P6.002…P7.098).

Settings:

Format of this parameter: (High word h) DCBA: (Low word L) UZYX


| | | | |
|---|---|---|---|
| **A** | Reserved | **X** | TYPE, Command type - Set to 1 |
| **B** | DLY, Delay time index | **Y** | OPT, Option |
| **C** | Reserved | **Z** | ACC, Acceleration time index |
| **D** | Reserved | **U** | DEC, Deceleration time index |
| **Data Content** | | Target speed [0.1 rpm / PPS] | |

- Y OPT: option

| **BIT** | **3** | **2** | **1** | **0** |
|---|---|---|---|---|
| **Command Type** | - | UNIT | AUTO | INS |

See PR Mode Setting on page 339, where you can configure the PR Mode for speed and control in KNX5100C Software.

## Position Control Command

When the Kinetix 5100 drive is in PR Operation Mode, you can use the Positioning function. There are two command types:

- Point-to-Point command
- Point-to-Point command (Proceed to the next command when completed).

  The only difference between the two is the function at the end of the command: stop or continue to the next consecutive PR. Continue means the next sequential PR is executed.

See PR Command Setting on page 282 on for details on the PR commands.

Figure 133 - PR Mode Position Interface of the Configuration Software

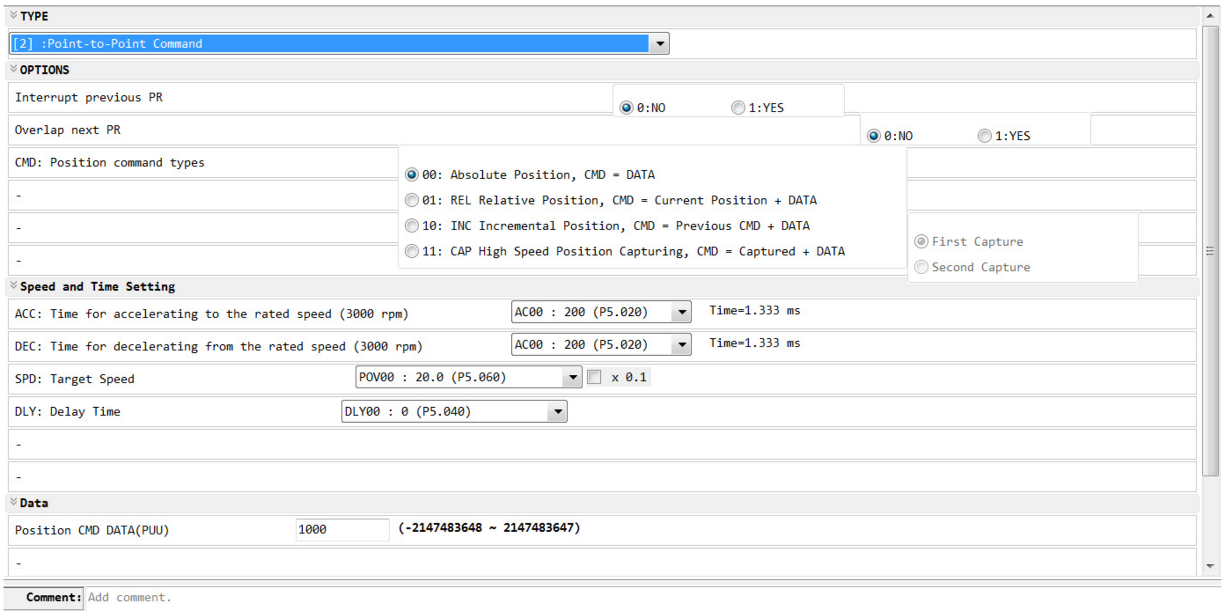
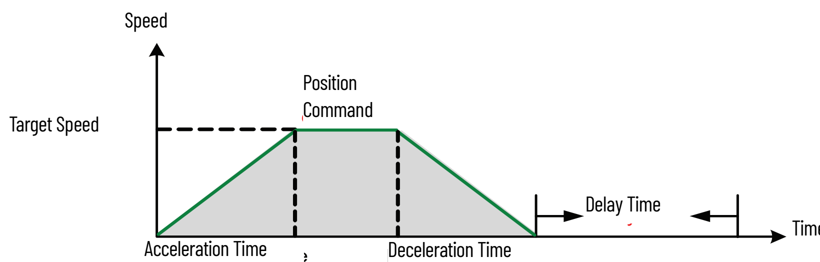



Figure 134 - Parameters for PR Mode Position Settings



These settings are the functions of each bit when a position command is applied.

Settings:

Format of this parameter: (High word h) DCBA: (Low word L) UZYX


| | | | |
|---|---|---|---|
| **A** | SPD, Target speed index | **X** | TYPE, Command type - Set to 2 or 3 |
| **B** | DLY, Delay time index | **Y** | OPT, Option |
| **C** | Reserved | **Z** | ACC, Acceleration time index |
| **D** | Reserved | **U** | DEC, Deceleration time index |
| **Data Content** | | Target position [PUU] | |

- Y OPT: option

| **BIT** | **3** | **2** | **1** | **0** | **Description** |
|---|---|---|---|---|---|
| **Command type** | CMD | | OVLP | INS | - |
| **Data Content** | 0 | 0 | - | - | ABS (absolute positioning) |
| | 0 | 1 | | | REL (relative positioning) |
| | 1 | 0 | | | INC (incremental positioning) |
| | 1 | 1 | | | CAP (high-speed position capturing) |

See Use the PR Mode Editor in KNX5100C Software on page 335, where you can configure the PR Mode for one of two PR Mode position command types:

- Mode 2 = Point-to-Point Command
- Mode 3 = Point-to-Point Command (Proceed to next command when complete)

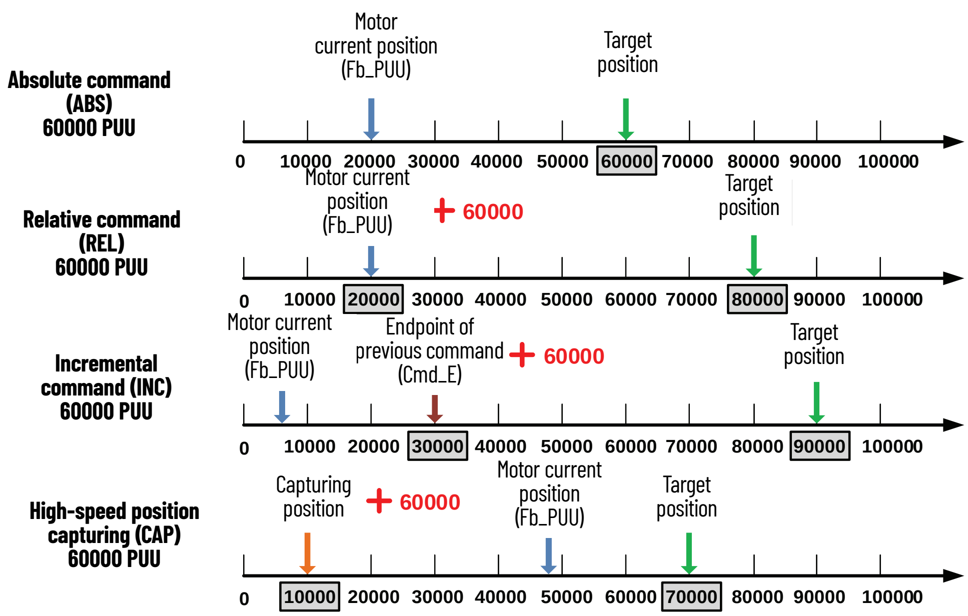
## Position Command Types

There are four types of position commands for the PR Mode. These same position commands can be used for IO Mode, although their names are different. The raC_*xxx*_K5100_MAM Set_MoveType is shown in brackets. You can choose the position command according to the application requirements. The functions of each type are described in the examples below. The condition in these examples is that a position command is still being executed and another type of command is inserted. To see how the position commands are combined, see Figure 135.

- Absolute position command (ABS, raC_*xxx*_K5100_MAM Type 0 = Absolute): when executed, the target position value equals the absolute command value. In Figure 135, an ABS command with the value of 60000 PUU is inserted in the previous PR command with setting target position of 60000 PUU on the coordinate axis.

- Relative position command (REL, raC_*xxx*_K5100_MAM Type 7 = Relative): when executed, the target position value is the motor's current position value plus the position command value. In the figure, a REL command with the value on 60000 PUU is inserted in the previous PR command. The target position is the motor's current position (20000 PUU) plus the relative position command (60000 PUU), which equals 80000 PUU in the coordinate system. The target position specified by the original command is omitted.
- Incremental command (INC, raC_*xxx*_K5100_MAM Type 1 = Incremental): when executed, the target position is the previous target position value plus the current position command value. In the example below, an INC command with the value of 60000 PUU is inserted in the previous PR command. The target position is the previous target position value 30000 PUU plus the relative position command 60000 PUU, which equals 90000 PUU. The previous destination specified by the previous command is combined to define the new one.
- High-speed position capturing command (CAP, raC_*xxx*_K5100_MAM Type 8 = Capture): when executed, the target position is the last position acquired by the Capture function plus the position command value. In the following example, a high-speed capturing command with the value of 60000 PUU is inserted in the previous PR command. The target position value is the captured position value of 10000 PUU plus the relative command of 60000 PUU, which equals 70000 PUU. The target position specified by the original command is omitted.

**Figure 135 - Four Types of Position Command**



# Jump Command

The drive provides a jump command in PR Mode. It can call any PR command or form PR commands into a loop, as shown in Figure 136. You can specify the PR command number to be jumped to by using PR Mode setting screen in the configuration software. Among the options, Interrupt Previous is available, this interrupts the currently executing motion command. DLY is the delay time determined by shared PR parameters ID332…ID347 (P5.040…P5.055). Once a jump command is issued, the servo drive will start counting the delay time and execute the jump once the delay time expires.

**Figure 136 - Jump Command in PR Mode**

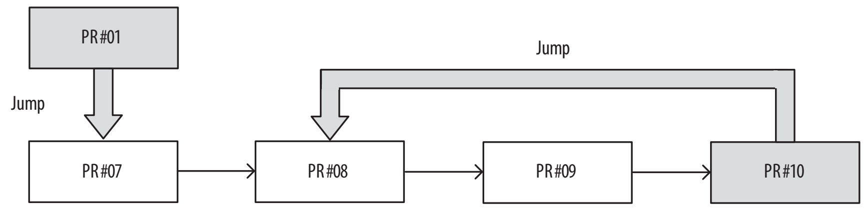
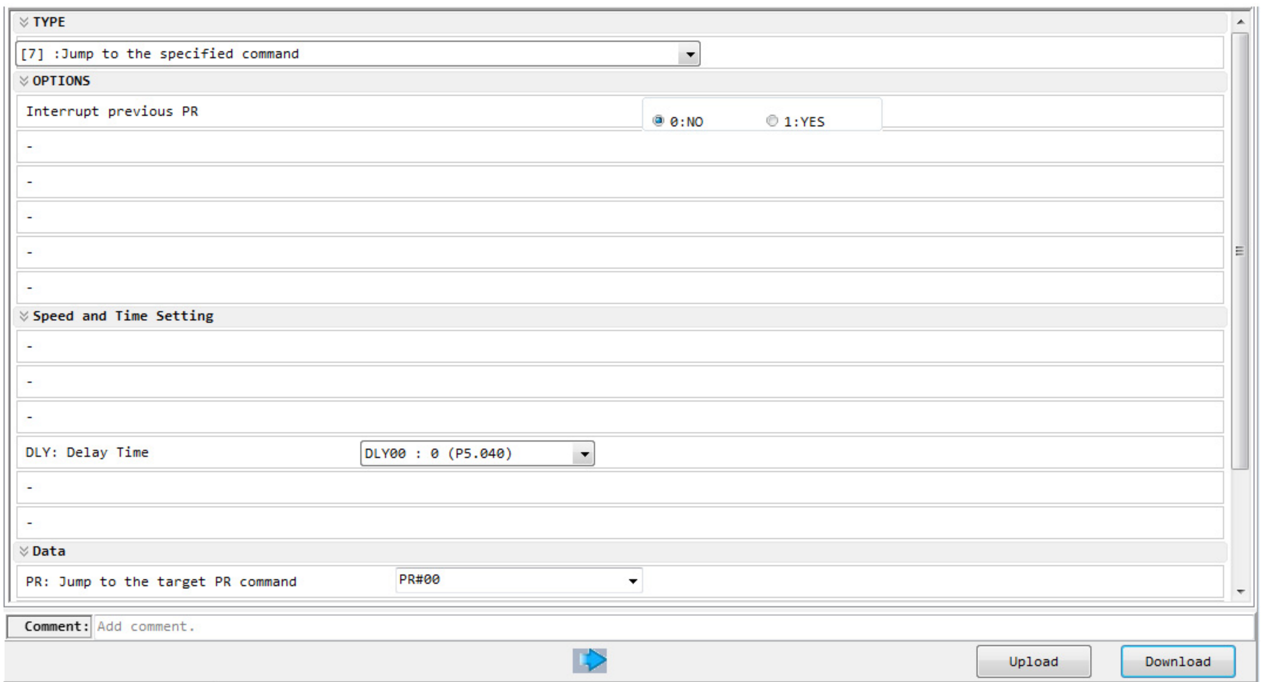



**Figure 137 - Using PR Mode Jump Command**



These settings are the functions of each bit when a jump command is applied using the ID399…ID595 (P6.002…P7.098) PRCmdXSetting.

Settings:

Format of this parameter: (High word h) DCBA: (Low word L) UZYX


| | | | |
|---|---|---|---|
| **A** | Reserved | **X** | TYPE, Command type - Set to 7 |
| **B** | DLY, Delay time index | **Y** | OPT, Option |
| **C** | Reserved | **Z** | Reserved |
| **D** | Reserved | **U** | Reserved |
| **Data Content** | | Jump to target PR command(0…99) | |

- Y: OPT: option

| **BIT** | **3** | **2** | **1** | **0** |
|---|---|---|---|---|
| **Command Type** | - | - | - | INS |

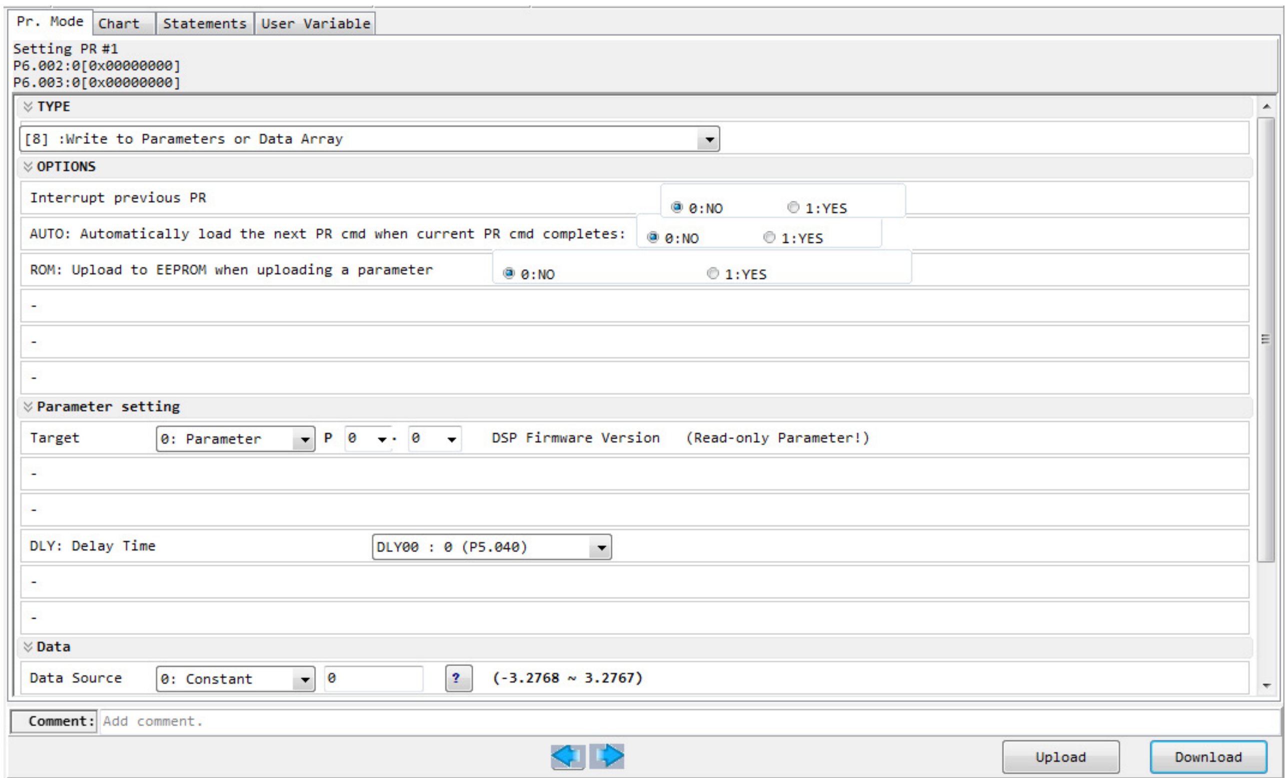
See Use the PR Mode Editor in KNX5100C Software on page 335, where you can configure the PR Mode as Jump to specified command.

## Write Command

The write command in PR Mode can write constants, parameters, data arrays, and monitoring variables to the specified parameters or data arrays. Users can write the parameter by using the PR Mode setting screen of the configuration software. This command can interrupt a currently executing PR and can load the next PR when the write is completed. The ROM option lets the drive write parameters to both RAM and EEPROM at the same time. However, frequent usage will shorten the life of EEPROM. DLY is the delay time selected by shared PR parameters ID332…ID347 (P5.040…P5.055). Once a jump command is issued, the servo drive will start calculating the delay time. The table below shows the bit function when a write command is used.

| Writing Target | Data Source |
|---|---|
| Parameter | Constant |
| Data array | Parameter |
| - | Data array |
| - | Monitoring variables |

**Figure 138 - Using PR Write Command**



These settings are the functions of each bit when a write command is applied using the PRCmdXSetting ID399…ID595 (P6.002…P7.098).

Settings:

Format of this parameter: (High word h) DCBA: (Low word L) UZYX


| | | | |
|---|---|---|---|
| **A** | DESTINATION | **X** | TYPE, Command type - Set to 8 |
| **B** | DLY, Delay time index | **Y** | OPT, Option |
| **C** | SOUR_DEST | **Z** | DESTINATION |
| **D** | 0 | **U** | DESTINATION |
| **Data Content** | | SOURCE | |

- Y: OPT: option

| **BIT** | **3** | **2** | **1** | **0** |
|---|---|---|---|---|
| **Command type** | - | ROM | AUTO | INS |

- C: SOUR_DEST: data source and data format to be written.

| **BIT** | **3** | **2** | **1** | **0** | **Description** | |
|---|---|---|---|---|---|---|
| **Command type** | SOUR | | - | DEST | Data source | Writing target |
| **Data content** | 0 | 0 | 0 | 0 | Constant | Parameter |
| | 0 | 1 | | 0 | Parameter | Parameter |
| | 1 | 0 | | 0 | Data array | Parameter |
| | 1 | 1 | | 0 | Monitoring variable | Parameter |
| | 0 | 0 | | 1 | Constant | Data array |
| | 0 | 1 | | 1 | Parameter | Data array |
| | 1 | 0 | | 1 | Data array | Data array |
| | 1 | 1 | | 1 | Monitoring variable | Data array |

- Z,U,A: DESTINATION: destination

| | **A** | **U** | **Z** |
|---|---|---|---|
| **Target: Parameter** | Parameter group | Parameter number | |
| **Target: Data array** | Data array number | | |

- SOURCE: data source setting

| | **D** | **C** | **B** | **A** | **U** | **Z** | **Y** | **X** |
|---|---|---|---|---|---|---|---|---|
| **Data source: Constant** | Constant data | | | | | | | |
| **Data source: Parameter** | - | | | | | Parameter group | Parameter number | |
| **Data source: Data array** | - | | | | | Data array number | | |
| **Data source: Monitoring variable** | - | | | | | | Monitoring variable number | |

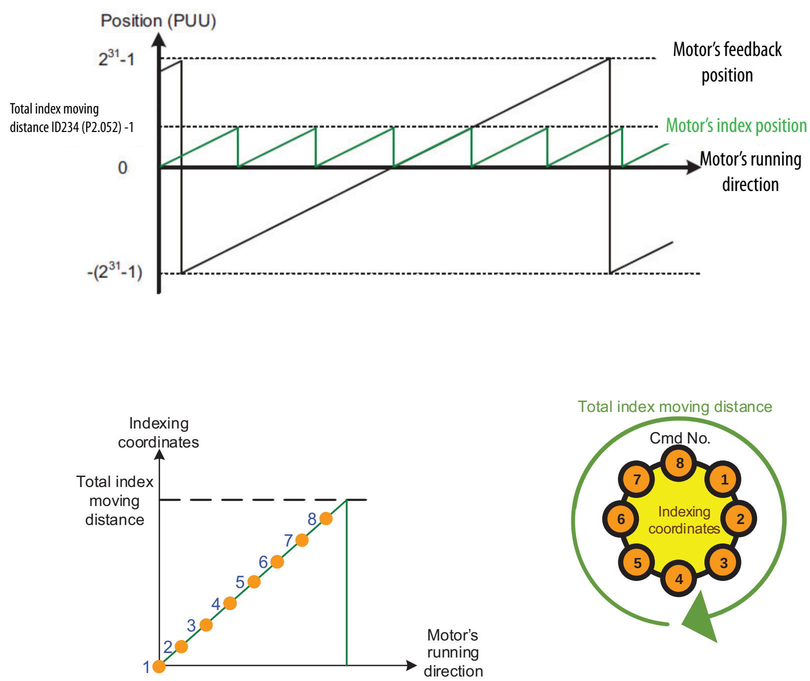
See Use the PR Mode Editor in KNX5100C Software on page 335 to configure the PR Mode as Write to Parameters or Data Array.

## Index Position Command

At this time, the Kinetix 5100 drive does not have a native rotary mode operation. This Index Position Command is a feature that lets you execute absolute indexing commands that persist through the natural unwind of the feedback device (typically, 2.147 billion counts).

An example is a conveyor that constantly indexes forward, once the natural unwind of the encoder occurs, the absolute position will continue to position using the index coordinate system. Since there is no unwind operation, the feedback counts register does not reflect the index coordinate position (PUU).

**Figure 139 - PR Mode Indexing Coordinates**




ID234 (P2.052) IndexingCoordinatesScale sets the spacing of the indexing coordinates, indexing command position, and indexing feedback position. If the value is too small, it can cause errors in the indexing coordinates.

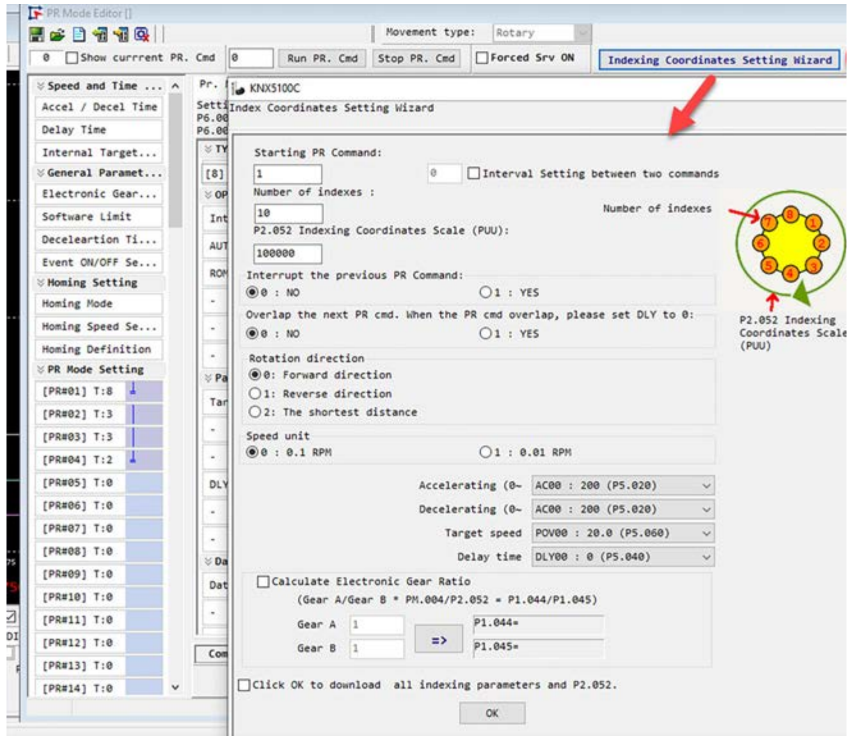
**Table 113 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID8 (PM.032) | MotorMaxSpeed |
| ID151 (P1.044) | GearRatioslaveCountsN1 |
| ID152 (P1.045) | GearRatioMasterCounts |
| ID234 (P2.052) | IndexingCoordinatesScale |
| ID600 (PM.004) | EncoderResolution |

**IMPORTANT** Prior to using the Index Position function, homing must be completed.

We have created an Index Coordinates Setting Wizard to guide you in selecting the correct values for your Index Position command.

**Figure 140 - PR Mode Index Position Screen**




## Hex Settings for Index Coordinate System

These settings are the functions of each bit when a index command is applied using the ID339…ID595 (P6.002…P7.098) PRCmdXSetting.

Settings:

Format of this parameter: (High word h) DCBA: (Low word L) UZYX


| | | | |
|---|---|---|---|
| **A** | SPD, Target speed index | **X** | TYPE, Command type - Set to 0xA |
| **B** | DLY, Delay time index | **Y** | OPT, Option |
| **C** | OPT2 | **Z** | ACC, Acceleration time index |
| **D** | Reserved | **U** | DEC, Deceleration time index |
| **Data Content** | | Index Position command [PUU](0 – P2.052-1) | |

- Y: OPT: option

| BIT | 3 | 2 | 1 | 0 | Description |
|---|---|---|---|---|---|
| Command type | DIR | | OVLP | INS | - |
| Data content | 0 | 0 | - | - | Forward (always move forward) |
| | 0 | 1 | | | Reverse (always move in the reverse direction) |
| | 1 | 0 | | | Shortest distance |
| | 1 | 1 | | | - |

- C: OPT2: Option 2

| BIT | 3 | 2 | 1 | 0 |
|---|---|---|---|---|
| Command type | - | AUTO | - | S_LOW |

See Index Coordinates Settings Wizard on page 329 for Index position control and use the Index Coordinates Setting Wizard.

## Index Coordinates Settings Wizard

The wizard simplifies the entries of the index coordinates by pre-populating the PR data that is specified. The wizard uses your entries and creates one (or multiple) PR# entries to represent the information entered in the wizard. Click Index Coordinates Setting Wizard in the PR screen of the configuration software to launch the wizard.

Figure 141 - Indexing Coordinates Setting Wizard

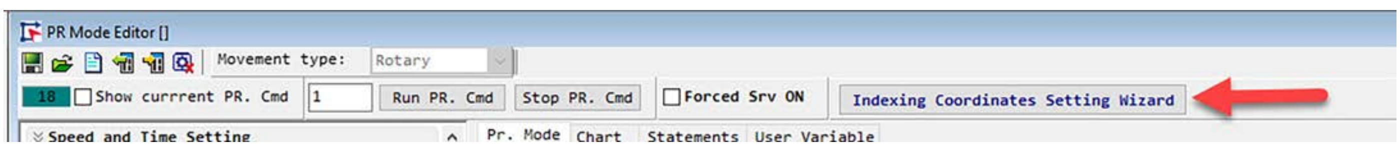
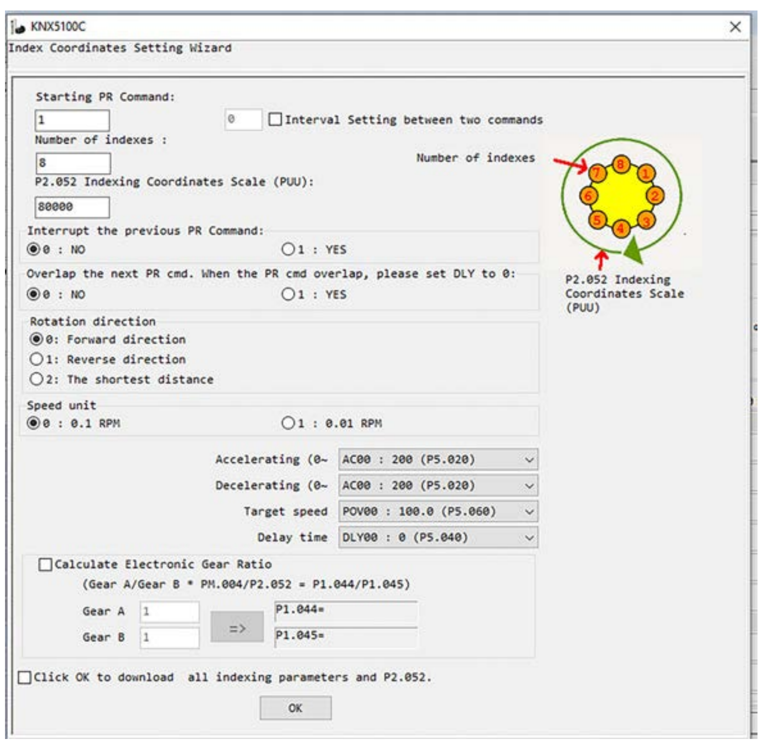



Figure 142 - Indexing Coordinates Setting Wizard in PR Mode



As shown in Figure 143, the start PR command is set to 1 and command number is set to 8 (which means that the wizard creates 8 sequential PRs) and total moving distance is 80000 PUU (the wizard creates 8 PRs with an equidistant 10000 PUU each distance). Click OK for the wizard to automatically pre-populate the PR values (Figure 144). You can modify the values with your application requirements if needed.

These index types are used with the raC_*xxx*_K5100_MAM, Move Types 2,3,4.

**Figure 143 - PR Mode Index Position Example**

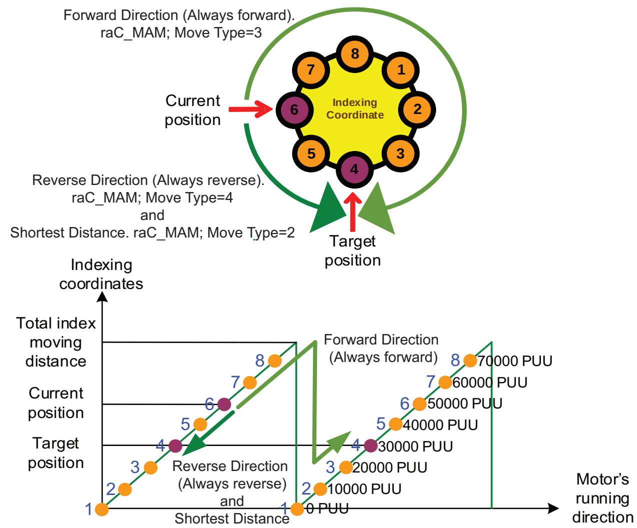
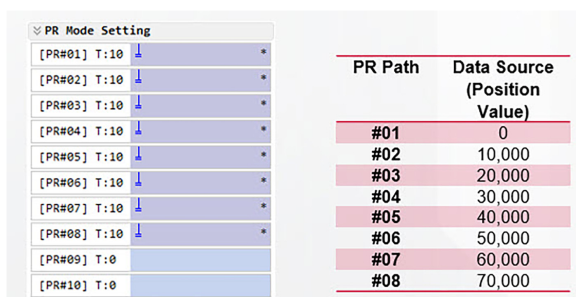


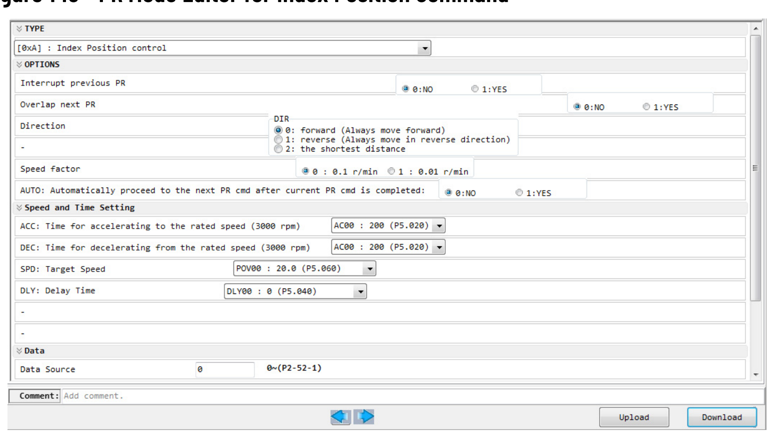

**Figure 144 - PR Mode Setting**




| PR Path | Data Source (Position Value) |
|---|---|
| #01 | 0 |
| #02 | 10,000 |
| #03 | 20,000 |
| #04 | 30,000 |
| #05 | 40,000 |
| #06 | 50,000 |
| #07 | 60,000 |
| #08 | 70,000 |

See Index Position Command on page 327 for information on the Index Coordinates function. If you choose a command type of [0xA]: Index Position Control, you can configure the OPTIONS and the Speed and Time Setting on the PR Mode tab.

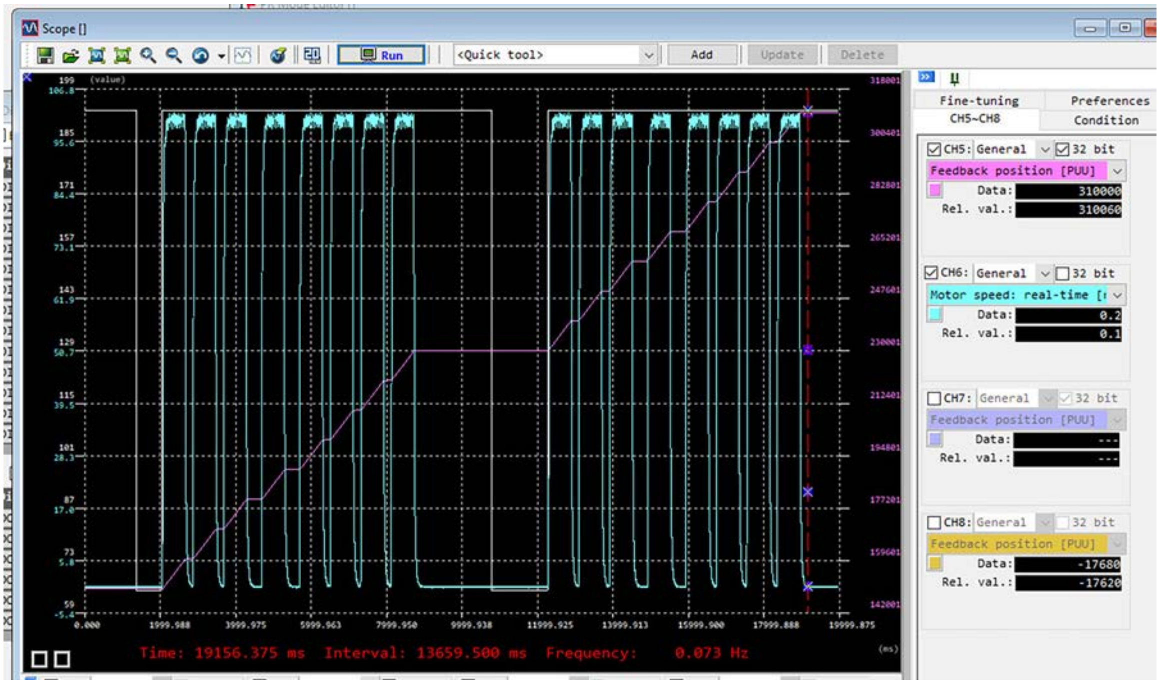
**Figure 145 - PR Mode Editor for Index Position Command**



## Index Position Command Operation

In the scope tracing in Figure 146, the blue pen is motor rpm and the pink pen is motor feedback position.

**Figure 146 - Index Position Command Operation**



When executing the indexes (in this example, PR#01...PR#-08) the motor must be homed before executing the indexes. The indexes move forward for 8 separate indexes, when it is complete, you can restart the sequence by setting Command Triggered DI signal. This Scope trace shows two sequences by using the Index Position instructions. In summary, the benefit to using this system is that the absolute positioning can occur with repetitive indexes, without having to re-calculate absolute targets. This system provides a 'quasi' rotary mode of operation.

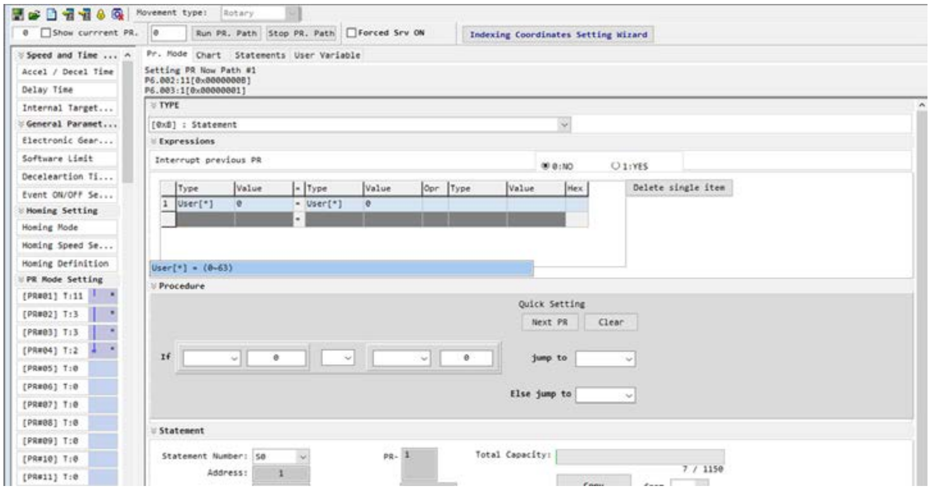
| | |
|---|---|
| **IMPORTANT** | The indexing coordinate system may not reflect actual motor counts, because its absolute range is persistent through the natural rollover of the motor feedback. For this reason, it is not considered a true rotary unwind. |

## Arithmetic Operation Commands

In PR Mode, the drive provides arithmetic and simple logic commands, including addition, subtraction, multiplication, division, OR, AND, MOD, and logic conditions. Available operands that can be written or read include user variable, parameter, data array, monitoring variable, and constant types.

Arithmetic operations must be set via the Arithmetic Operations dialog box in KNX5100C software. See Index Position Command Operation on page 331. To avoid error occurrences, do not use the front panel or a Message instruction to do the setting.

**Figure 147 - PR Arithmetic Operations Screen**



| Type | | Definition |
|---|---|---|
| User[*] | User Variable (0…63) | 64 total user variables stored in the drive - you can use these variables, but they are internal to the drive only. These variables are 32 bit registers. |
| Px.*xxx* | Parameter Entry | Use the pull-down menu to select the parameter.<br>**IMPORTANT:** Not all parameters support a write using the statement command - it is more likely to have success using a Write to Parameter Command dedicated operation. However, depending on the parameter and the drive mode including state, not all parameters can be modified. |
| Arr[*] | User Data Array | There are 800 user Data Array values that can be modified. These include E-CAM points. |

### Arithmetic Operations

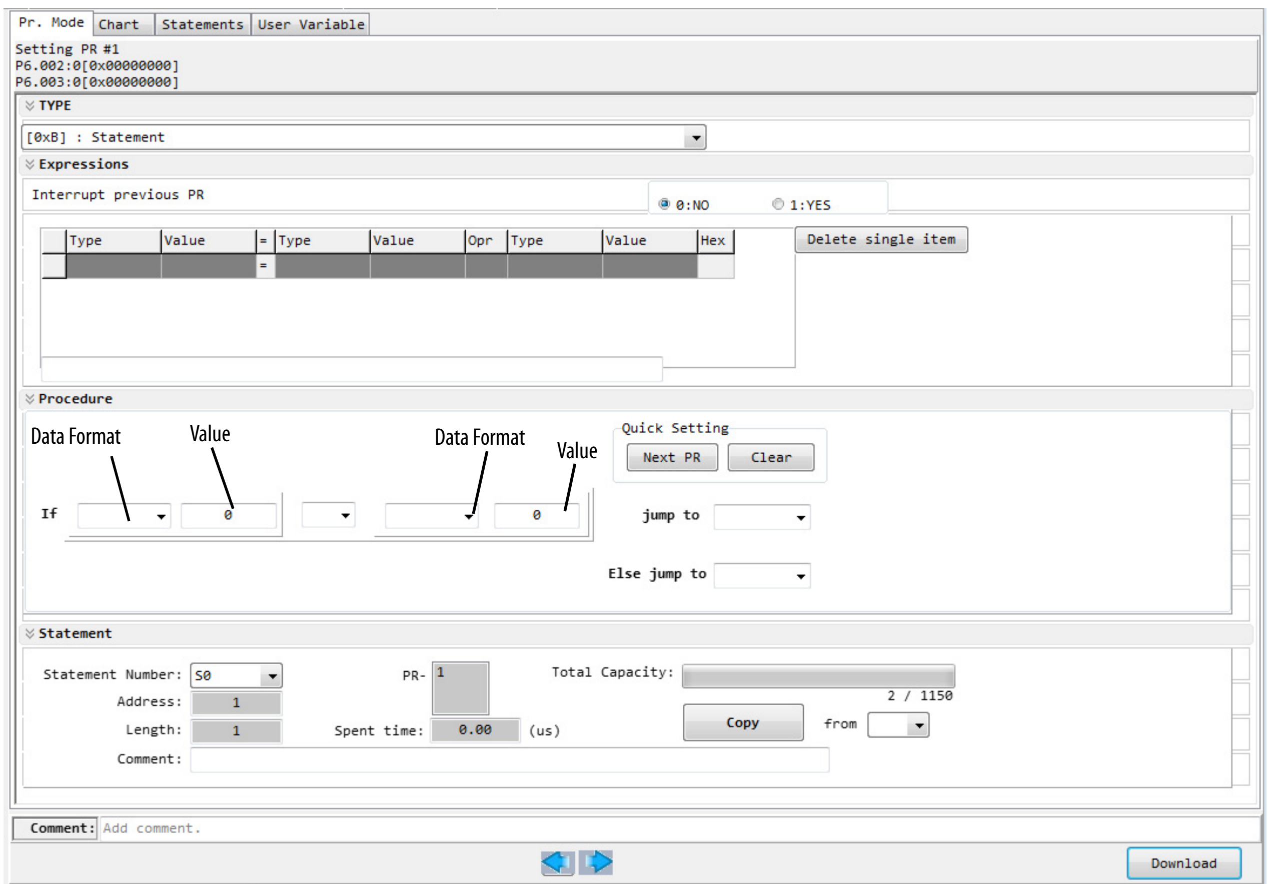
When you configure a PR command type as [0xB] Statement, you must use the Arithmetic Operations dialog box in KNX5100C software to define the commands, including addition, subtraction, multiplication, division, and logic conditions. The configuration dialog box has three sections: Expressions, Procedure, and Statement.

When in PR Mode, the Statement type allows you to define an expression, then evaluate the logical output of the PR once the Expression executes and the Procedure statement is evaluated. The Statement type only executes once and must have the Servo On signal true. The Statement type only operates within the PR programming environment. For example, if you initiate a Jog Forward command by using the Digital Input, the Statement PRs do not execute in parallel. The Statement type (like other PRs) executes once the initial PR is selected (by using Digital IO) and the Command Triggered Digital Input transitions ON.

### *Statement Type Characteristics*

- Statements are executed once (the statement does not continuously evaluate; unless a JMP statement is used)
- Statements only operate while the drive is enabled

**Figure 148 - PR Arithmetic Operations Screen**



### *Expressions Section*

This section supports addition, subtraction, multiplication, division, AND, OR, and MOD operation as well as logical operations for multiple data. Table 114 shows the supported operators and calculation data with data format in DEC and HEX.

**Table 114 - Description of Each Field in the Expressions Section**

<table>
<tr><th>Data to be Written</th><th>=</th><th>Calculation Data</th><th>Operator</th><th>Calculation Data</th></tr>
<tr><td rowspan="2">User variable (User[0...63])</td><td rowspan="5"></td><td>User variable (User[0...63])</td><td rowspan="5">Addition (+)<br>Subtraction (-)<br>Multiplication (*)<br>Division (/)<br>Obtain remainder (%)<br>And (&)<br>Or (|)</td><td rowspan="2">User variable (User[0...63])</td></tr>
<tr><td>Constant (Constant)</td></tr>
<tr><td>Parameter (PX.XXX)</td><td>Data array (Arr[0...799])</td><td>Constant (Constant)</td></tr>
<tr><td rowspan="2">Data array (Arr[0...799])</td><td>Parameter (PX.XXX)</td><td rowspan="2">Data array (Arr[0...799])</td></tr>
<tr><td>Monitoring variable (Mon[*])</td></tr>
</table>

### *Procedure Section*

This section uses the IF statement to evaluate whether the user-defined condition is fulfilled. If it is true, jump to the specified PR command pull-down setting is used. If it is false, jump to the other specified PR command pull-down setting is used. If you click Next PR in Quick Setting, the software automatically inputs the condition and then jumps to the next PR command. If you leave this section blank, then the PR procedure stops once the basic operation is done. See Table 115 for data formats and operators.

**Table 115 - Field Description for the Procedure Setting Section**

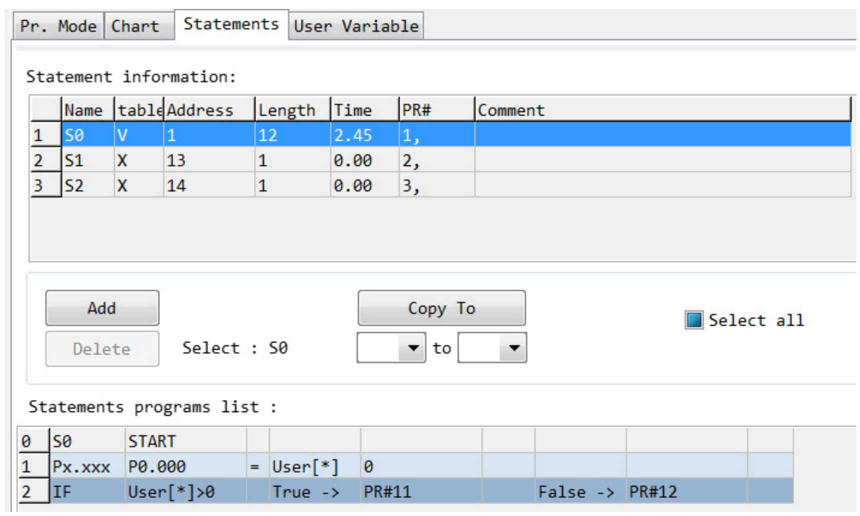
<table>
<tr><th>Data format</th><th>Operator</th><th>Data format</th></tr>
<tr><td>User variable (User[0...63])</td><td rowspan="5">Greater than (>)<br>Greater than or equal to(≥)<br>Less than (<)<br>Less than or equal to (≤)<br>Equal to (=)<br>Not equal to (≠)</td><td rowspan="2">User variable (User[0...63])</td></tr>
<tr><td>Constant (Constant)</td></tr>
<tr><td>Data array (Arr[0...799])</td><td>Constant (Constant)</td></tr>
<tr><td>Parameter (PX.XXX)</td><td rowspan="2">Data array (Arr[0...799])</td></tr>
<tr><td>Monitoring variable (Mon[*])</td></tr>
</table>

*Statements Tab Section*

This section includes existing statements and memory capacity. Statements save the data from the expression and procedure sections. Data in the expression and procedure sections of the same statement always remain identical and can be shared by multiple PR commands. If data in those two sections are different, then the data is saved to another statement. The time required to execute the statement is shown in the Spend Time field. Total Capacity shows the servo drive memory capacity. Basic operations cannot be performed if there is no memory space available.

The Statements tab is shown in Figure 149. The upper section displays all the statements and the lower section displays the operations in each statement and the values.

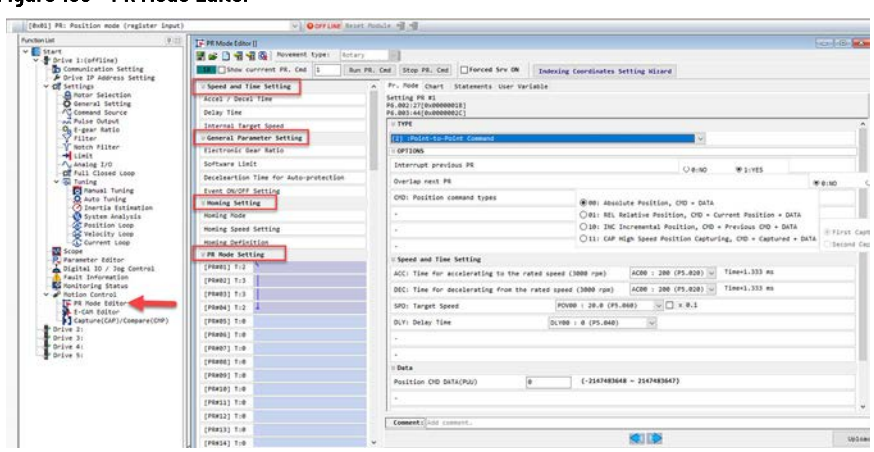
**Figure 149 - PR Procedure**




## Use the PR Mode Editor in KNX5100C Software

The PR Mode Editor is accessed by KNX5100C software:
Function List>Motion Control>Parameter Editor

**Figure 150 - PR Mode Editor**



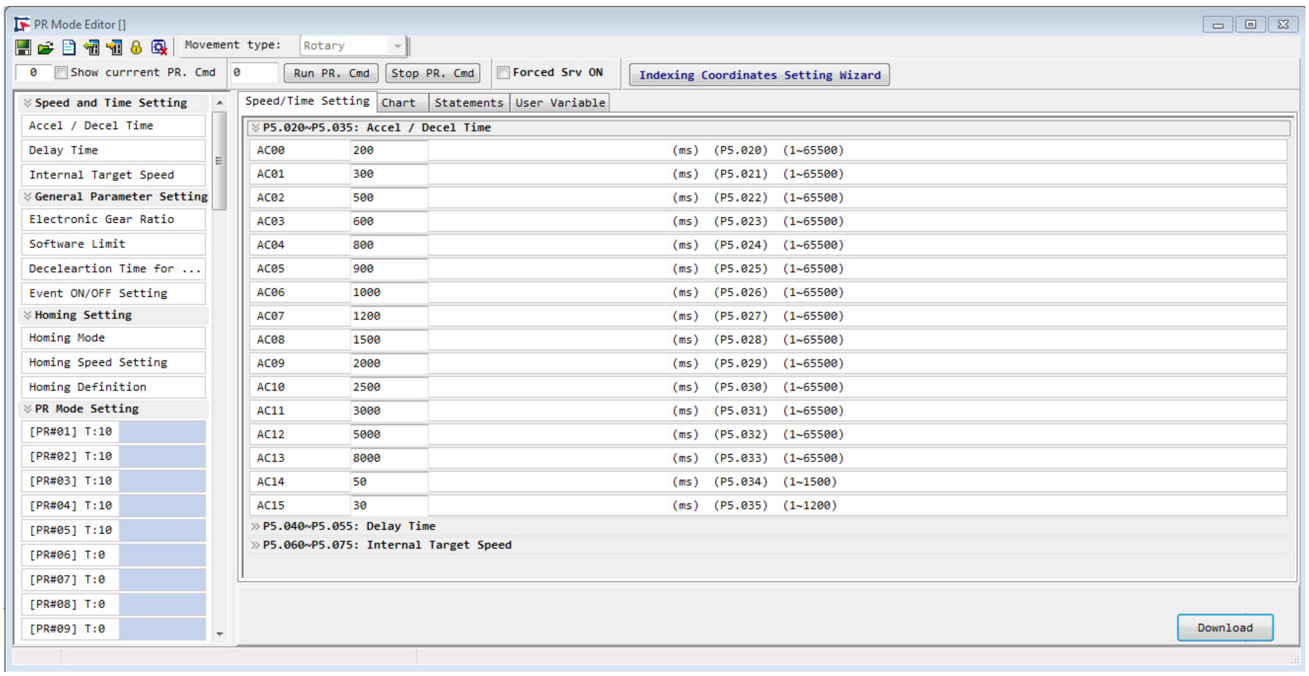
## Speed and Time Settings

You can use KNX5100C software to configure the shared PR parameters for these Speed and Time Settings:

- Accel/Decel Time (shown in Figure 151)
- Delay Time
- Internal Target Speed

There are 16 accel/decel times and 16 internal (preset) speeds. These values can be modified by using KNX5100C software from Function List>Parameter Editor>Motion or from Function List>PR Mode Editor>Speed and Time Setting. You can modify these parameters by using explicit writes via Class 3 Messages, or by using KNX5100C software.

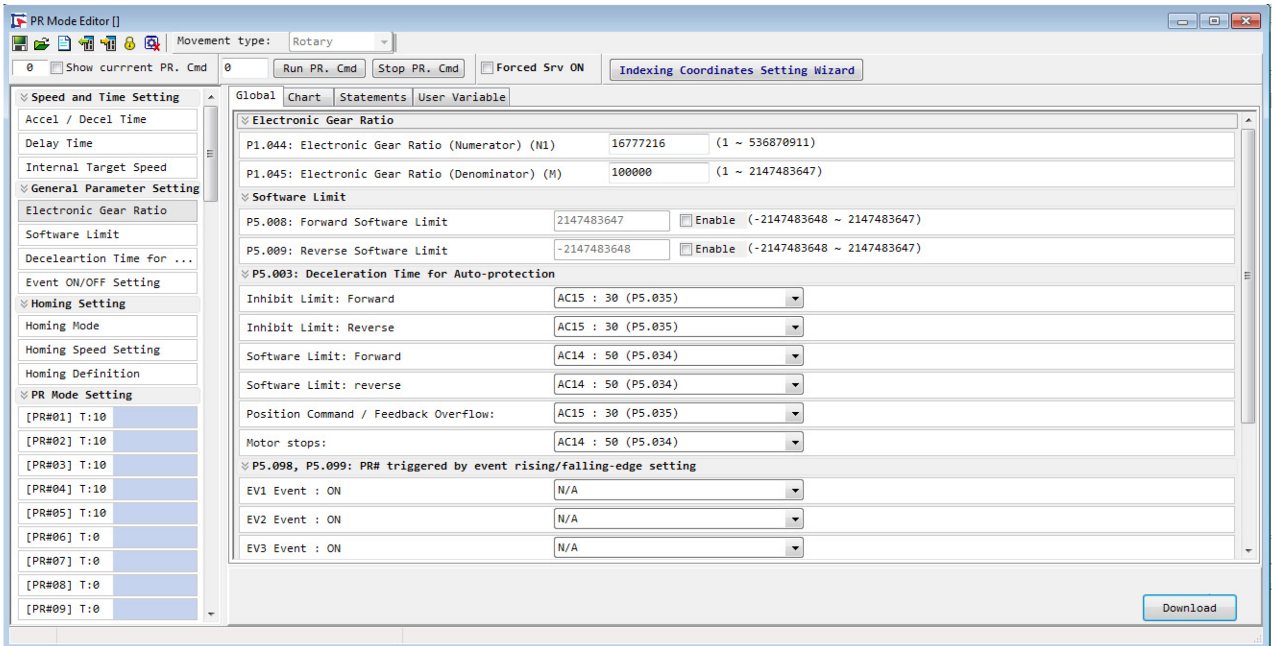
**Figure 151 - Speed/Time Setting Tab**



## General Parameter Settings

You can set the general parameters, such as electronic gear ratio, software limit, Deceleration time, and Event On/Off. See Configure Electronic Gear (E-Gear) Ratio on page 162, Configure Limits on page 170, and Event Trigger on page 349 for more information.

**Figure 152 - General Parameter Settings**



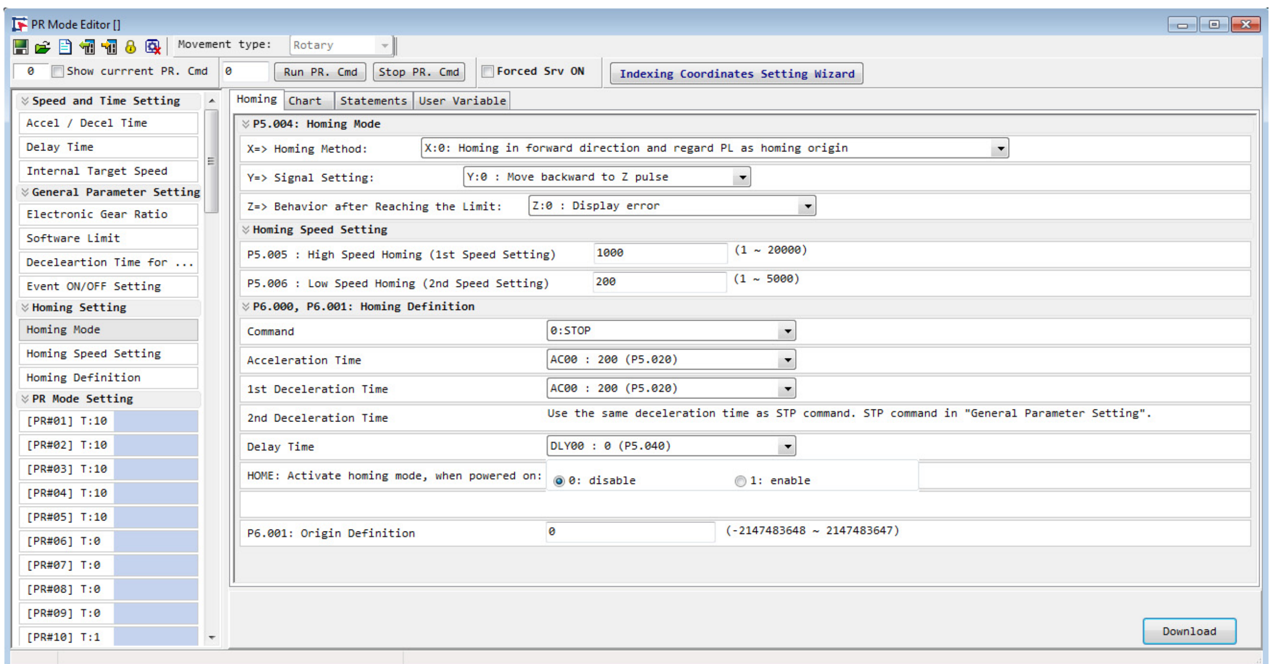
## Homing Setting

From the Homing Setting, you can configure the Homing method, speed settings, and Homing Definition parameters. See Homing on page 292 for more information on the Homing Mode and Speed Settings. The Homing Definition settings are shown:

- Command: This pull-down menu selects what the next operation is when the Homing is successfully completed.
- Acceleration/Deceleration/Delay: The pull-down menu selections for accel/decel/delay times that are used with the Homing Method timing diagrams are chosen in the Homing Definition section.
- Home: You can enable the Homing Operation on power-up. When this option is enabled, the drive power is cycled and the motor is enabled, the homing sequence begins.

> The homing operation is also PR#00. This is not changeable and is selectable in PR Mode when choosing a PR to execute.

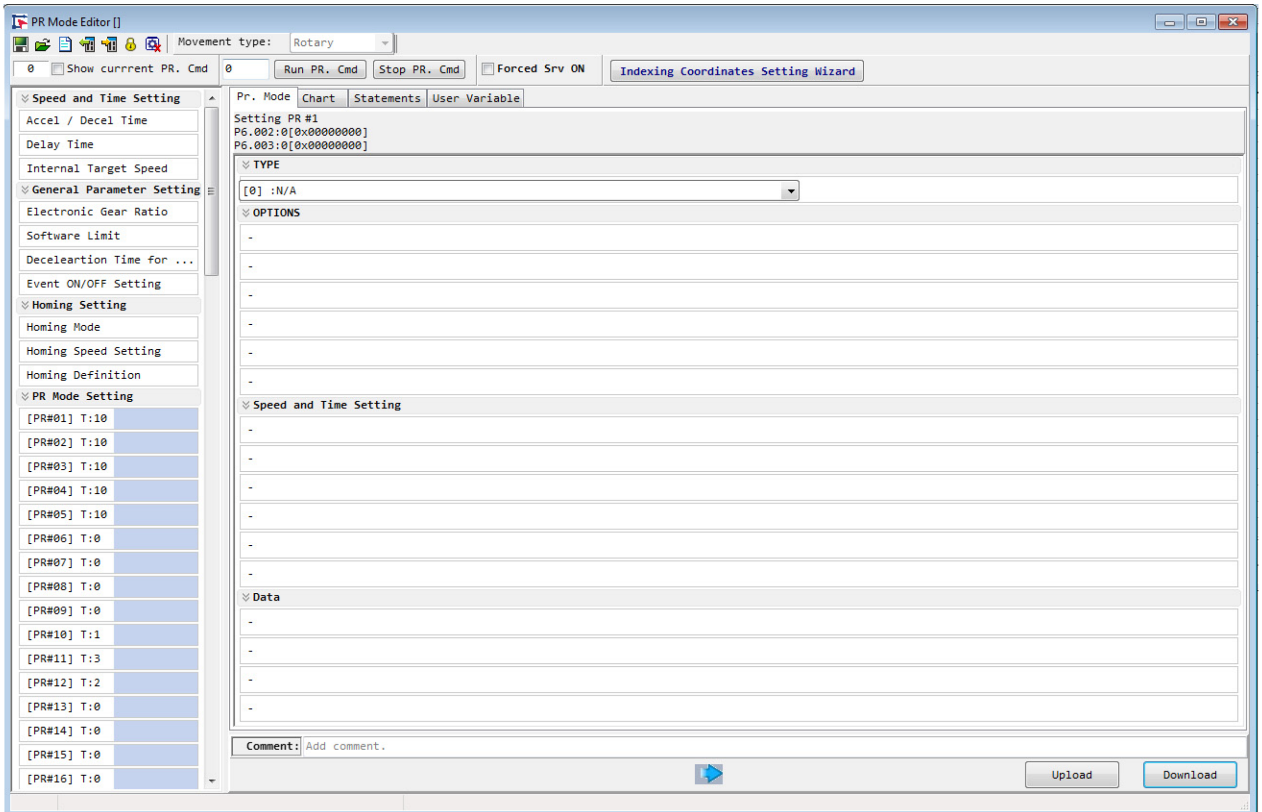
**Figure 153 - Homing Tab**



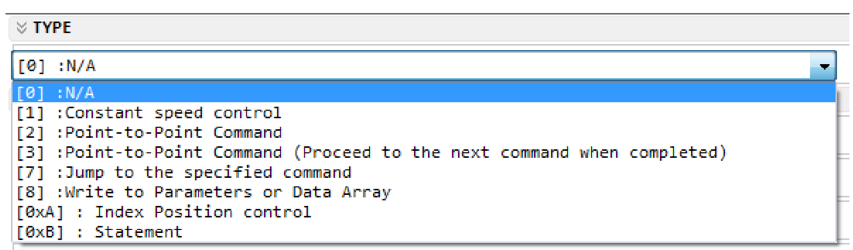
## PR Mode Setting

From the PR Mode Setting, you can configure the PR commands.

**Figure 154 - PR Mode Tab**




The Type pull-down menu lets you select the PR command type and corresponds to the X value in the PRCmdXSetting parameters, for example parameter PRCmd1Setting ID399 (P6.002).



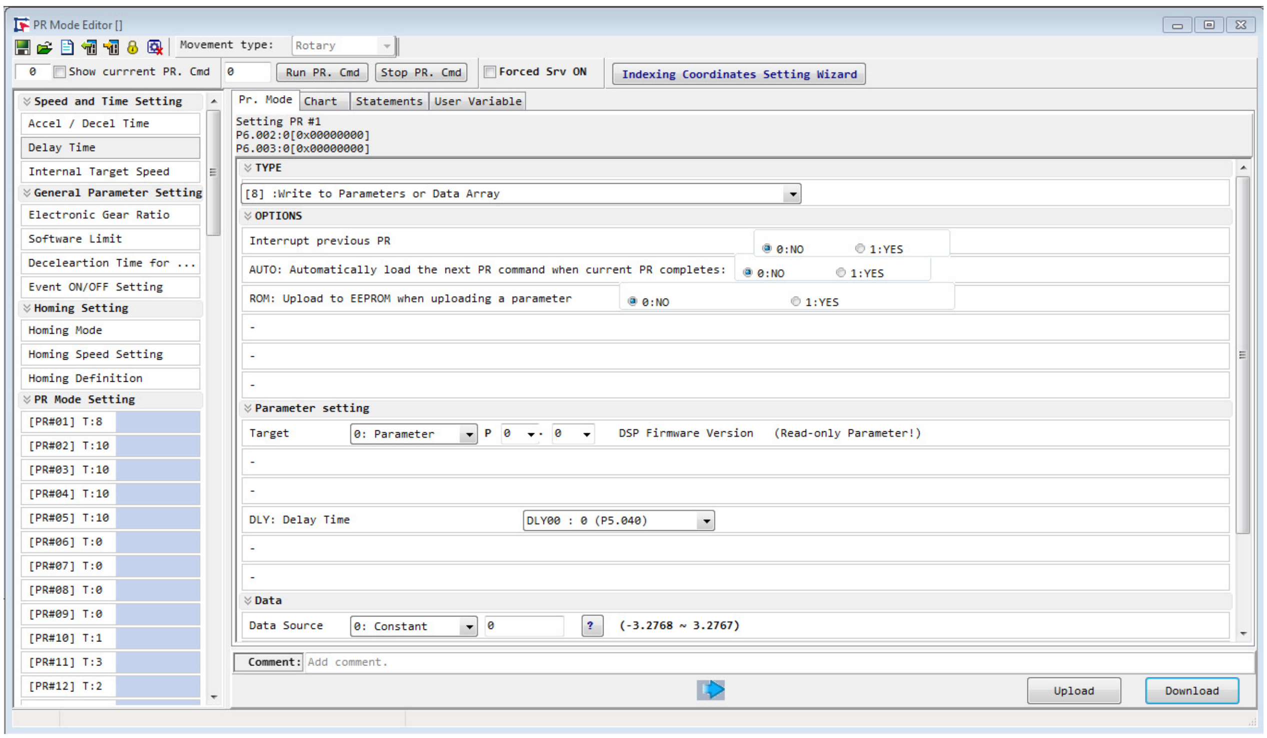

| X:TYPE, Command Type |
|---|
| 1: Constant speed control |
| 2: Point-to-point command |
| 3: Point-to-point command (Proceed to the next command when completed) |
| 7: Jump to the specified PR command |
| 8: Write to parameter or Data Array. |
| A: Index position control |
| B: Statement / arithmetic operation |

Each command type, except for (B) Arithmetic/Statement, lets you configure the Options and the Speed and Time Setting for the PR command. The options differ depending on the command type. These settings correspond to the Y, A, U, A, B, and C values of the PRCmdXSetting parameters, for example parameter PRCmd1Setting ID399 (P6.002).

See PR Mode Definitions on page 282 for more information.

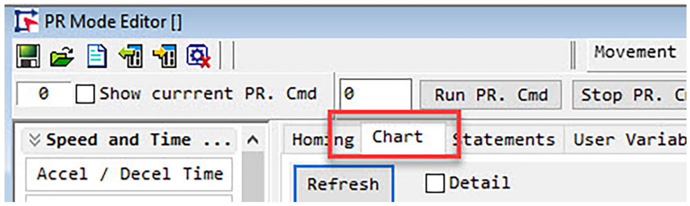
- Jump to the specified command (7) - This command type lets you create looping program sequences where you can jump to specific PR# values. See Jump Command on page 323 for more information.
- Write to Parameter or Data Array (8) - This command type lets you write a specific parameter or data array value. See Write Command on page 325 for more information.

**Figure 155 - PR Command Settings**



# Display of PR Procedure in KNX5100C Software

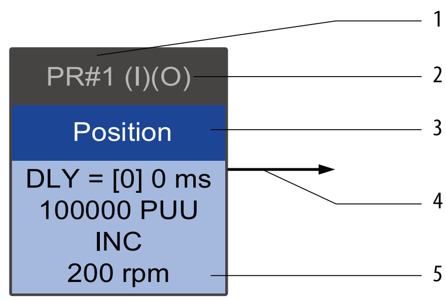
This section describes how the software displays information related to each of the seven types of PR Mode commands. This display is on the Chart tab of the PR Mode Editor in KNX5100C software. To help you understand how PR procedure works, the configuration software presents the execution order and calling sequence of all PR procedures.




## Parts of the PR Display

The PR display includes five parts: number, execution property, command type, next PR command, and command data.

Figure 156 - PR Display




1. Number: the PR number, ranging from PR#0…PR#99 (100 sets of PR commands).
2. Execution property: (B) Execute homing when power on; (O) Command overlap; (R) write data to EEPROM; (I) command interrupt.
3. Command type: there are six types of PR commands: homing, speed, position, writing, jumping, and arithmetic operations. The color displayed in this section depends on the command type.
4. Next PR command: if followed by a PR command, the arrow points to the specified PR command.
5. Command information: displays the details of this PR command. The color depends on the information types.

## Homing PR Display

In the display of homing methods, PR#0 always signifies the homing procedure, which is identified or indicated as 'Homing'. See Figure 157.

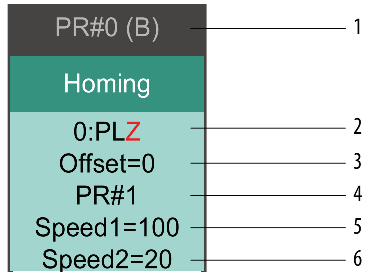



**Figure 157 - Homing Methods Display**

1. Command execution type: to execute homing when the drive is in Servo On state, it displays (B); if homing is not required, then no information is displayed.
2. Method selection: homing methods and Z pulse setting are shown in the table below. Characters with red text (see Figure 157) indicate which 'method' is used to set the Home Position. For example, if a Z pulse is used, the Z is used to set the Home Position, so the Z is in red text. If there is no marker pulse used and the ORG transition is used to set the Home Position then ORG is in red text.
   - F signifies running forward
   - R signifies running in reverse
   - ORG signifies using the Home Origin DI
   - CUR signifies using the present position as home
   - BUMP represents the collision point (Home to Torque)

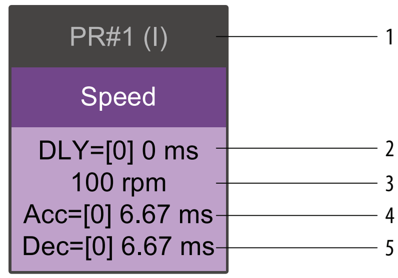
| Homing methods | Displayed text (using a marker pulse, Z) | Displayed text, not using a marker pulse (Z) |
|---|---|---|
| X = 0: homing in forward direction with PL as the homing origin | 0: PLZ | 0: PL |
| X = 1: homing in reverse direction with NL as the homing origin | 1: NLZ | 1: NL |
| X = 2: homing in forward direction with ORG (when it switches from off to on state) as the homing origin | 2: F_ORGZ | 2: F_ORG |
| X = 3: homing in reverse direction with ORG (when it switches from off to on state) as the homing origin | 3: R_ORGZ | 3: R_ORG |
| X = 4: look for the Z pulse in forward direction with it as the homing origin | 4: F_Z | |
| X = 5: look for the Z pulse in reverse direction with it as the homing origin | 5: R_Z | |
| X = 6: homing in forward direction with ORG (when it switches from on to off state) as the homing origin | 6: F_ORGZ | 6: F_ORG |
| X = 7: homing in reverse direction with ORG (when it switches from on to off state) as the homing origin | 7: R_ORGZ | 7: R_ORG |
| X = 8: use the current point as the origin | 8: CUR | |
| X = 9: look for collision point in forward direction and use it as the origin | 9: F_BUMPZ | 9: F_BUMP |
| X = A: look for collision point in reverse direction and use it as the origin | A: R_BUMPZ | A: R_BUMP |

3. Offset: origin offset, ID398 (P6.001)
4. Command: next PR command to be executed after homing
5. Homing at high speed: first homing speed, ID298 (P5.005) HomingSpeed.
6. Homing at low speed: second homing speed, ID299 (P5.006) HomingCreepSpeed.

## Speed Command PR Display

You can use the Speed command in any PR command (PR#1…PR#99). It is identified or indicated as "Speed". See Figure 158.

**Figure 158 - Speed Command Display**

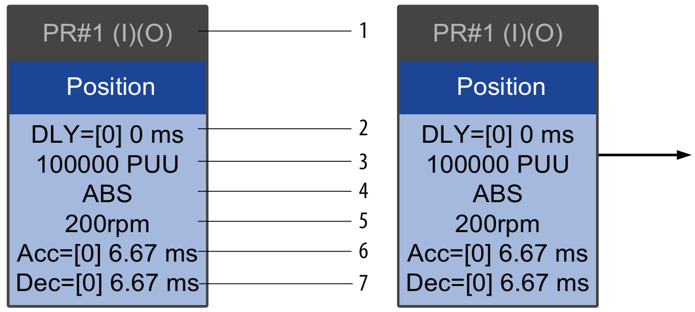



1. Command execution type: a Speed command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2. Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller; the servo drive starts counting the delay time once it reaches the target speed.
3. Target speed: the set target speed.
4. Acceleration time (ACC): determined by shared PR parameters; length of time to reach the 3000 rpm speed from stopped.
5. Deceleration time (DEC): determined by shared PR parameters; length of time to decelerate from 3000 rpm speed to stopped.

## Position Command PR Display

You can use the Position command in any PR command (PR#1...PR#99). It is marked as 'Position', and includes the options to 'Stop once position control completed' and 'Load the next command once position control completed'. The only difference is that 'Load the next command once position control completed' shows an arrow pointing to the next PR. See Figure 159 and the PR command to the right.

**Figure 159 - Position Command Display**

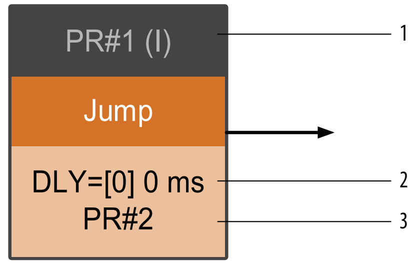



1. Command execution type: a Position command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. The Position command can overlap (OVLP) the next PR command. If delay time is set to 0 when this function is enabled, it displays (O). If the Overlap function is not used, no information is displayed.
2. Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller. The servo drive starts counting the delay time once it reaches the target position.
3. Target position: the set target position.
4. Position command type: 'ABS' means an absolute positioning command; 'REL' means relative positioning; "INC" means incremental positioning; 'CAP' means high speed position capture.
5. Target speed: determined by shared PR parameters.
6. Acceleration time (ACC): determined by shared PR parameters; the length of time to reach the 3000 rpm speed from stopped.
7. Deceleration time (DEC): determined by shared PR parameters; the length of time to decelerate from 3000 rpm speed to stopped.

## Jump Command PR Display

You can use the Jump command in any PR command (PR#1...PR#99). It is identified or indicated as 'Jump' and followed by an arrow pointing to the next PR command. See Figure 160.

**Figure 160 - Jump Command Display**

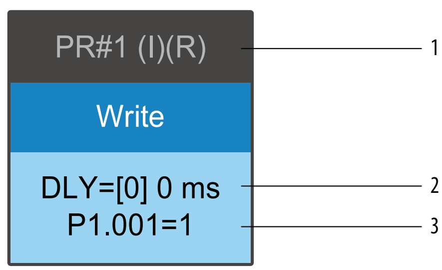



1. Command execution type: the Jump command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2. Delay time (DLY): determined by shared PR parameters.
3. Target PR number: the target PR number.

## Write Command PR Display

You can use the Write command in any PR command (PR#1 - PR#99). It is identified or indicated as 'Write'. See Figure 161.

**Figure 161 - Write Command Display**



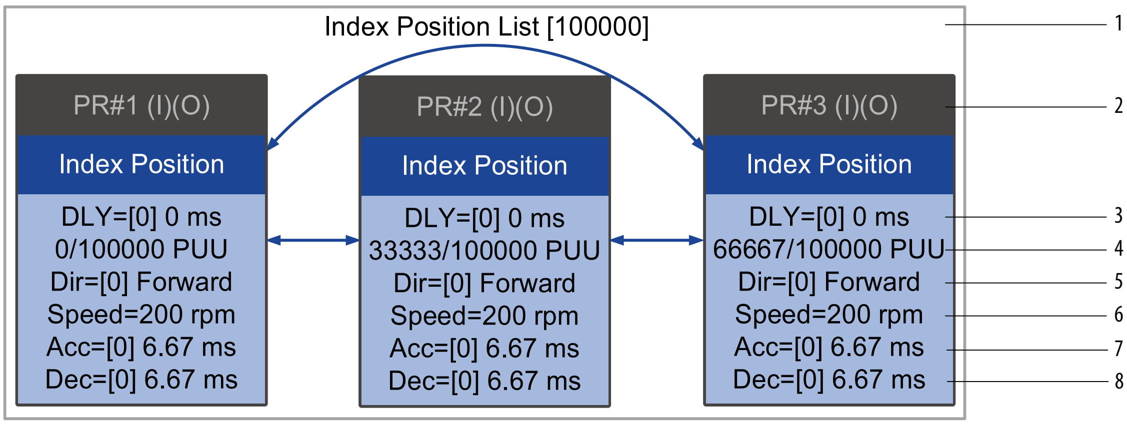

1. Command execution type: a write command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. You can determine whether to write the data to EEPROM. If writing data to EEPROM is required, it shows (R); if not, no information is displayed.
2. Delay time (DLY): determined by shared PR parameters.
3. Writing target and data source: the corresponding target and data sources are shown in the table below. Note that constants can be written in DEC or HEX format.

| Writing Target | Data Source |
|---|---|
| Parameter (P*X.XXX*) | Constant |
| Data array (Arr[#]) | Parameter (P*X.XXX*) |
| - | Data array (Arr[#]) |
| - | Monitoring variable (Mon[#]) |

## Index Position Command PR Display

You can use the Indexing Position command in any PR command (PR#1…PR#99). The number of PR commands is determined by the index number. It is identified or indicated as "Index Position". See Figure 162.

Figure 162 - Indexing Position Command Display

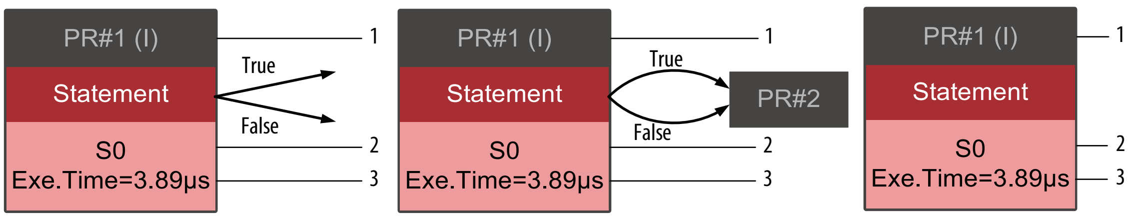



1. Indexing Position command section: the number of the index position. It shows the total moving distance at the top using double arrows to show that the motor can run reciprocally between each target position in each PR command.
2. Command execution type: a position command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I). If not, no information is displayed. The Position command can overlap (OVLP) the next PR command. If delay time is set to 0 when this function is enabled, it displays (O). If the Overlap function is not used, no information is displayed.
3. Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller. The servo drive starts counting the delay time once it reaches the target position.
4. Position command: the numerator is the position of this PR command; the denominator is the total moving distance of this indexing Position command, which is set by ID234 (P2.052) IndexingCoordinatesScale.
5. Rotation direction (Dir): available options are Forward (always move forward), Reverse (always move in reverse direction), and the shortest distance.
6. Target speed: determined by shared PR parameters.
7. Acceleration time (ACC): determined by shared PR parameters; the length of time to reach the 3000 rpm speed from stopped. See Shared PR Parameters on page 287.
8. Deceleration time (DEC): determined by shared PR parameters; the length of time to decelerate from 3000 rpm speed to stopped. See Shared PR Parameters on page 287.

### Arithmetic Operation PR Display

You can use arithmetic operations and statements in any PR command (PR#1...PR#99). It is identified or indicated as 'Statement'. When the condition is fulfilled, an arrow pointing to the next PR command appears with a solid line. If the condition is unfulfilled, an arrow pointing to the next PR appears with a dotted line. You can choose to execute the next PR command and stop once the execution is completed. See Figure 163.

**Figure 163 - Arithmetic Operation Display**




1. Command execution type: an arithmetic operation command can interrupt (INS) the previous PR command. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2. Statement number: displays the statement number used in the PR command.
3. Execution time (Exe.Time): the time required to execute the arithmetic operation.

## Trigger Methods for PR Commands

This section describes the four triggering methods for PR commands.

### Digital Input (DI) Trigger

When you use PR Operation Mode, you can choose the PR command to be executed by using Digital Inputs with a binary weighted equivalent values (Register Position command Selection - Bit 0...Bit 6). Use DI Command Triggered [0x08] to initiate the selected PR command.

See Description of Digital Input Functions on page 425 for more information.

This can also be set in the Digital I/O and Jog Function dialog box in KNX5100C software, as shown in Figure 164.

Figure 164 - I/O Setting Screen

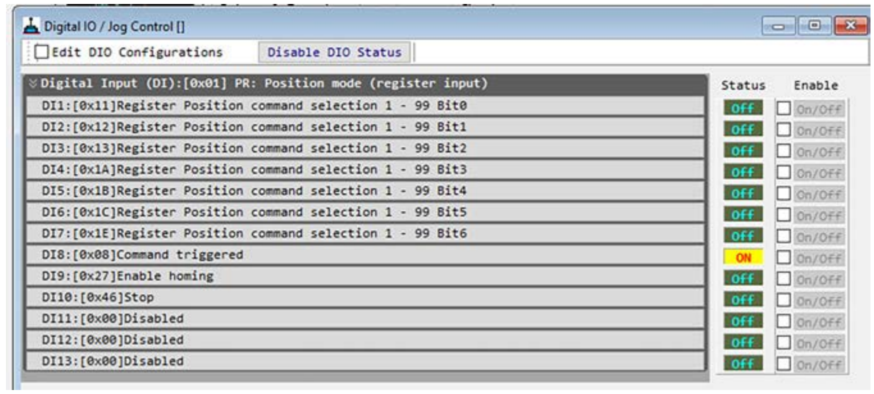



Table 116 - Use DI to Generate the Binary Weighted PR Command to be Triggered

| Position Command | DI 6 | DI 5 | DI 4 | DI 3 | DI 2 | DI 1 | DI 0 | Parameter |
|---|---|---|---|---|---|---|---|---|
| **Homing** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | HomeSetting ID397 (P6.000<br>HomePosition ID398 (P6.001) |
| **PR#1** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | PRCmd1Setting ID399 (P6.002)<br>PRCmdData ID400 (P6.003) |
| **...** | | | | | | | | |
| **PR#49** | 0 | 1 | 1 | 0 | 0 | 0 | 1 | PRCmd49Setting ID495 (P6.098)<br>PRCmd49Data ID496 (P6.099) |
| **PR#50** | 0 | 1 | 1 | 0 | 0 | 1 | 0 | PRCmd50Setting ID497 (P7.000)<br>PRCmd50Data ID498 (P7.001) |
| **...** | | | | | | | | |
| **PR#99** | 1 | 1 | 0 | 0 | 0 | 1 | 1 | PRCmd99Setting ID595 (P7.098)<br>PRCmd99Data ID596 (P7.099) |

Once the DI combination is set, toggle DI - Command Triggered to execute the PR selection (shown in Figure 164).

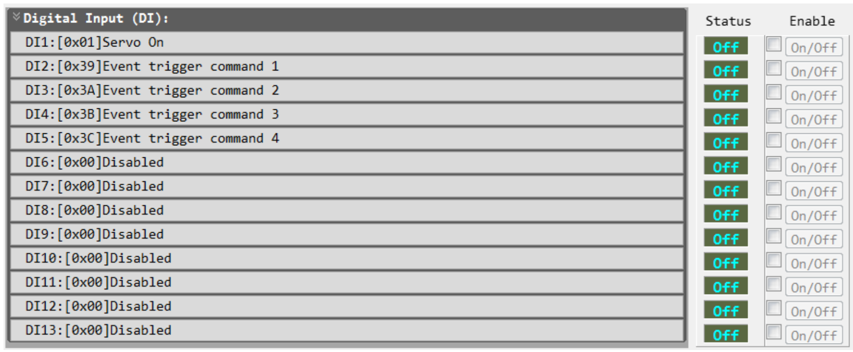
In addition, there are two sets of DI for special functions, DI. Enable homing [0x27] (shown in Figure 164) return to homing origin and DI. Stop [0x46] (shown in Figure 164), used to stop the motor. When DI Enable Homing is triggered, the homing operation executes. When Stop is executed, any currently executing PR and motor movement is stopped.

See Digital I/O and Jog Function in KNX5100C Software on page 177 for more information on configuring the Digital I/O.

## Event Trigger

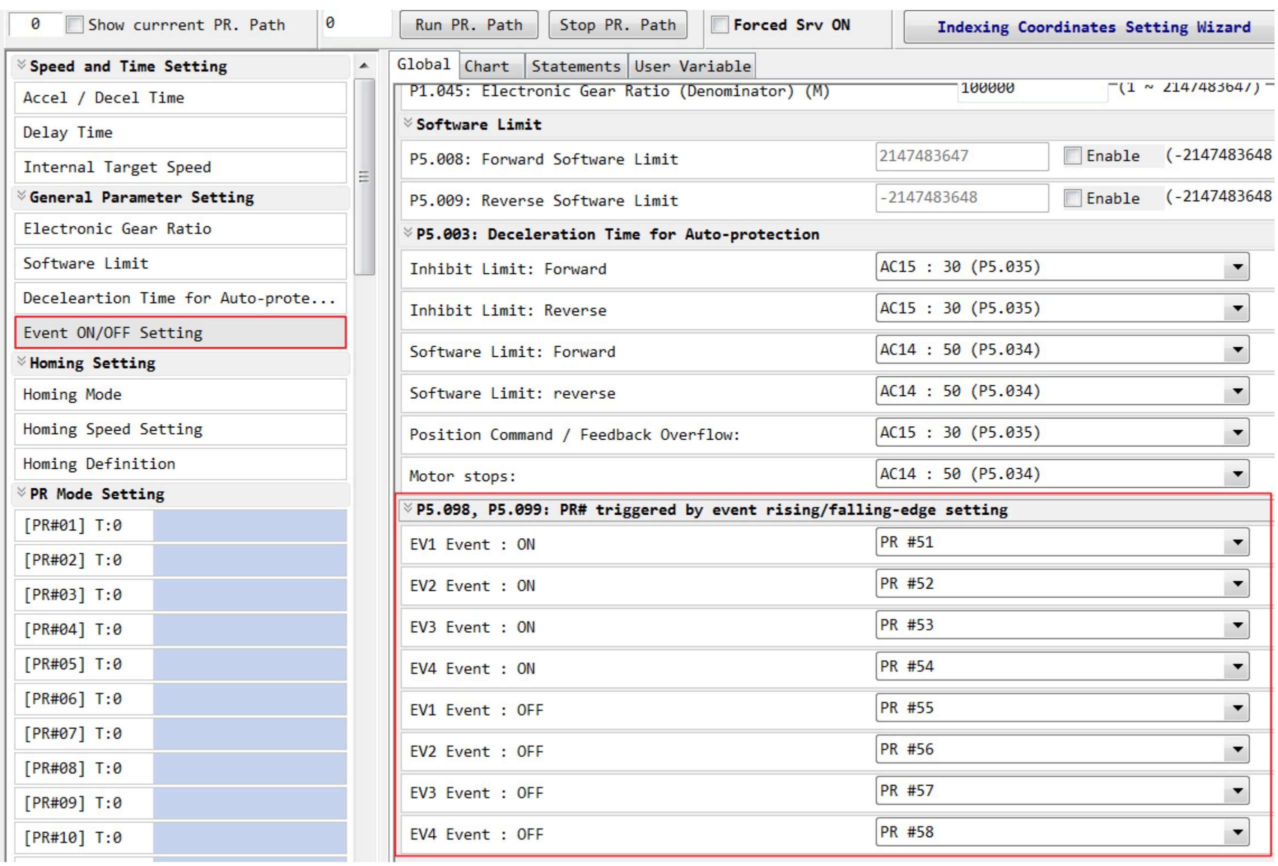
There are four event trigger commands that use Digital Inputs (DI.Event Trigger Command 1…4) that can be set to execute a PR#. Valid PR numbers are from PR#51…PR#63. The association for the PR to execute is configured in KNX5100C software (Function List>Motion Control>PR Mode Editor>General Parameter Setting). The edge transition of DI.Event Trigger Command executes the associated PR#. This method is a way of using the 'interrupt' condition in the Positioning mode.

**Figure 165 - I/O Setting Screen**




Notice the Events can be triggered with the ON transition or the OFF transition. Different PR#s can be triggered for different conditions.

**Figure 166 - Event Setting for Event Trigger**



## Use PR Command Trigger ID300 (P5.007)

This method is executed when an Ethernet/IP explicit write operations are performed with the drive, and you use PRCmdTrigger parameter ID300 (P5.007), you can specify which PR# is executed when you set the Command Triggered DI signal.

- If you write 0 to the PRCmdTrigger register, the servo drive executes homing.
- If you write 1…99 to PRCmdTrigger register, the servo drive executes the specified PR command (1…99).
- If you write 1000, the servo drive stops executing PR commands and stops motor movement, which is the same as using the DI.Stop.
- Values 100…999 are not valid.

| Explicit Write Data Value<br>PRCmdTrigger ID300 (P5.007) | Action Taken by the Drive |
|---|---|
| 0 | Servo executes the configured Homing Mode |
| 1…99 | Executes the specified PR configured in the drive |
| 1000 | The drive terminates the executing PR command and stops the motor movement |
| 100…999 | Invalid |

| Explicit Read Execution Point | Drive/Motor Execution | Returned Value in ID300 (P5.007) |
|---|---|---|
| During the beginning of the command - before motion starts | Drive is processing the command, motor has not started movement | PR# that is specified in the drive. |
| While the command is complete and the motor is moving but not reached its target position | Motor is moving, but has not reached the target position | PR# that is specified + 10,000 |
| While the command is complete and the motor has reached its target position | Motor is finished moving and reached the target position | PR# that is specified + 20,000 |

Using ID300 (P5.007) is useful to monitor the status of the PR# operation within the drive from an external controller.

## Use IO Mode and Add-On Instruction

When the drive is configured for IO Operating mode, a pre-entered PR# can be executed by using raC_*xxx*_K5100_MAI (Motion Axis Index) Add-On-Instruction.

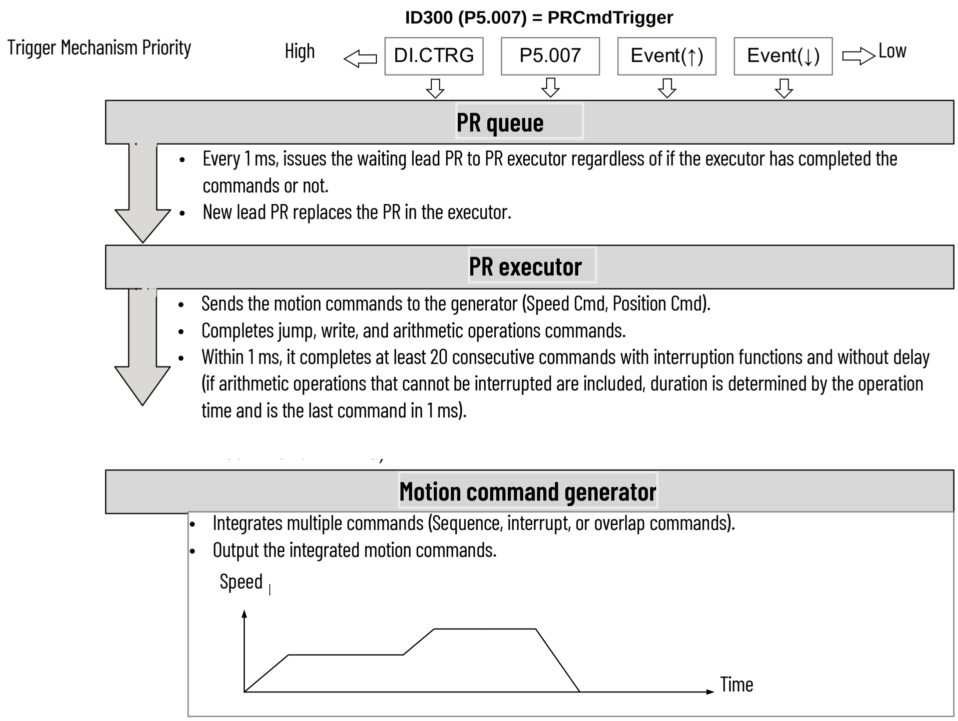
Because the Motion Axis Index Add-On Instruction uses a previously configured PR, you cannot have an active Ethernet/IP network connection when you are configuring the PR commands. The simplest way to configure your PR commands is to use the KNX5100C software.

Once the PR Commands are configured, they cannot be changed when the I/O connection is established. You can use this method when one of the pre-defined Motion Operation Add-On-Instructions cannot meet your requirements. For example, you can use this method to trigger a PR that writes a parameter to the drive.

## PR Execution Process

The drive updates the command status every 1 ms. Figure 167 illustrates the PR procedure execution flow and how the servo drive deals with PR commands. Once a PR procedure is triggered, it goes through three internal processing units, which are PR queue, PR executor, and motion command generator.

**Figure 167 - PR Arrangement Procedure of the Drive**




### *Trigger Mechanism Priority*

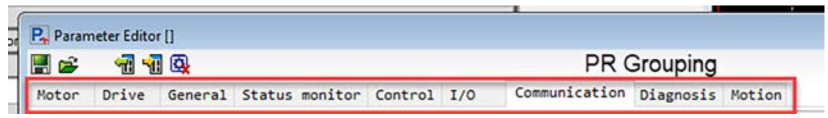
The priority for the triggering methods is the following:

- (1) DI trigger (DI.Command Triggered)
- (2) Explicit Write, PRCmdTrigger parameter ID300 (P5.007)
- (3) DI.Event Trigger 1…4
- (4) Explicit Write, EventRisingEdgePRNumber parameter ID386 (P5.098), EventFallingEdgePRNumber parameter ID387 (P5.099)

A PR is executed as long as a trigger signal is received. When two different trigger methods are used for one PR procedure within the same ms, commands with higher priority are executed first. If multiple trigger commands are generated at the same time (within 1 ms), the last command is not sent to the PR queue.

*PR Queue*

The triggered PR command is the lead PR. The PR and its container Group are organized and prepared to be sent to the PR Executor. In each ms, regardless of another PR being queued, the servo drive sends the lead PR and its PR group to the PR executor. Therefore, as long as a PR command is triggered, the PR queue collects the command and sends the command to the executor.




*PR Executor*

Once the PR executor receives the lead PR, the PR group in execution is replaced immediately. If a PR group includes motion commands, such as speed commands and position commands, the PR executor sends them to the Motion Command Generator. If the lead PR contains write or jump commands, they are completed immediately when the PR executor processes the lead PR. These commands do not enter the Motion Command Generator. Any arithmetic based operations (Statement commands) are executed immediately when entering PR executor. Depending on the expression, the execution times vary and these commands cannot be interrupted until they are completed.

The PR executor can consecutively complete a minimum of 20 PR commands with interrupt commands (INS) and without a delay time setting within 1 ms.

If there is a PR command that hasn't been completed within 1 ms and a new PR group has been sent to the executor by the queue, the new PR group then replaces the previous one.

*Motion Command Generator*

Motion commands include speed and position types. The PR executor sends this command type to the Motion Command Generator. This generator has a buffer for creating the motion profile. This generator includes the capability to modify the existing cycle profile (overlap, interrupt, and Proceed to next). Motion commands can be executed as soon as they enter the generator. If other motion commands (that are merge capable) enter the generator, it is integrated with the existing command in the generator. This integration is based on the PR settings.

## Sequence Command Execution

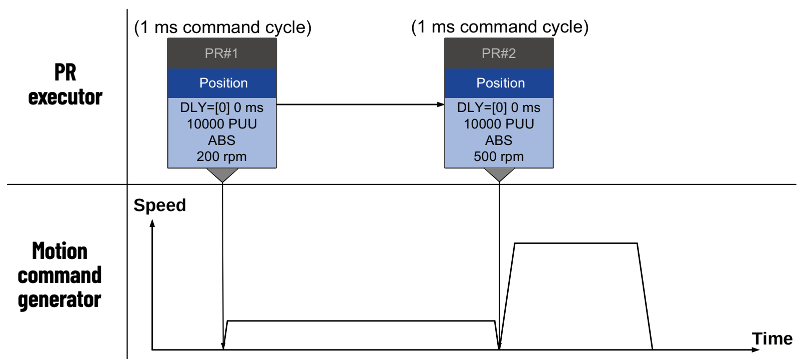
Commands that you can configure are position and speed commands. A sequence command is a motion command without an overlap or interrupt function. When you use position commands, the Delay Time begins timing when the target position is reached. When you use speed commands, the Delay Time begins timing after the target speed is reached.

### Consecutive Position Commands

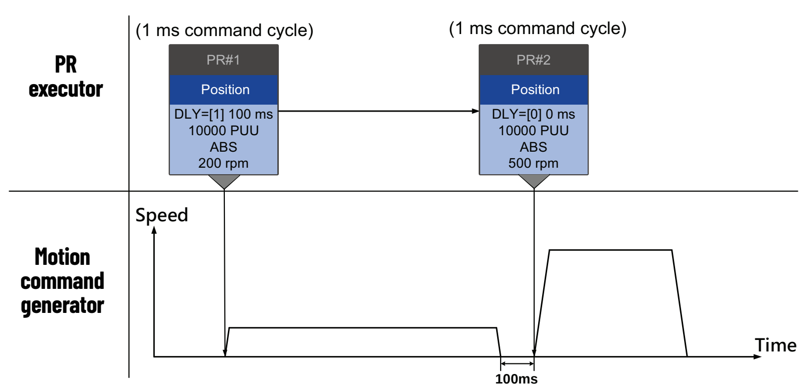
When the PR executor receives two position commands consecutively, and they are not set with interrupt or overlap functions, the PR executor sends this lead PR to the motion command generator. The profile generator creates the cycle profile from this lead PR command. After the lead PR completes, if no delay time is set, the PR executor sends the second PR (which now becomes the lead PR) to the motion generator and the cycle profile is made for the second position command.

If the first position command uses DLY (Delay Time), the PR executor starts the DLY timing when the motor reaches the target position. When the DLY expires, the second position command is executed as described earlier and shown in Figure 168.

**Figure 168 - Position Command**




**Command without Delay**



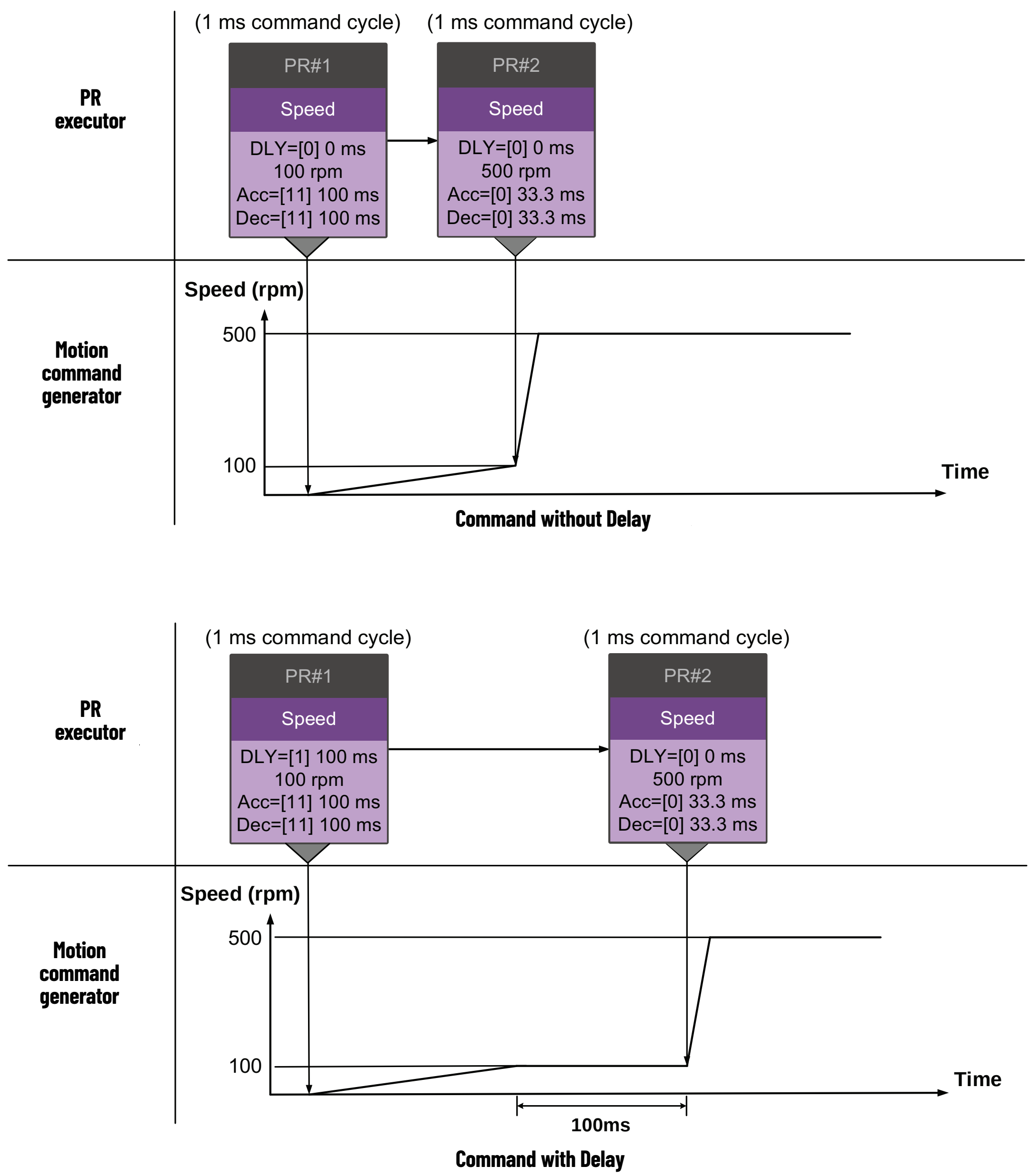

**Command with Delay**

*Consecutive Speed Commands*

When the PR executor receives two speed commands consecutively, and they are not set with interrupt or overlap functions, the PR executor sends this lead PR command to the motion command generator. The generator creates the cycle profile for this speed command. When this lead PR command completes (either by delay or interrupt), the second PR speed command is sent to the motion command generator and the cycle profile is created using the second command (which now becomes the lead PR).

If the first speed command is used with a DLY (Delay Time), the DLY begins timing once the motor reaches the target speed. When the DLY expires, the second speed command is executed as described earlier and shown in Figure 169.

**Figure 169 - Speed Command**



*Multiple Commands*

This section shows how multiple commands are processed by the drive, as shown in Figure 170.

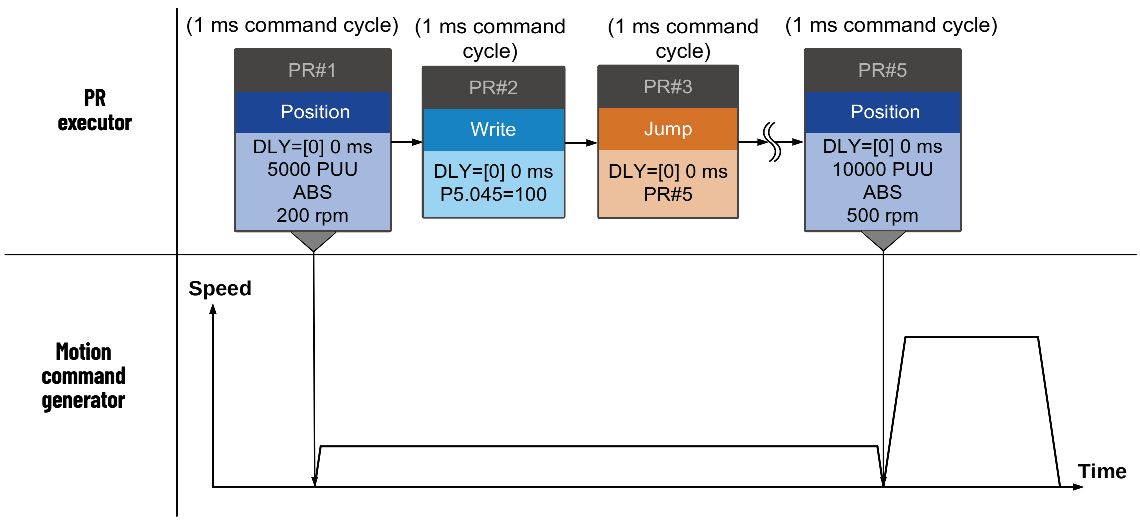
In the first ms, after a command is triggered, the PR queue sends a position command to the PR executor. The PR executor receives a position command and sends this command to the motion command generator, then the cycle profile is generated.

In the second ms, the PR executor receives a write command and executes it immediately.

In the third ms, the PR executor receives a jump command and executes it right away. These two commands are not sent to the motion command generator; the PR executor and the motion command generator can execute commands independently.

In the fourth ms, the PR executor receives a position command.

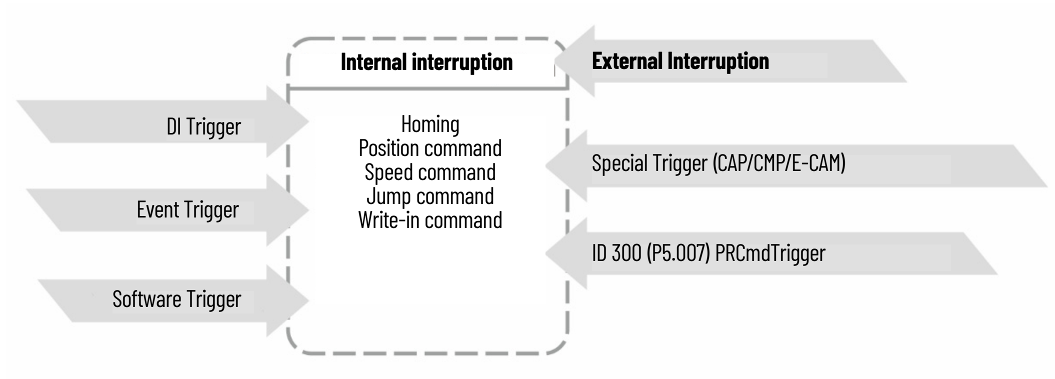
**Figure 170 - Sequence Command - Multiple Commands**



## Command Interrupts Execution

Interruption (INS) is an action that results in a change with the motion command (and the cycle profile). The current motion command is interrupted with the second motion command. Results of the interruption differ based on the command types. There are two types of interruption: internal and external, as shown in Figure 171.

Figure 171 - Internal and External Interruption




### *Internal Interrupts*

With a typical sequence of PR commands that use Auto (Auto execute the next command), the system processes the next command when the current command is completed.

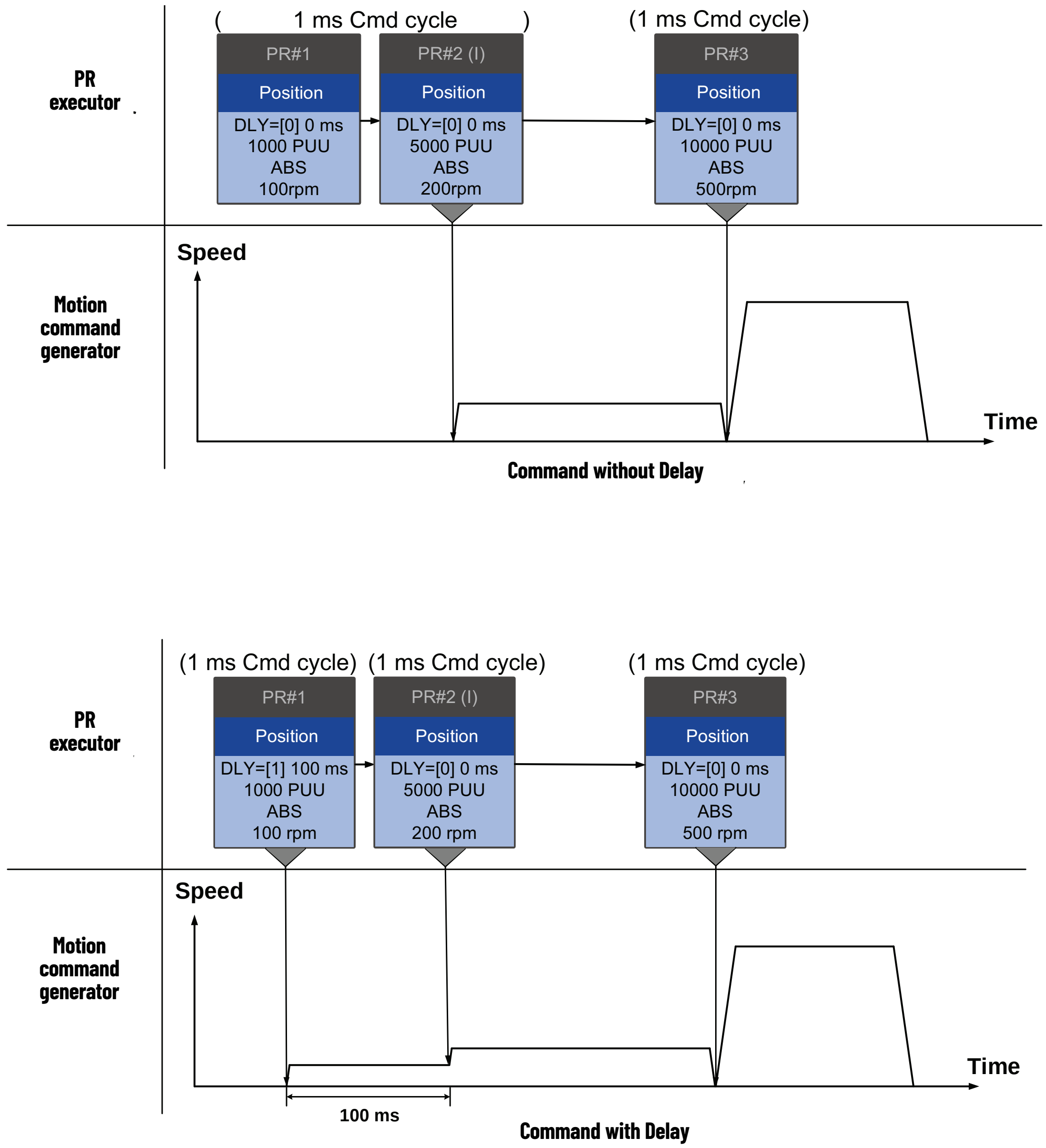
However, if the next command is of the type shown for an internal interrupt (shown in Figure 172), the drive processes this command immediately. For example, a Point to point PR is considered an internal interrupt. If Interrupt Previous PR is selected with this PR command, the drive immediately changes the executing cycle profile to reflect this new PR command

### *Position Commands*

See Figure 172 to use these two examples.

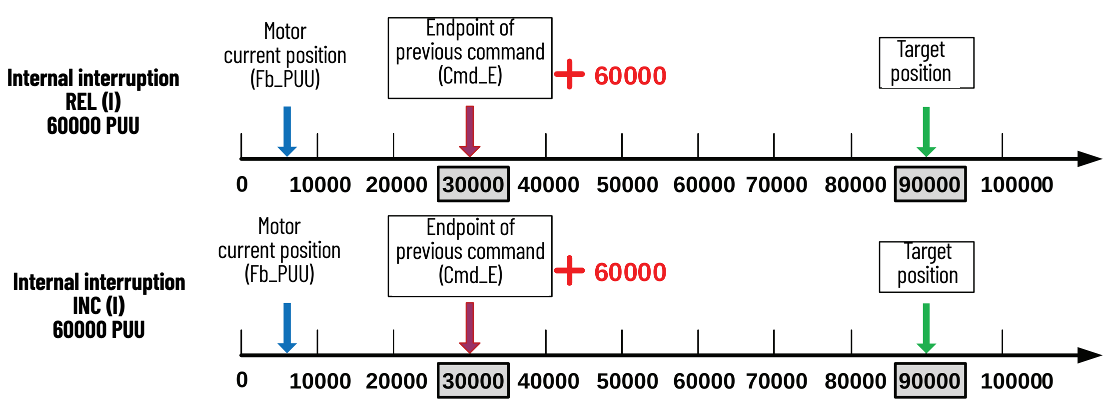
- Example 1: When the PR executor receives three consecutive position commands with the second command using the interrupt setting (PR#01 -> PR#02 (I)->PR#03), the PR executor treats the PR#01 and PR#02 as one command. Because both the PR commands occurred in the same 1 ms cycle, and there is no DLY used, the PR executor replaces PR#01 with PR#02. It sends the second PR to the motion command generator for execution. When PR#02 is complete, the PR executor sends PR#03 to the generator.
- Example 2: Using the same three consecutive position commands, if PR#01 uses a 100 ms DLY (Time Delay), the PR executor processes PR#01 and PR#02, because the DLY is used with PR#01, the PR#01 movement executes while DLY is timing. When the delay has expired, and PR#01 has not reached its target position, the PR executor then processes PR#02 and sends it to the motion command generator and the command profile executes PR#02 (still a point-to-point index). Once PR#02 is completed, PR#03 is sent to the motion command generator and PR#03 is executed.

Figure 172 - Internal Interruption - Position Command




The REL and INC position command types operate the same way. The target position is the previous target position (30,000 in Figure 173) plus the new Command Position (60,000 in Figure 173).

Figure 173 - Example of Relative and Incremental Position Command for Internal Interruption

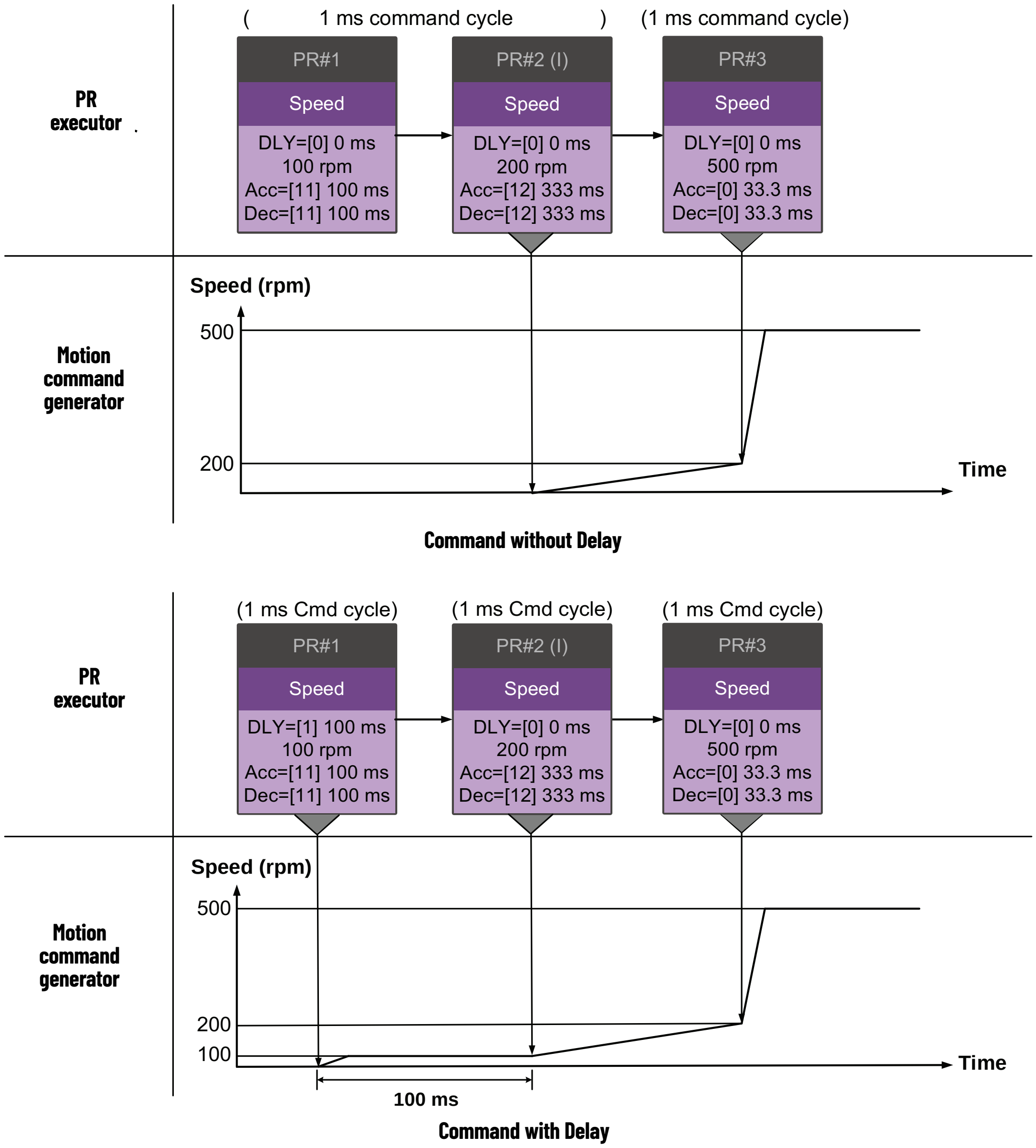


### *Speed Commands*

See Figure 174 to use these two examples.

- Example 1: When the PR executor receives three consecutive speed commands with the second command using the interrupt setting (PR#01 -> PR#02 (I)->PR#03), the PR executor treats the PR#01 and PR#02 as one command. Because both the PR commands occurred in the same 1 ms cycle, and there is no DLY used, the PR executor replaces PR#01 with PR#02. It sends the second PR to the motion command generator for execution. When PR#02 is complete, the PR executor sends PR#03 to the generator.
- Example 2: Using the same three consecutive speed commands, if PR#01 uses a 100 ms DLY (Time Delay), the PR executor processes PR#01 and PR#02, because the DLY is used with PR#01, the PR#01 target speed executes while DLY is timing. When the delay has expired, the PR executor then processes PR#02 and sends it to the motion command generator and the command profile executes PR#02 (still a constant speed type). Once PR#02 is completed (reaches target speed), PR#03 is sent to the motion command generator and PR#03 is executed.

Figure 174 - Internal Interruption - Speed Command




### *Multiple Commands*

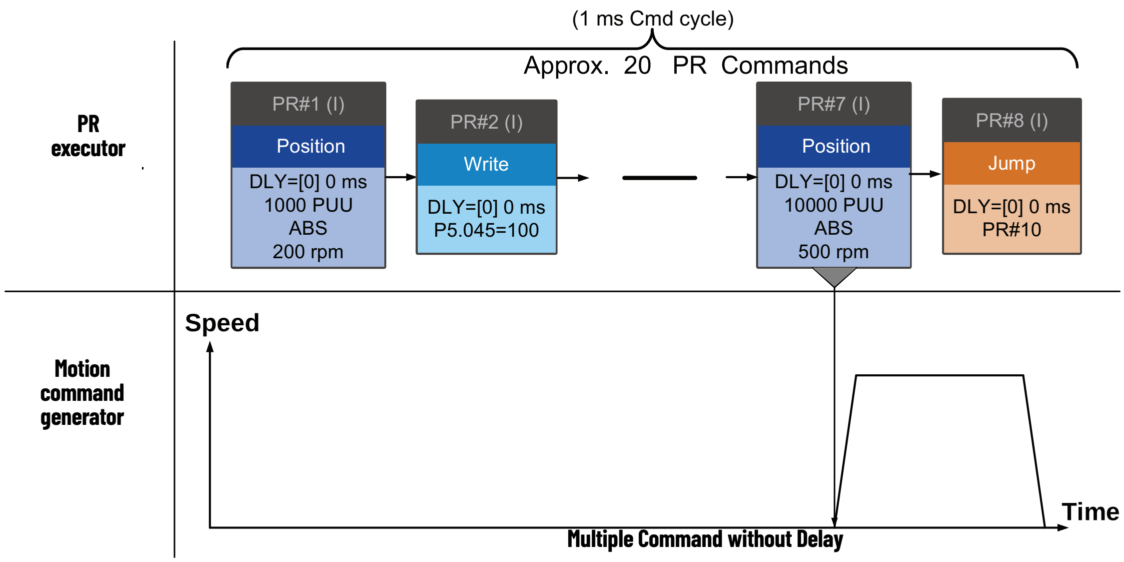
The PR queue updates once every 1 ms Command cycle. If all PR commands are set with interrupt function, the queue can read at least 20 PR commands in 1 ms.

If these multiple PR commands contain multiple motion commands, the PR queue only issues the last command it receives to the motion command generator for execution. Therefore, in the same PR group, only one PR command with motion command is executed. This sequence is different for non-motion PR types where jump and write commands are executed once received by the PR queue (see Figure 175).

If one of the PR types uses a delay, the PR queue schedules all subsequent commands on the basis of the PR type that uses a DLY (Delay Time).

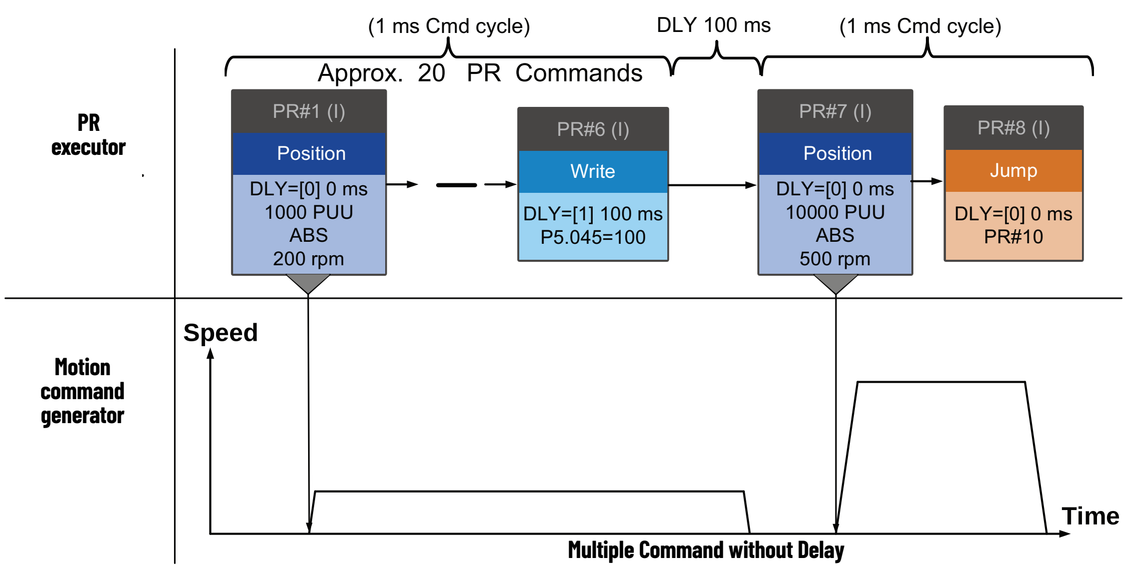
- Example 1 shows multiple commands that are received in the same 1 ms Command period. You can see that the last PR (PR#07) is the command that is executed, as shown in Figure 175.

**Figure 175 - Internal Interruption - Multiple Commands without Delay**




- Example 2 shows multiple commands that are received in the same 1 ms update with DLY (Delay Time) used. In this case, the first motion commanded PR begins executing while the DLY is occurring; the DLY is grouped with the first 1 ms cycle. Once DLY expires, the next PR (PR#07) begins executing, which occurs in the second 1 ms cycle, as shown in Figure 176.

**Figure 176 - Internal Interruption - Multiple Commands with Delay**

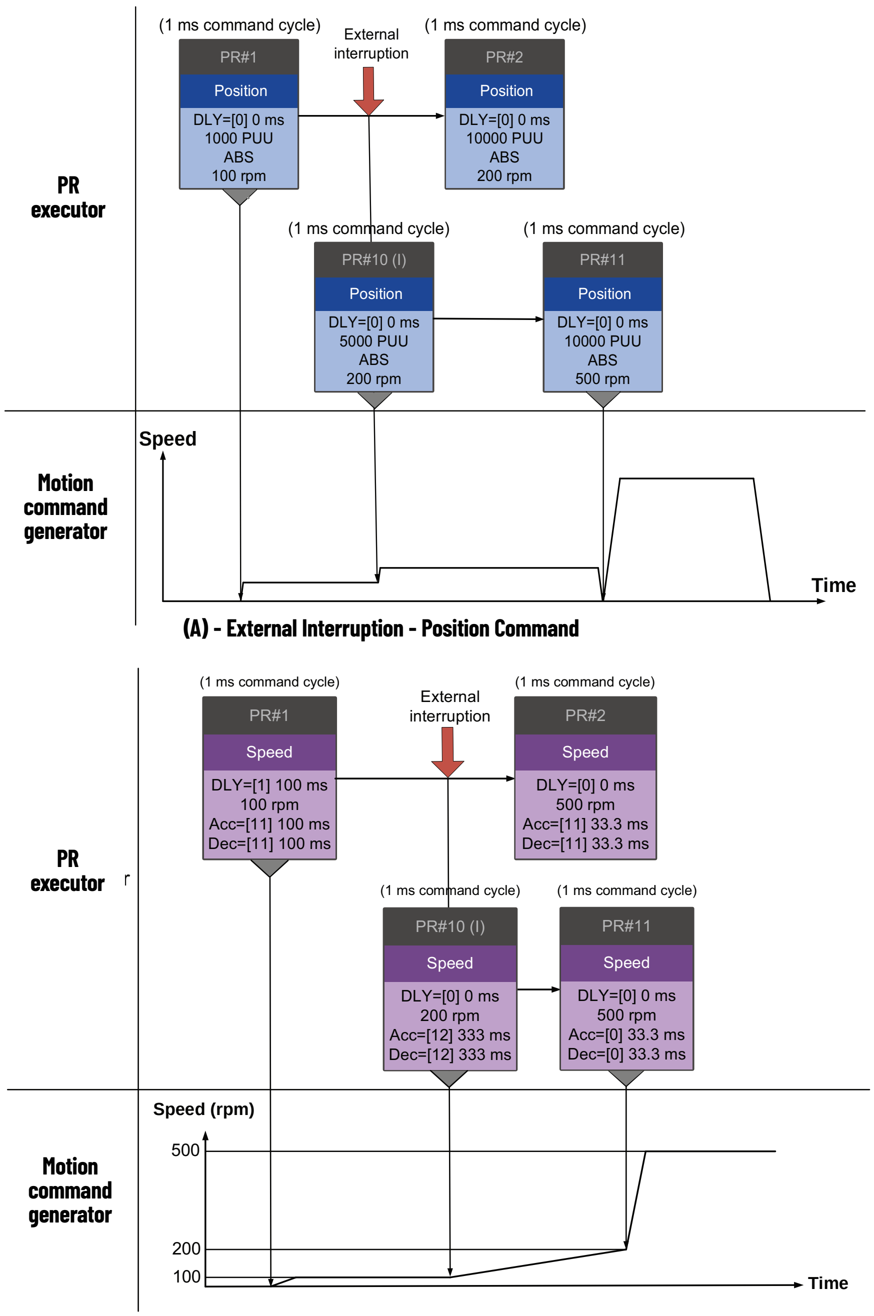


### *External Interrupts*

When an external interrupt is used, it uses an external interrupt trigger method to execute another PR command, see Figure 171.

When the PR queue receives a PR position command with the interrupt setting (Interrupt Previous PR=1), it is sent to the motion command generator immediately and any required motion command changes integrate with any currently executing motion. The use of DLY does not change the result of an external interruption. The external interruption of Speed or Position command types operate the same way. Therefore, you can integrate a Constant Speed PR type with a Positioning type and vice versa.

**Figure 177 - External Interruption**




**(A) - External Interruption - Position Command**

**(B) - External Interruption - Speed Command**

## Overlap Command Execution

The Overlap function is available only with Position Type commands. When the Overlap function (Overlap next PR =1) is used with a primary PR, the PR queue (and PR executor) looks for the secondary PR position type so it can merge the two Position commands while the primary PR command is decelerating. The calculation for the merging is shown

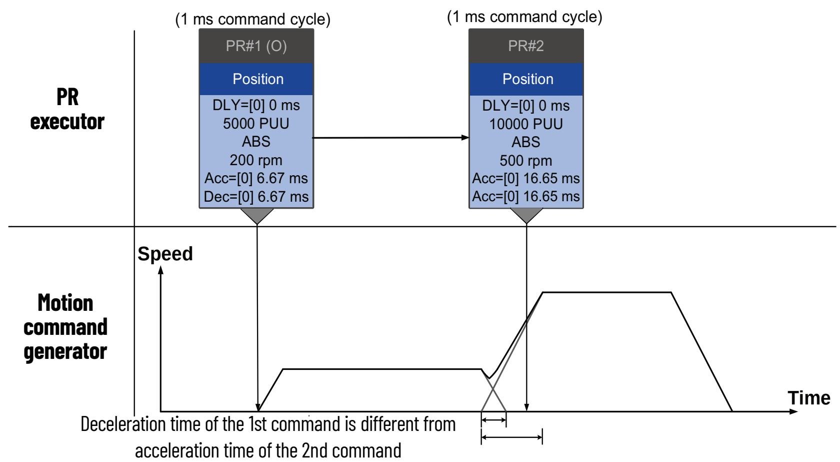
$$\frac{\text{1st target speed (Spd1)}}{3000} \times \text{Deceleration time (Dec)} = \frac{\text{2nd target speed (Spd2)}}{3000} \times \text{Acceleration time (Acc)}$$

| | |
|---|---|
| **IMPORTANT** | Do not use the DLY function when you use the Overlap function. Because you can still select the DLY (Delay Time) when Overlap is used, this delay occurs at the end of the primary PR motion command and delays the second PR profile from starting. |

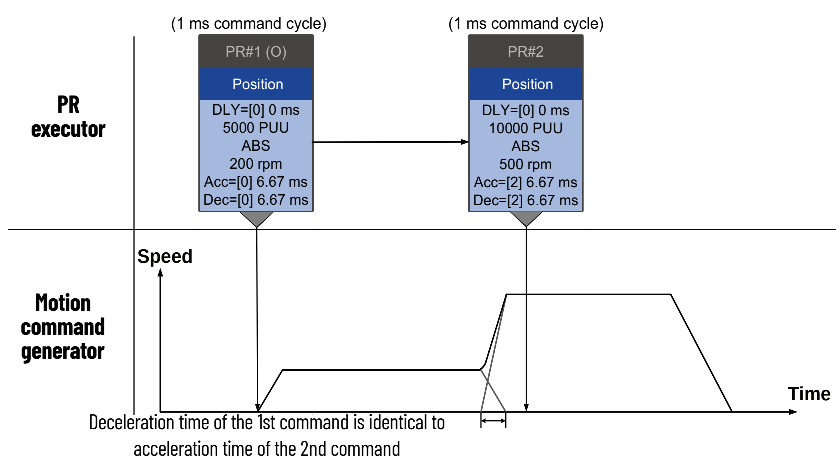
If the Deceleration of the primary PR is the same as the Acceleration of the secondary PR, the velocity transition between the two PRs is very smooth.

An Interrupt command has a higher priority over an Overlap command. Thus, when Overlap function is set in the current position command and the next motion command is set to apply the Interrupt function, only Interrupt function is conducted.

**Figure 178 - Overlap Command**




**Overlap Command - Acceleration and Deceleration Time are Different**




**Command with Delay - Acceleration and Deceleration Time are Identical**

## Arithmetic Operation Command Execution

Arithmetic commands (typically in Statement type PR commands) have the same execution priority as Jump and Write commands. When executed consecutively, Arithmetic operations commands can interrupt the currently executing PR command but cannot be interrupted by a PR command. This sequence is to confirm that all arithmetic operations are completed before the PR commands enter the PR queue (and PR executor). If a PR attempts to interrupt an arithmetic command by highest priority, either interrupt or PRCmdTrigger input, the interrupt occurs on the next command cycle (after the current 1 ms cycle completes).

Figure 179 - Multiple Commands with Arithmetic Operations

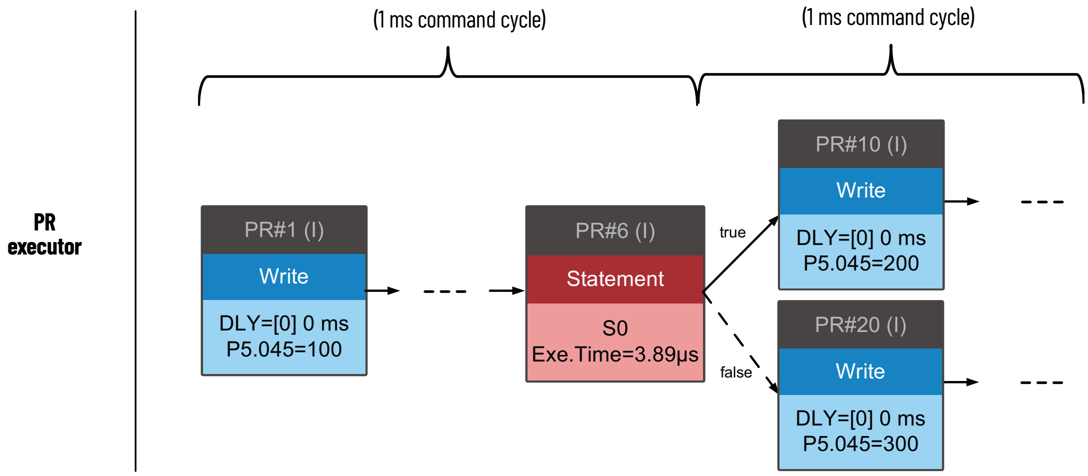
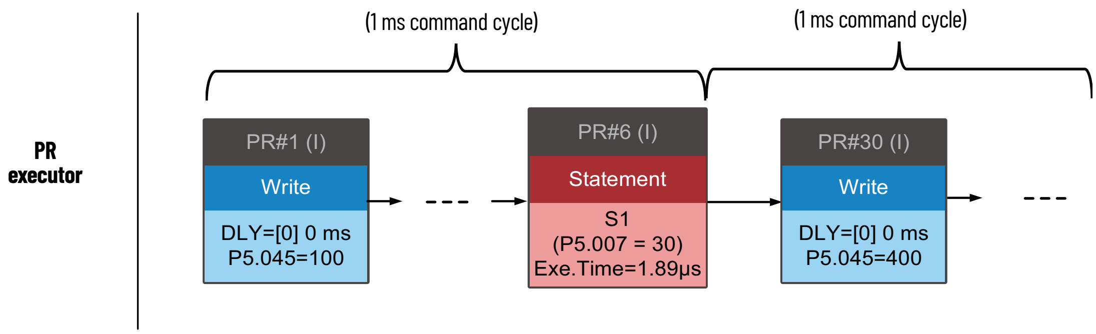



Figure 180 - Writing Trigger Command in Statement Section



# Notes:

Chapter 12

# Motion Control Applications



Motion control applications often include high speed dependencies. These dependencies includes being able to capture and compare motor positions and execute high-speed functions with synchronization.

This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

## High-speed Position Capture Function (CAP)

The High-speed Position Capture function uses high speed digital inputs (DI9 and DI10) to quickly and accurately capture the motor position, then store it in a data array for later use.

The following parameters define the function.

**Table 117 - High-speed Capture Related Parameters**

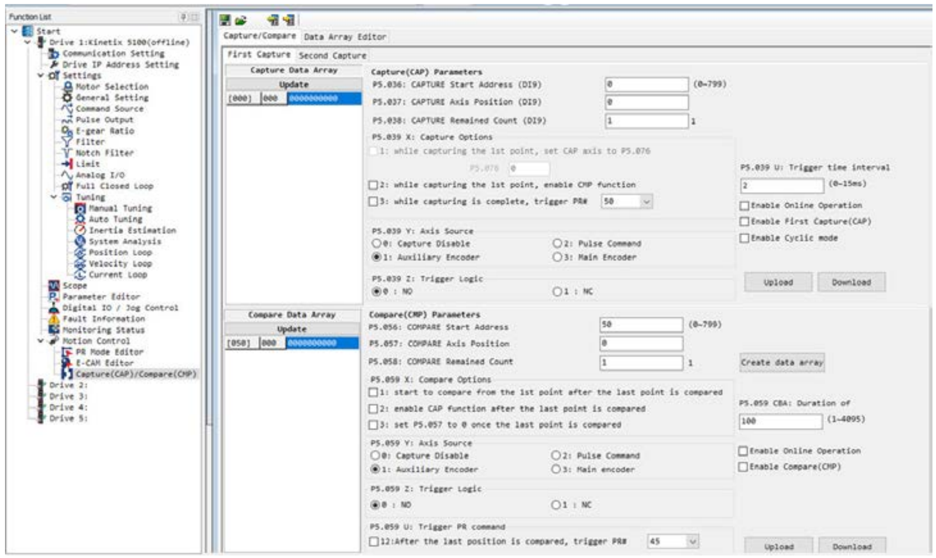
| Parameter | Name |
|---|---|
| ID328 (P5.036) | DI9CaptureStartAddress |
| ID392 (P5.107) | DI10CaptureStartAddress |
| ID330 (P5.038) | DI9CaptureRemainedCount |
| ID394 (P5.109) | DI10CaptureRemainedCount |
| ID131 (P1.019) | DI9ExtraConfiguration |
| ID183 (P1.103) | DI10ExtraConfiguration |
| ID331 (P5.039) | DI9CaptureControl |
| ID395 (P5.110) | DI10CaptureControl |
| ID329 (P5.037) | DI9CaptureAxisPosition |
| ID393 (P5.108) | DI10CaptureAxisPosition |
| ID132 (P1.020) | DI9CaptureMaskRange |
| ID184 (P1.104) | DI10CaptureMaskRange |
| ID368 (P5.076) | DI9FirstCaptureResetPosition |
| ID396 (P5.110) | DI10FirstCaptureResetPosition |

There are two capture functions can be used simultaneously and are configured using KNX5100C software. To use the capture functions, navigate to Function List>Motion Control>Capture(CAP)/Compare(CMP) and:

- Configure the Capture Options

- Choose a source for the position
- Choose a time interval
- Determine if you need Online operation or cyclic mode

**Figure 181 - High-speed Capture**



The following example of the Capture function uses Figure 182. This example uses DI9 as the capture input (in KNX5100C software, the first capture uses DI9, the second capture uses DI10). Initial setup of the drive/High Speed Input to use the CAP function:

- Use KNX5100C software, remove any input assignments at DI9/DI10; when you use the CAP function, no other association should be present
- Verify there is no Event Trigger that is using PR 50/60; the Event execution is separate from the CAP function. They cannot use the same PR command or DI.
- Use KNX5100C software, at PR50/60 verify that no other PR command is presently used; the CAP function uses these PR commands to execute the CAP index.

Choose the options and settings that you need:

- CAPTURE Start Address (ID328,P5.036)

  Captured data is stored in this shared User Data Array (0…799 elements). This data is sequentially stored based on the number of CAPTURES performed in that particular cycle. Once the CAPTURE cycle is complete and if it is triggered again, the old capture data is overwritten with the present capture data.
- CAPTURE Axis Position (ID329, P5.037)

  The most recent returned position of the capture function, which is stored for each capture instance in the User Data Array.
- Enter a positive value in CAPTURE remained count (DI9)

  This option essentially enables the capture function, alternatively, you can see the status of the function from the Function List>Motion Control>Parameter Editor, Capture Control DI9 (ID331m P5.039 X.0);

when this value is larger than zero, Bit 0 is ON. This state indicates that the capture function is executing.

When the Capture function is executing, the DI9CaptureRemainedCount (ID330, P5.038) parameter indicates the remaining number of captures to be performed. Whenever a capture cycle occurs, this value decrements by 1 until the value is 0. The zero value indicates that the Capture function has completed.

- Choose to perform the Compare (CMP) function when the position is captured.

  This option performs a compare function after the capture has occurred.

- Choose a PR to execute when the capture is complete.

  When the capture is completed, use the pull-down menu to choose a specific PR# to execute.

- Choose the source of position for your capture function.

  Here you can choose the position feedback source that is used for capturing. You can also choose Capture Disable which is another way to disable the capture function if your remaining count is still greater than zero.

- Choose the trigger logic.

  Choose whether the capture executes when a N.O. (Normally Open) or N.C. (Normally Closed) condition occurs on DI9 (this condition is thought of as rising edge, falling edge).

  The logical evaluation considers DI9 to be configured as a N.O. input. When this configuration is true, the logic behaves as shown. If DI9 is an N.C. input, the logic levels are reversed.

- Choose the time interval for retriggering the capture function.

  This time interval avoids nuisance sensor trips typical in high-speed applications. You can set the capture function only to occur once this time has elapsed.

- Use DI9CaptureMaskRange (ID132, P1.020) if necessary.

  To help prevent the same position data (or position data within a small window) from being captured repeatedly, you can configure the drive to avoid capturing multiple identical data sets by defining a masking range for data capture. This range defines the pulses that must occur before any new data is stored.

**Table 118 - High-speed Position Capture, Additional Information**

| P5.039 (for DI9) DI9CaptureControl | Bit | Function | Description |
|---|---|---|---|
| X | 0 | Enable capture function | When bit 0 = 1, and ID330 (P5.038) > 0, data capturing starts and DO.CAP_OK signal is off. The value of ID330 (P5.038) decrements as data capture continues.<br>When ID330 (P5.038) = 0 it means that data capture is complete. When the data capturing is completed, the DO.CAP_OK signal is on, and bit 0 is cleared to 0.<br>If bit 0 is already 1, the written value must not be 1; you have to write 0 to disable the Capture function. |
| | 1 | Reset the axis position when first data is captured | When bit 1 = 1, after the first data is captured, the Capture axis position is set to the value of ID368 (P5.076) DI9FirstCaptureResetPosition. |
| | 2 | Enable Compare function after the first data is captured(1) | When bit 2 = 1, when the first data is captured, the Compare function is enabled. (ID351.X (P5.059.X) CompareControl bit 0 = 1 and ID350 (P5.058) CompareRemainedCount resets to the previous setting amount). If the Compare function is already enabled, then this bit function is ignored. |
| | 3 | Execute specific PR after the last data is captured | When bit 3 = 1, the drive executes the specific PR once data capture is complete (2). |
| Y | – | Source of capture axis | 0: Disabled<br>1: Auxiliary encoder (Aux)<br>2: Pulse command (I/O)<br>3: Main encoder of motor (MFB) |
| Z | – | Trigger logic | 0: N.O. (normally open)<br>1: N.C. (normally closed) |
| U | – | Minimum trigger interval | – |
| DC | | The specific PR#1…PR#99 | – |

(1) Compare function only supported in first capture.
(2) See Use IO Mode and Add-On Instruction on page 350. PR mode operation is fixed with DI9 using PR#50 and DI10 using PR#60

**Figure 182 - High-speed Position Capture Flowchart (DI9 example)**

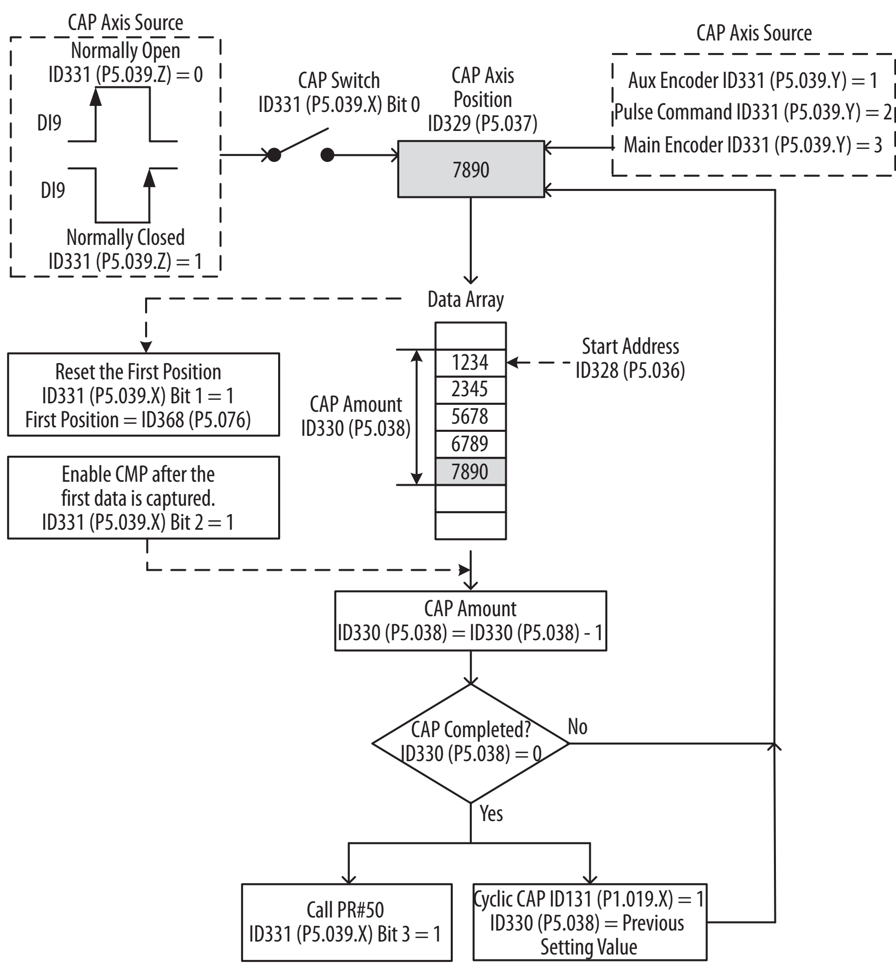
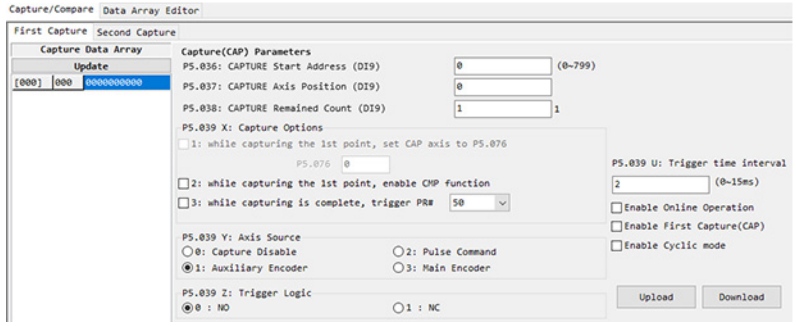


Figure 183 - Capture Function Screen




## Using PR Command Programming with the Capture Function

You can use KNX5100C software to configure the Capture function. However, if the functions must change while the application is running, you can use PR Write command to change it.

With PR write command programming, write commands configure the high-speed position capture function, as well as execute the motion commands once configuration is complete. See Chapter 11 for details on PR command programming.

The following example describes how the PR command works and is illustrated in Figure 184.

1. PR#1 confirms that the Capture function is disabled, with ID331.X (P5.039.X) NAME Bit 0 = 0. This confirmation is done in case the previous Capture did not complete.
2. PR#2 sets the start address of data array ID 328 (P5.036) to #100.
3. PR#3 sets the CAPTURE remained count ID 330 (P5.038) as 3, which executes 3 captures before the capturing function is completed.
4. PR#4 sets the First Capture Reset Position (ID368, P5.076) to 0 for the first capture point.
5. PR#5 sets a cyclic capture mode and uses a 1 ms delay before executing the next PR command.
6. PR#6 enables the capture function and resets the first point. Once the data capture is complete, the drive executes PR#50. It selects the main encoder of the motor as the Axis Source and applies 'normally closed' contact as trigger logic with trigger interval of 2 ms.
7. PR#7 sets the initial speed command at 50 rpm.
8. Once the last capture occurs, PR#50 executes a Point-to-Point move (proceed to next), with CMD type CAP (type 11) and Position CMD Data = 50000 PUU
9. PR#51 uses a PR with command type of Constant speed control.

**Figure 184 - PR Command with Application of High-speed Capture (DI9 example)**

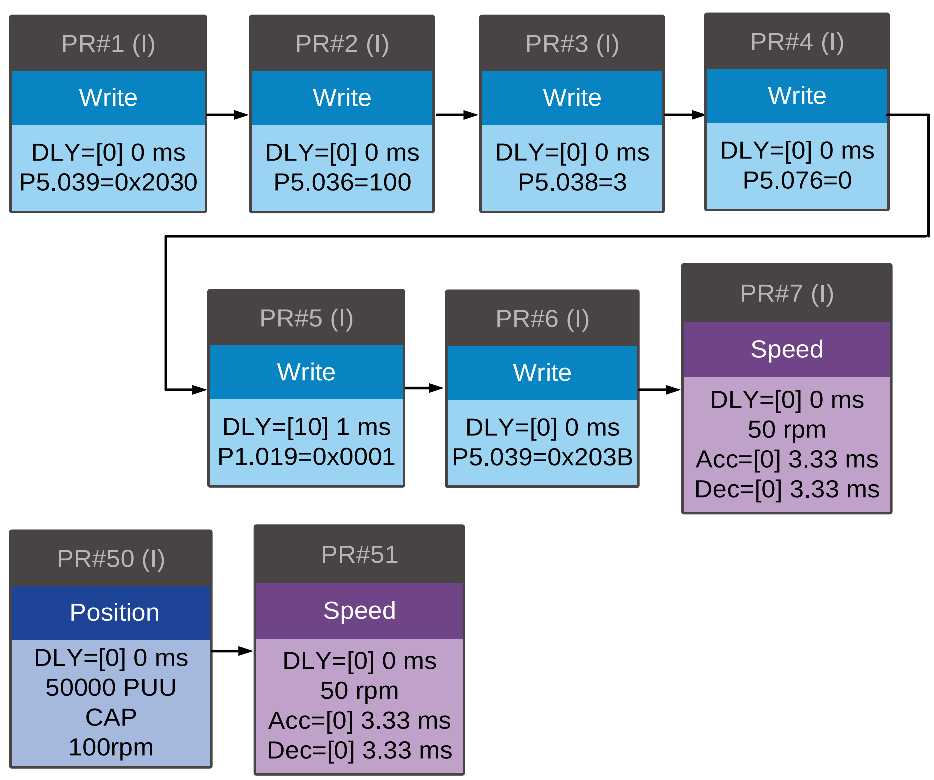
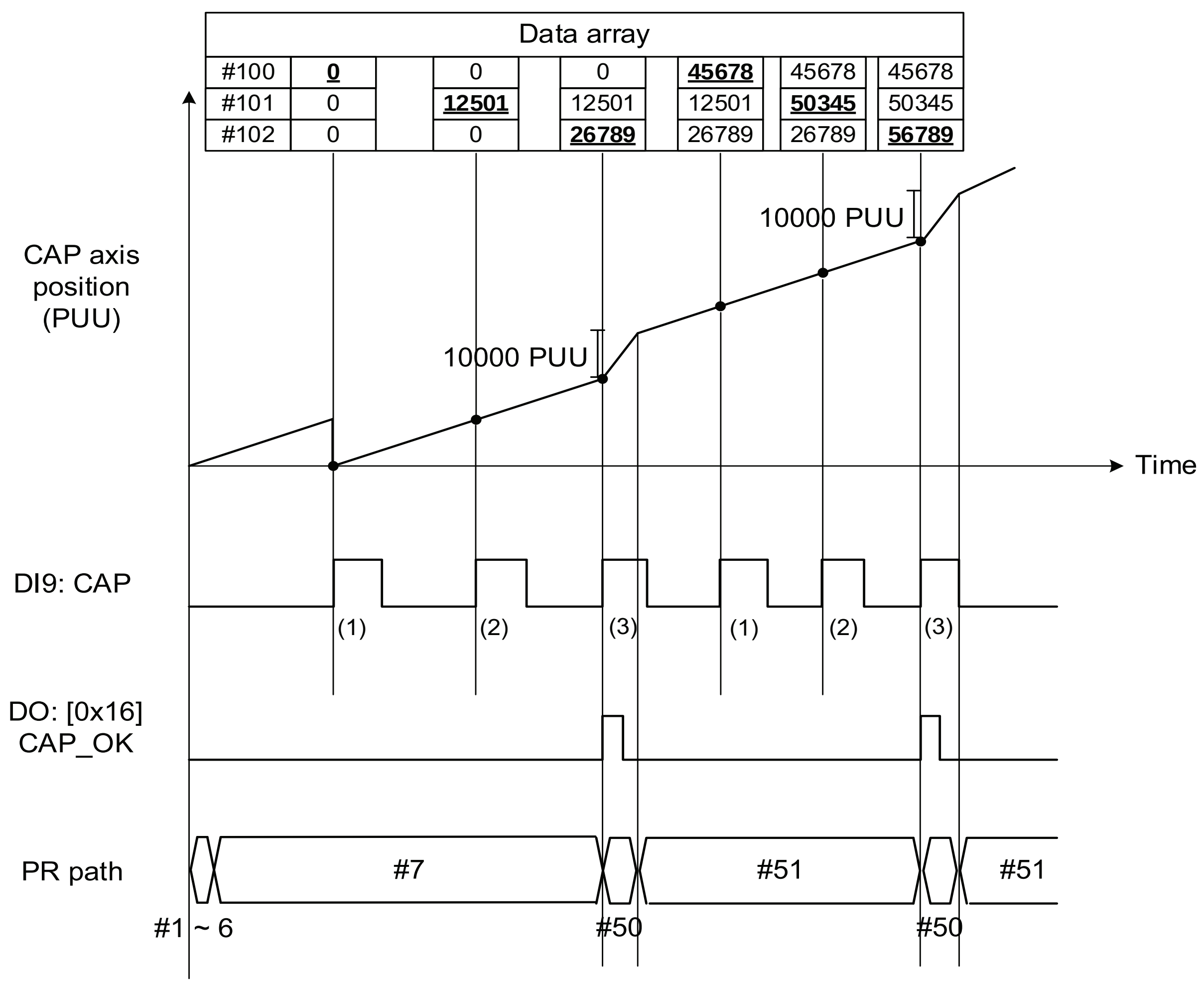



Figure 185 shows how the data is captured in the data array when the capture function is executed. At (1) after DI9 is triggered, the capturing axis is reset to 0 and the data is stored in data array #100. When DI9 is triggered the second (2) and third (3) times, the position data is written to the data arrays #101 and #102, respectively. Once the first capture cycle is completed, the DO:CAP_OK [0x16] signal turns on and then PR#50 (high speed position capture command) and PR#51 (motion with fixed speed) are executed. The servo drive will execute the next cycle. The DO:CAP_OK signal is off when procedure is completed and the capturing amount is set to 3.

When DI9 is triggered for the fourth (1) time, the capture axis position is not reset and the position data of the capturing axis is written to data array #100 again. Therefore, the data that was logged in the previous cycle is overwritten. At the moment DI9 is triggered for the fifth and sixth times, the position of capturing axis is written to data arrays #101 and #102, respectively. As soon as the second capture cycle is finished, DO:CAP_OK (DO:First CAP procedure completed) CAP turns on and then PR#50 point-to-point command (Proceed to next) and PR#51 (constant speed control) are executed.

When applying cyclic capture mode (P1.019.X = 1), once the final capture has completed, and any PR executes, the cycle of recording new values in the data arrays is repeated. The capture function resumes storing data in the data array from CAPTURE Start Address (DI9) (ID 328, P5.036). Any data that was logged in this data array location is overwritten with the new captured value.

**Figure 185 - High-speed Capture Application Example**



## High-speed Position Compare Function (CMP)

The high-speed position compare function compares the captured actual position of the motion axis with the value saved in data array. When the compare condition is fulfilled, a high-speed digital signal (DO4)(1) is output immediately for motion control. As this function is carried out by the hardware, KNX5100C software compares the data accurately on high speed motion axes. When the CMP function is enabled, the servo drive employs DO4 to force an output signal, which is not user-defined.

The following parameters define the function.

**Table 119 - High-speed Capture Related Parameters**

| Parameter | Name |
|---|---|
| ID348 (P5.056) | CompareStartAddress |
| ID349 (P5.057) | CompareAxisPosition |
| ID350 (P5.058) | CompareRemainedCount |
| ID351 (P5.059) | CompareControl |
| ID330 (P5.038) | DI9CaptureRemainedCount |
| ID331 (P5.039) | DI9CaptureControl |
| ID131 (P1.019) | DI9ExtraConfiguration |
| ID133 (P1.023) | NonVolatileCompareDataOffset |
| ID134 (P1.024) | VolatileCompareDataOffset |
| ID153 (P1.046) | EncoderOutputResolution |
| ID179 (P1.097) | EncoderOutputDenominator |

To configure the Compare function, you need to:

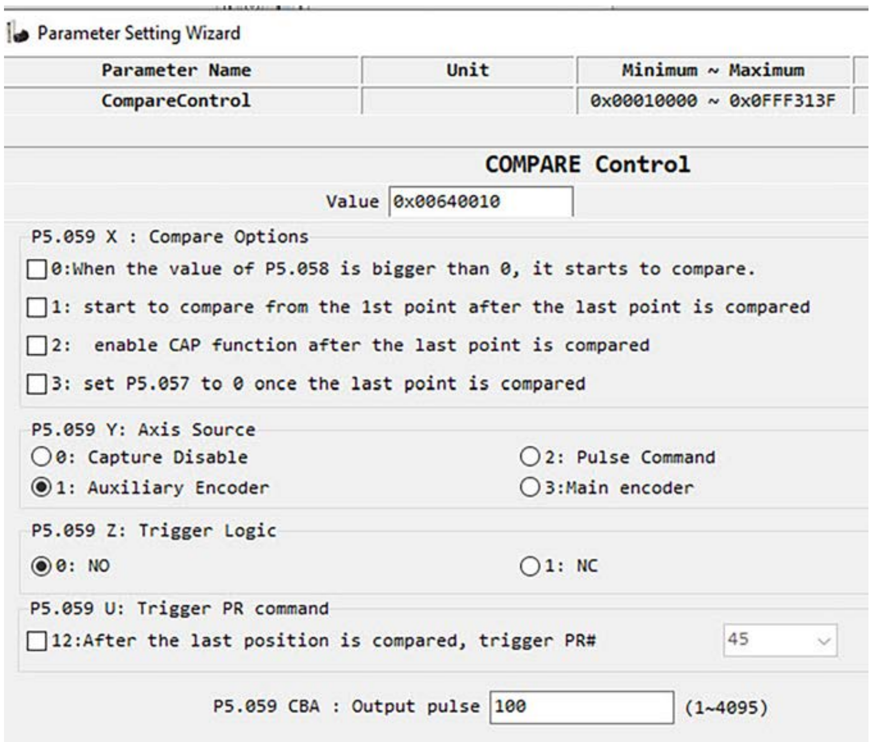
- Define and enable the operation of the compare function, including definition of the axis source and trigger logic
- Define the start position for data compare in the data array
- Set the amount of data to be compared
- Enable the cyclic mode

Figure 188 describes the compare function.

(1) With execution time 5 μs only.

Use parameter ID351 (P5.059) CompareControl to enable or disable the Capture function and to define the axis source and trigger logic. See Table 120.

**Figure 186 - Compare Control**

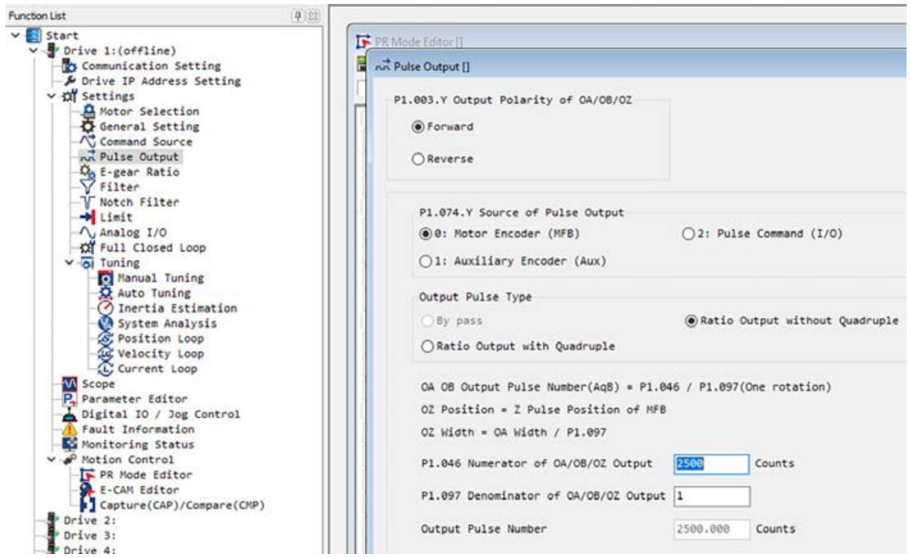



## Table 120 - High-speed Position Compare, Additional Information

| ID351 P5.059 CompareControl | Bit | Function | Description |
|---|---|---|---|
| X | 0 | Compare feature | If bit 0 is set to 1, the compare feature executes when ID350 (P5.058) is > 0. |
| | 1 | Cyclic mode | If bit 1 is set to 1 and all compare procedures are completed, ID350 (P5.058) resets to the setting value and then compare procedure starts again. |
| | 2 | Enable Capture function after data compared | If bit 2 is 1, after all comparing is done, enable the Capture function (Set ID331 (P5.039.X) bit 0 to 1, and set the previous value to ID330 (P5.038) as the data size to be captured); if Capture function has been enabled, then this function is invalid. |
| | 3 | Reset position of the comparing axis to 0 | If bit 3 is 1, once the last data array element is compared, ID349 (P5.057) is set to zero. |
| Y | – | Source setting of comparing axis | 0: Capturing axis<br>1: Auxiliary encoder (AUX)<br>2: Pulse command (I/O)<br>3: Main encoder (MFB)<br>If capturing axis is selected, source of the capturing axis ID331 (P5.039.Y) cannot be changed. If encoder of the motor is selected, pulse resolution is determined by ID153 (P1.046) (Encoder pulse number output setting) and ID176 (P1.097). |
| Z | – | Trigger logic | 0: N.O. (normally open)<br>1: N.C. (normally closed) |
| U | – | Trigger PR command | If bit 0 is set to 1, PR#50 (DI9) or PR#60 (DI10) is triggered when the last data array segment is compared. |
| CBA | – | Pulse output duration (ms) | – |

*Using the Motor Encoder as the Compare Source*

**Figure 187 - Pulse Output**




If the capturing axis is selected, the source of the capturing axis ID331 (P5.039.Y) cannot be changed. If the motor encoder is selected, the pulse resolution is determined by EncoderOutputResolution ID153 (P1.046) and EncoderOutputDenominator ID179 (P1.097).

When EncoderOutputDenominator ID179 (P1.097) = 0, OA/OB pulse output (Output Pulse Number from Figure 187) only refers to the setting of EncoderOutputResolution ID153 (P1.046).

Example 1:

> When EncoderOutputDenominator ID179 (P1.097) = 0;
> EncoderOutputResolution ID153 (P1.046) = 2500
>
> OA/OB output = EncoderOutputResolution ID153 (P1.046) uses quadruple (4x the frequency), which is 10,000 pulses.

When EncoderOutputDenominator ID179 (P1.097) has been set (value is not 0), OA/OB pulse output needs to be calculated via the numerator and denominator of EncoderOutputResolution ID153 (P1.046) and EncoderOutputDenominator ID179 (P1.097), and converted using quadruple (4x frequency).

Example 1:

When ID179 (P1.097) = 5; ID153 (P1.046) = 2500

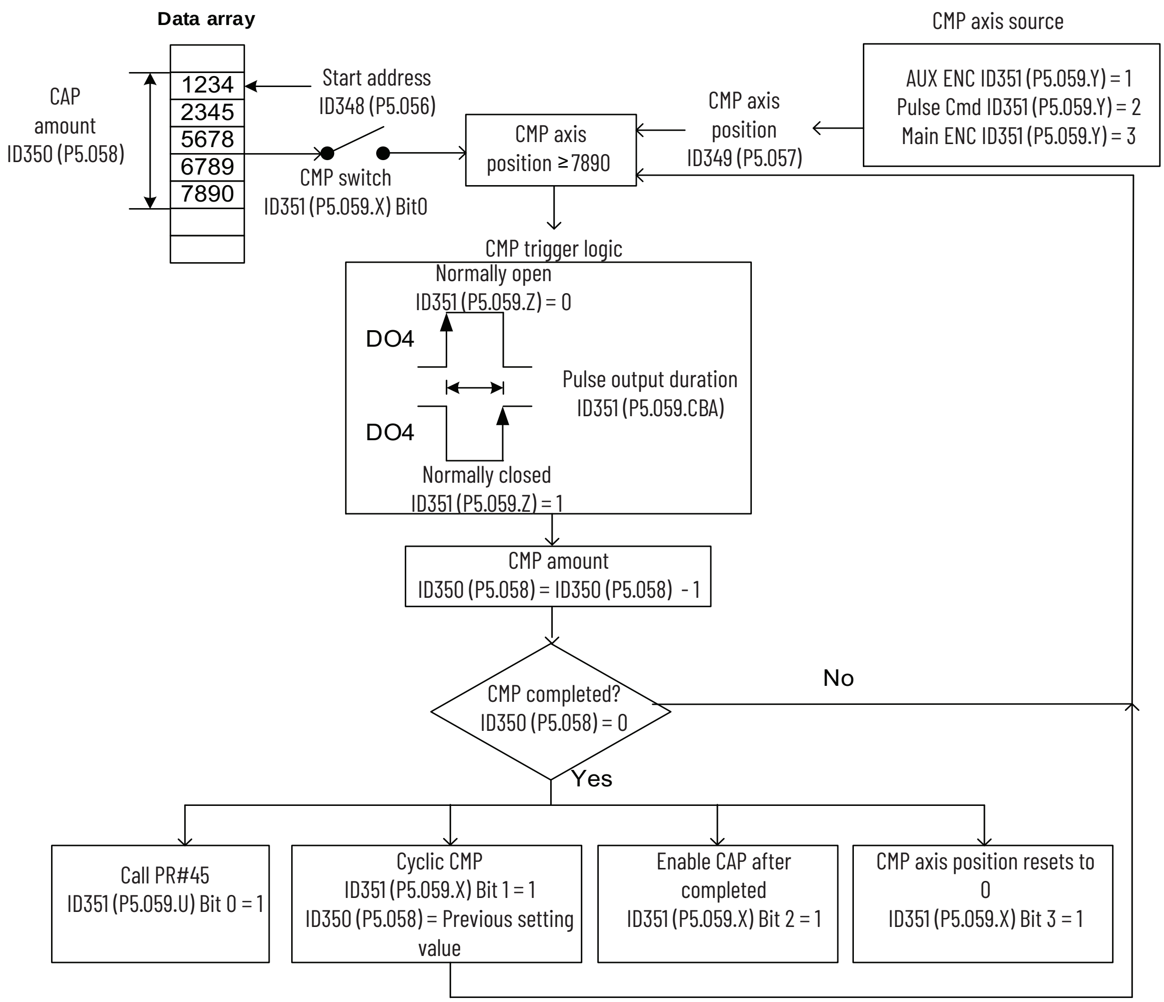
$$\text{OA/OB output} = \frac{2500}{5} = 500 \text{ pulses}$$

Example 2:

When ID179 (P1.097) = 7; ID153 (P1.046) = 2500

$$\text{OA/OB output} = \frac{2500}{7} = 357.142857 \text{ pulses}$$

**Figure 188 - High Speed Position Compare Flowchart**



### Using PR Command Programming with the Compare Function

To use the Compare function, you must be in PR operation mode and use PR commands.

With PR command programming, write commands configure the high-speed position compare function, as well as execute the motion commands once configuration is complete. See Chapter 11 for details on PR command programming.

The following example describes how the PR command works and is illustrated in Figure 190. Set the numerator ID153 (P1.046) EncoderOutputResolution and EncoderOutputDenominator ID179 (P1.097), whose default is based on the comparing an axis using 10000 pulses per motor rotation.

1. PR#1 use write commands to edit data array #50.
2. PR#2 use write commands to edit data array #51.
3. PR#3 use write commands to edit data array #52.
4. PR#4 confirms that the Compare function is disabled (ID331.X (P5.039.X) Bit 0 = 0).
5. PR#5 sets the start position to 50.
6. PR#6 sets the compare amount to 3, with a delay of 1 ms to allow the PR command with the use of Compare function to be executed.
7. PR#7 enables the Compare function in cyclic mode, which clears the compare axis to 0 after compare is complete and executes PR#45. It selects encoder of the motor as the capturing axis, setting 'normally closed' as the trigger logic with pulse output duration of 100 ms.
8. PR#8 sets the speed command to 50 rpm.
9. PR#45 sets the incremental command to 50000 PUU and then carries on to PR#46, keeping the speed command setting of 50 rpm.

**Figure 189 - PR Command with Application of Compare Function**

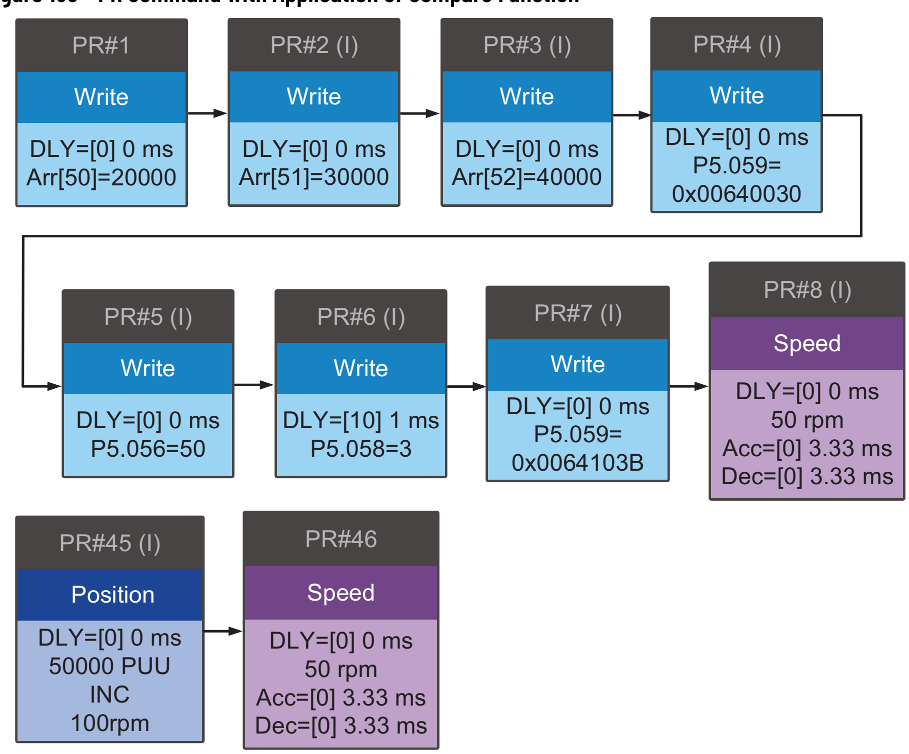
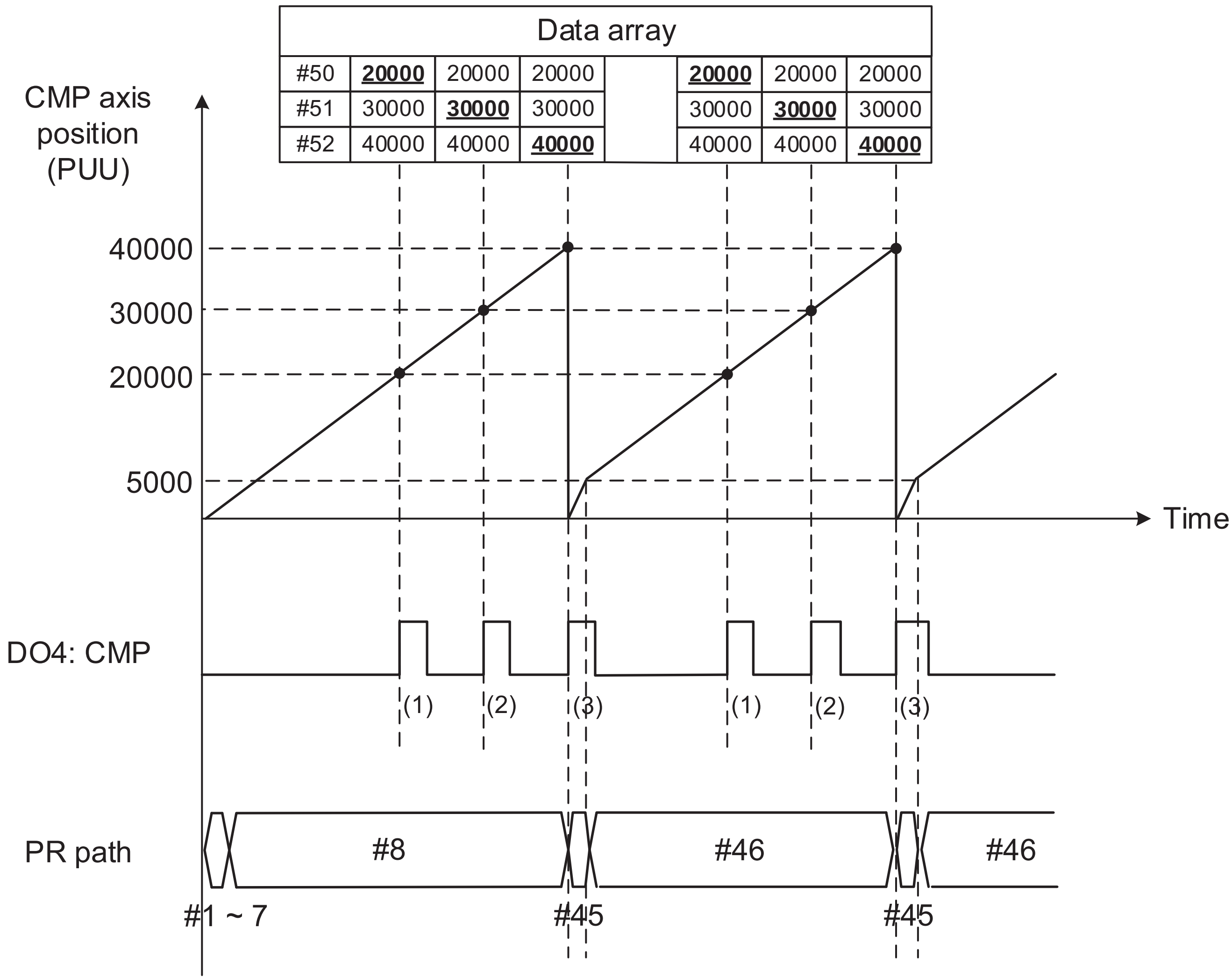


Figure 190 shows how the data is compared in the data array when the compare function is executed.

**Figure 190 - Application Example of High-speed Compare**




## Data Array

The data array can store up to 800 data (0…799) elements with each element being 32 bit. It can be used to store the high-speed capture data and high-speed compare data as well as E-CAM slave points. You can allocate the data array to fit your application. There is no pre-defined allocation of data elements, which provides flexibility.

| | |
|---|---|
| **IMPORTANT** | The Data Array is volatile. That means it does not store values through a power cycle. You can set Force Function ID193 (P2.008) = 30 and then set Force Function = 35; this operation writes the Data Array values to EEPROM. Now, they persist through a power cycle. You can see the present values of the Data Array by navigating KNX5100C software; Motion Control>Capture/Compare>Data Array Editor. |

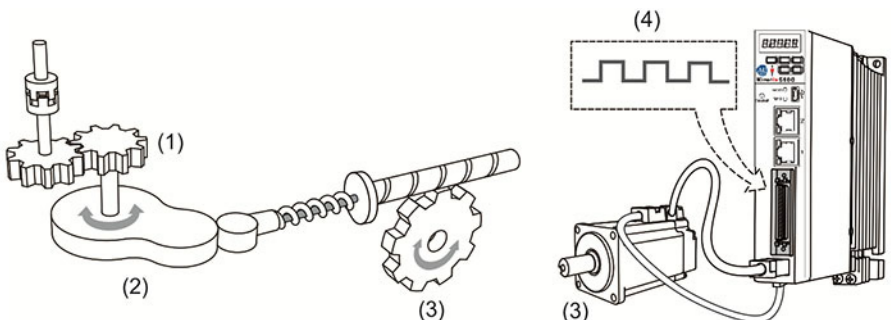
## E-CAM

The Kinetix 5100 drive has an electronic camming feature. Position cams, in effect, provide the capability of implementing non-linear electronic gearing relationships between the Kinetix 5100 motor (slave) and a master device (another drive, encoder, or time). No maximum velocity, acceleration, or deceleration limits are used.

The motion of the master device and the designated cam profile that is derived from the associated cam table determine the speed, acceleration, and deceleration of the slave axis.
The E-CAM feature executes a position cam that is created by a user-defined profile in the KNX5100C software or directly from the user-defined data array.

The mechanical cam and electric cam are illustrated in Figure 191.

**Figure 191 - Mechanical Cam and E-CAME-CAM**




(1) - Master Axis Input and Gear
(2) - Mechanical Cam
(3) - Slave Axis Output
(4) - Master Axis Input for E-CAM

The E-CAM function can be used only in PR Operating mode. After the E-CAM engagment conditions are met and the E-CAM is active, the slave axis follows the pre-defined cam profile, and the position of the slave axis is a function of the master position (or time). As a result of master movement, pulses are created. Those master pulses are used as the reference for the slave to follow; and the slave follows those pulses based on its pre-defined profile, shown in Figure 192. The E-CAM function can be enabled or disable by setting parameter ID376 (P5.088.X).

**Figure 192 - E-CAM Curve**

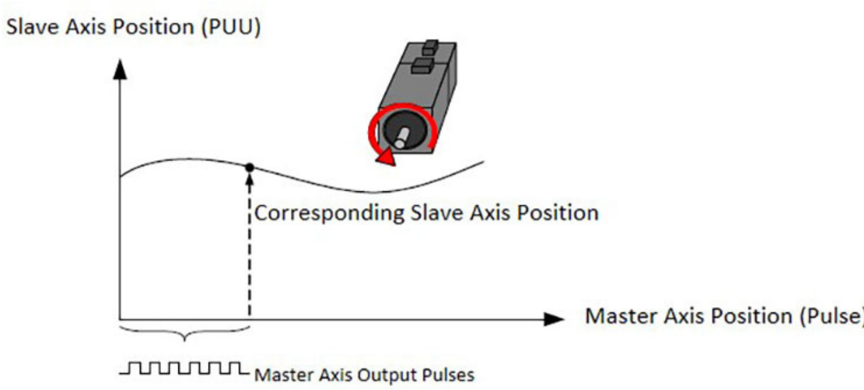
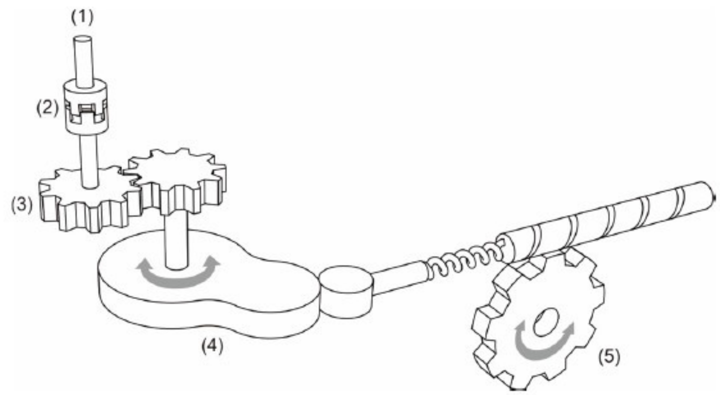


Figure 193 uses the mechanical cam concept to illustrate the E-CAM parameter settings.

**Figure 193 - Electronic cam simulates mechanical cam assembly with servo drive parameters**




(1) Master Axis: master axis signal source is set by ID376 (P5.088.Y)
(2) Clutch: time to engage or disengage is set by ID376 (P5.088.UZ), ID375 (P5.087), ID377 (P5.089)
(3) Master Axis Gear Ratio: pulse input resolution is set by ID371 (P5.083), ID372 (P5.084)
(4) E-CAM Curve: curve is set by ID369 (P5.081), ID370 (P5.082), ID373 (P5.085), scale is set by ID311 (P5.019)
(5) Slave Axis Gear Ratio: output signal resolution is set by ID151 (P1.044), ID152 (P1.045)

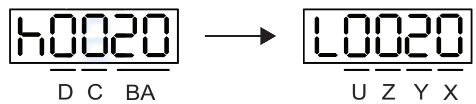
**Table 121 - E-CAM General Settings**

| Parameter | Name |
|---|---|
| ID245 (P2.073) | ECamConfiguration |
| ID246 (P2.074) | ECamDIDelayTimeCompensation |
| ID247 (P2.075) | ECamAlignementTargetPosition |
| ID248 (P2.076) | ECamControlConfiguration |
| ID249 (P2.078) | ECAMDOCamArea_RisingEdge |
| ID250 (P2.079) | ECAMDOCamArea_FallingEdge |

## E-CAM Control Settings

The format of ID376 (5.088) ECamControl is: (High word h) DCBA: (Low word L) UZYX

**Figure 194 - Parameter Format**




| | | | |
|---|---|---|---|
| BA | PR command to execute | X | Activation setting of E-CAM function |
| C | Reserved | Y | Command source |
| D | Reserved | Z | Engaging condition |
| - | - | U | Disengaging condition |

Definition as follows:

- X: E-CAM command

| Bit | Function | Description |
|---|---|---|
| 0 | E-CAM activation | 0: E-CAM is disabled 1: E-CAM is enabled (relevant parameters cannot be modified once E-CAM is enabled) |
| 1 | E-CAM does not disengage when servo is off | 0: when the servo is stopped by alarm or servo is off, the clutch disengages 1: when the servo stops because of alarm or servo is off, the clutch remains engaged. When the servo enables again, E-CAM can operate directly. |
| 2 | ECamCurveScale ID311 (P5.019) is effective immediately | 0: ID311 (P5.019) is effective after next engagement 1: ID311 (P5.019) is effective immediately |
| 3 | Reserved | - |

- Y: command source

  1: auxiliary encoder

  2: pulse command

  4: time axis (1 ms)

- Z: engaging condition

  0: immediately

  1: trigger DI.CAM

- U: disengaging condition (2, 4, and 6 cannot be selected at the same time)

| U | Disengagement condition | Action after disengaged |
|---|---|---|
| 0 | Never disengage | - |
| 1 | DI.CAM permissive is OFF | In stop status |
| 2 | Master axis reaches the disengage value of ID377 (P5.089) (Sign indicates the direction) | In stop status |
| 6 | Same as 2, but the existing speed continues when disengaging and the engaged length slightly exceeds ID377 (P5.089) ECamMasterPositionToDisengage. This is suitable for when calling the next PR Position command immediately after disengaging. | |
| 4 | Master axis exceeds the value of disengaging ID377 (P5.089) (sign indicates the direction) | Return to pre-engaged status Lead pulse is ID380 (P5.092) ECamSkippedMasterPulses |
| 8 | When U = 1, 2, or 6: disable E-CAM after disengaging | Set X to 0 |
| | When U = 4: Avoid jittering when it returns to pre-enagaged status | N/A |

- BA: auto execute the specified PR command

  When disengaging condition (ID376 (P5.088.U: 2, 4, 6)) is met, a PR 00…3F (hexadecimal; 00 means no action) is executed automatically.

- C: reserved
- D: reserved

## Master Axis Signal Source

When using an electronic cam, you must first determine the source of the master axis, which can be an auxiliary encoder (via Aux Port), another Kinetix 5100 motor (via PT wiring), or time (ms). The source is determined by parameter ID376 (P5.088.Y) ECamControl.

- Auxiliary Encoder - ID376 (P5.088.Y) = 1, the external encoder signal from the Aux Feedback Connector (AUX) is used as the source of the master axis signal. And the master axis position is monitored with ID309 (P5.017) AuxEncoderPosition.
- Pulse Input - ID376 (P5.088.Y) = 2, the pulse input from the I/O connector is used as the source of the master axis signal. And the master axis position is monitored with ID310 (P5.018) PulseCmdPosition.
- Time Axis (1ms) - ID376 (P5.088.Y) = 4, the 1ms pulse generated internally by the servo drive is used as the source of the master axis signal.

You can monitor the master axis by using parameter ID374 (P5.086).

### *Digital Output CAM_Area Settings*

The Kinetix 5100 drive provides two digital outputs that can operate based on the present Master position within the E-CAM cycle. The first DO (0x18) ON transition is determined by Ecam DO.Cam xxxx Rising Edge Angle ID378 (P5.090) and the OFF transition is determined by Ecam DO.Cam xxxx Falling Edge Angle ID379 (P5.091), as illustrated in Figure 196. The second DO (0x1A) is operated in a similar manner and is shown in Figure 197.

**Figure 195 - Digital Output CAM Area**

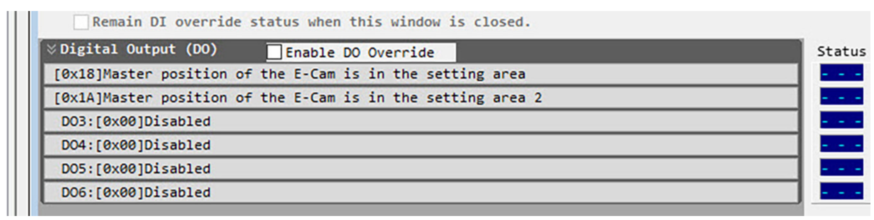
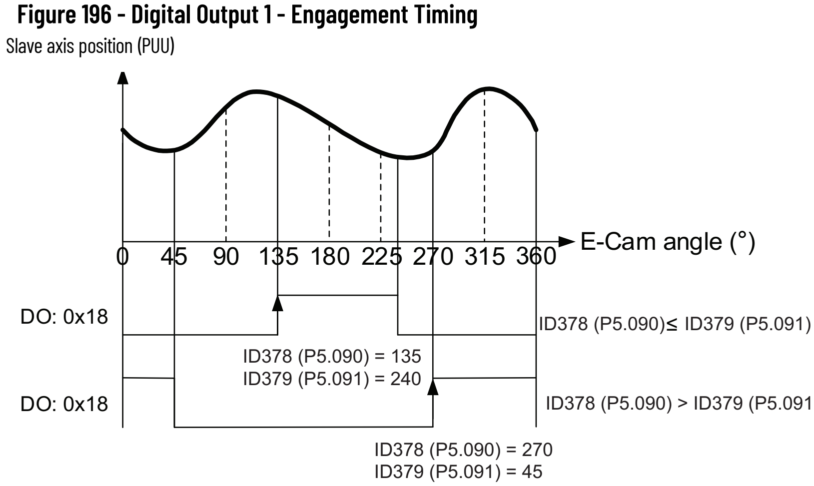



**Figure 196 - Digital Output 1 - Engagement Timing**



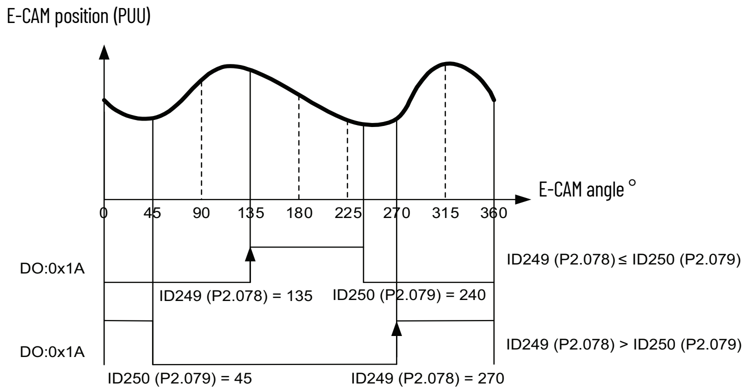
The following parameters define the function.

**Table 122 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID378 (P5.090) | ECamDOCamArea1RisingEdgeAngle |
| ID379 (P5.091) | ECamDOCamArea1FallingEdgeAngle |
| ID249 (P2.078) | ECamDOCamArea2RisingEdgeAngle |
| ID250 (P2.079) | ECamDOCamArea2FallingEdgeAngle |

The relationship between DO.CAM_Area2 and the parameter values is shown in Figure 197. When E-CAM is not engaged, this signal is always off.

**Figure 197 - Digital Output 2 - Engagement Timing**



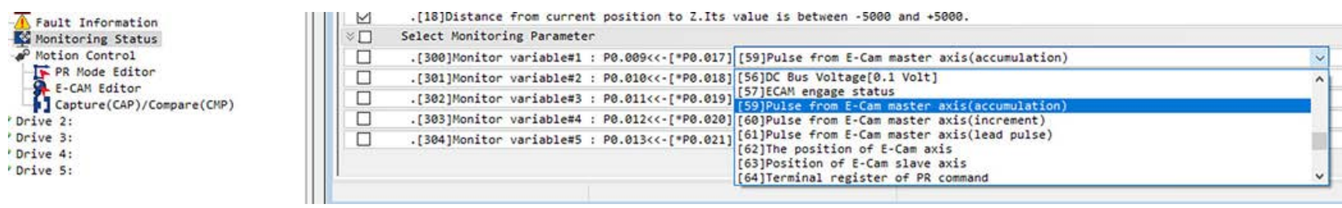
*System Variables for Master Access Monitoring*

The Kinetix 5100 drive also provides four system variables to monitor the master axis:

- Cumulative Pulse of Master Axis - system variable 059(3Bh): this variable is the feedback position of the Master. (E-CAMMasterAxisPosition, ID374 (P5.086))
- Incremental Pulse of Master Axis - system variable 060(3Ch): the incremental number of pulses of the E-CAM master axis in 1ms.
- Lead Pulse of Master Axis - this variable is described as a Master Offset Position. That is, after the E-CAM has been enabled, this position is the incremental position that occurs (from the point of enabling) before the E-CAM is engaged (and following the Master).
- Position of Master Axis - system variable 062(3Eh): the position of the E-CAM master axis.

Go to Settings>Monitoring Status and select the variables to monitor by using Monitoring Items and running the monitor. You can map these variables to System Variable Monitoring values by using the Settings>Parameter Editor>Status Monitor. This setting lets you use the Scope to monitor the values real-time.

**Figure 198 - Monitoring Parameters**




When using the E-CAM, the Pulse Output function (KNX5100C>Settings>Pulse Output) provides pulses so the next drive can receive and follow those pulses.

The Kinetix 5100 drive only provides four pulse output pins OA, /OA, OB, /OB respectively. The pulse can be input to the drive through the I/O connector or AUX connector. The servo drive output signal source is determined by ID173 (P1.074.Y). If the AUX connector is used as the pulse input channel, as shown in Figure 199, then the value of ID173 (P1.074.Y) of each drive shall be set to 1. If the I/O connector is used as the pulse input channel, as shown in Figure 200, then the value of ID173 (P1.074.Y) of each drive is set to 2.

Figure 199 - Using Kinetix TBIO Pulses (Master) and Auxiliary Feedback (AUX) Connector (Slave)

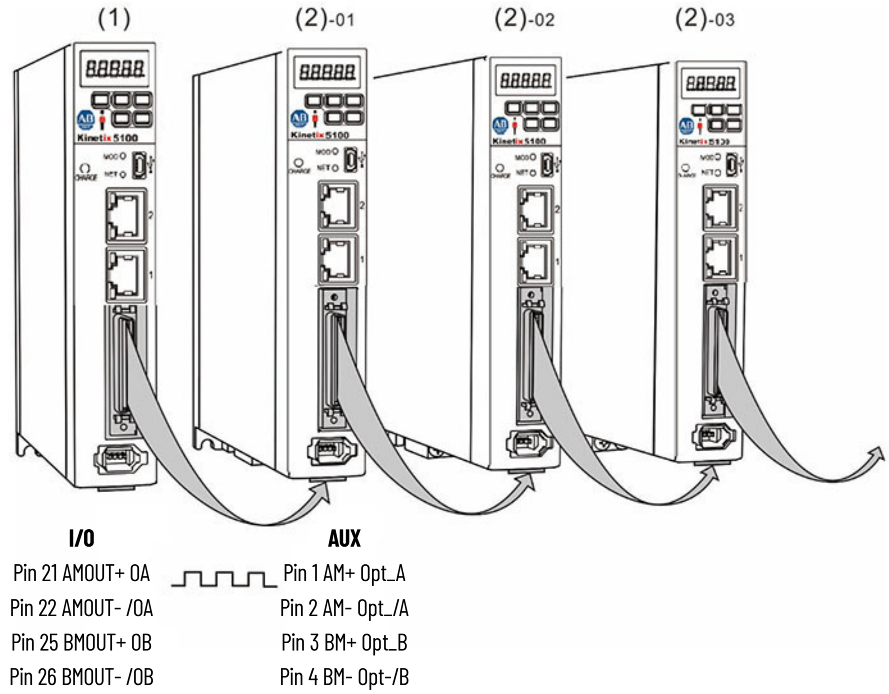
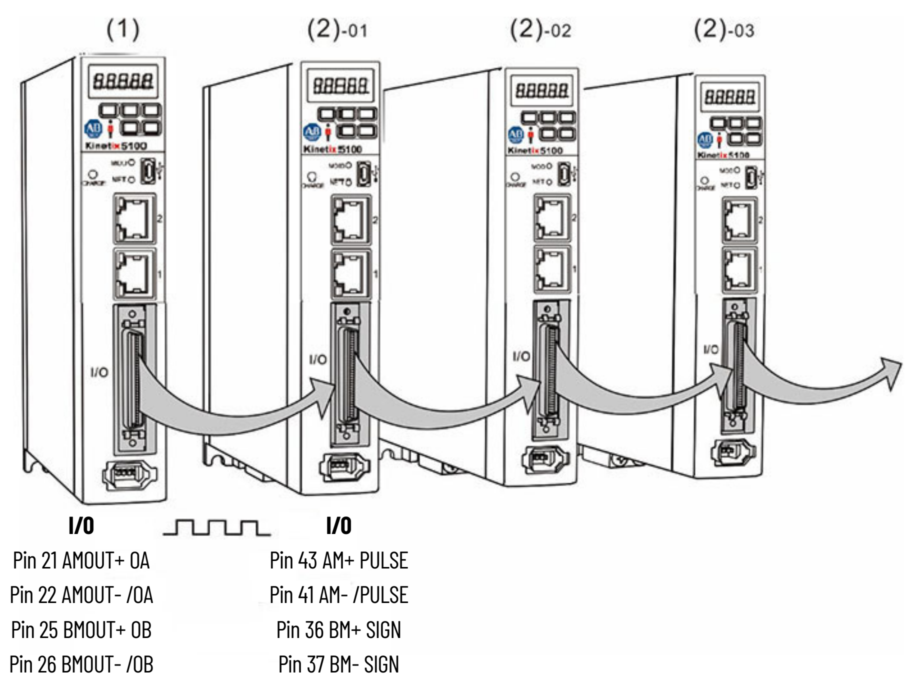



Figure 200 - Using Kinetix 5100 TBIO Pulses (Master) and Kinetix 5100 TBIO Pulses (Slave)



## Clutch Engagement and Disengagement

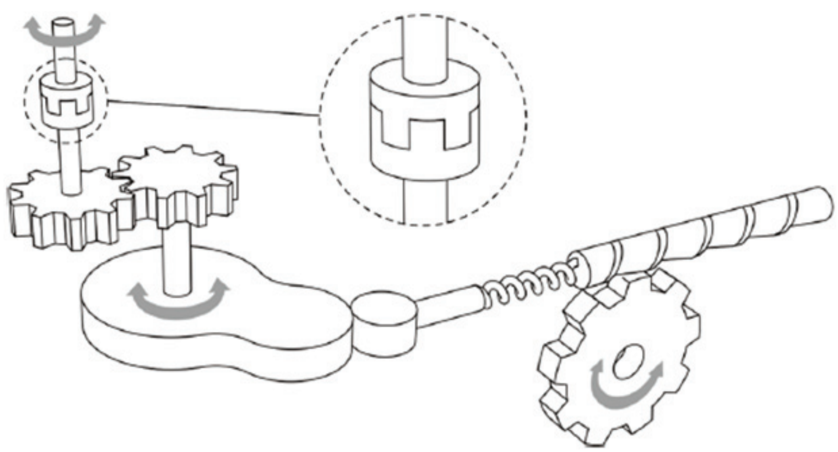
When the E-CAM function is enabled, the state of the clutch determines whether the slave axis start operates according to the received master axis signal or not. When the clutch is engaged, the slave axis operates according to the received master axis pulses and the cam curve. When the cam is disengaged, the slave axis does not operate according to the cam curve even if the slave axis receives master axis pulses.

### *Condition for Engagement*

When the E-CAM function is enabled, the slave axis can only be operated according to the master axis signal and the cam curve when the clutch is in the engaged state, as shown in Figure 201. The timing condition of the clutch engagement can be set by ECamControl parameter ID376 (P5.088.Z). The Kinetix 5100 drive provides two different timing conditions that are selectable.

- Immediate engagement (ECamControl ID376 (P5.088.Z) = 0) — The clutch is engaged immediately when the E-CAM function is active.
- Engagement using a Digital Input E-CAM engaging control [0x36] (ECamControl ID376 (P5.088.Z) = 1) — The clutch is engaged when the digital input DI:E-CAM engaging control [0x036] transitions on. When this DI is on, the clutch remains engaged until a disengagement condition is reached.

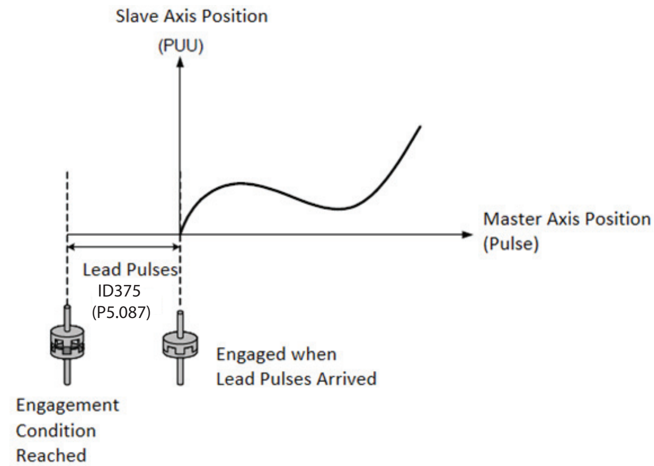
**Figure 201 - Clutch Engagement Diagram**



| | |
|---|---|
| **IMPORTANT** | The E-CAM function does not allow E-CAM engagement based on the absolute position of the master feedback source. |

In addition, the initial lead pulse number of the master axis before engagement is set by ECamLeadPulseBeforeEngaged parameter ID375 (P5.087). The E-CAM begins executing the profile when E-CAM function is enabled and the number of master pulses from ID375 (P5.087) occur, which is considered a type of offset from the immediate engagement type.

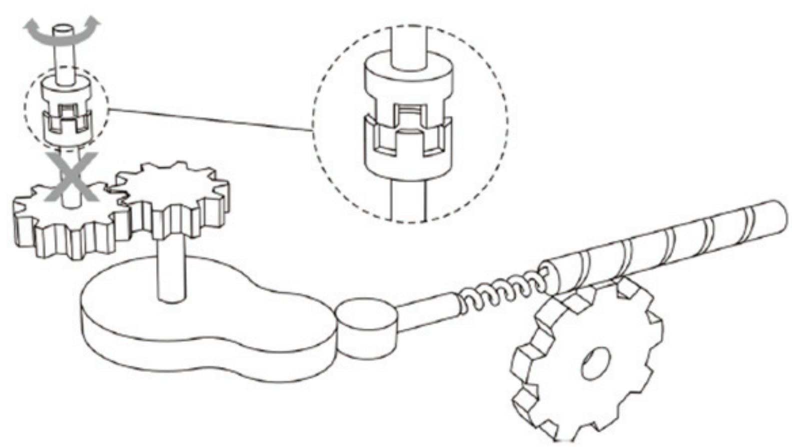
**Figure 202 - Clutch Engagement Lead Pulses**




*Condition for Disengagement*

When the E-CAM function is enabled and the clutch is engaged, the slave axis follows master pulses based on the cam curve. When the slave axis completes the cam cycle, it is stopped either by disabling the E-CAM function or disengaging the clutch. This action is shown in Figure 203. If the clutch is disengaged, the slave axis remains stationary regardless of the action of the master axis.

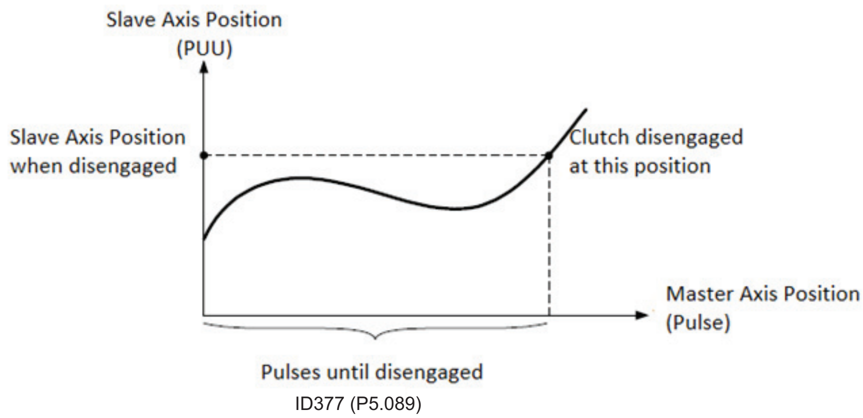
**Figure 203 - Clutch Disengagement Diagram**



You can choose the disengagement condition based on your requirements by setting ECamControl ID376 (P5.088). The Kinetix 5100 drive provides five disengagement timing conditions:

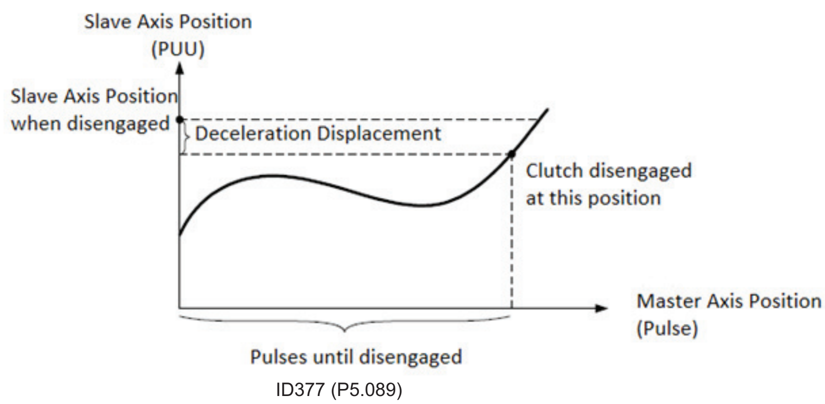
- Continuous (ID376 (P5.088.U) = 0 — The clutch does not disengage until the E-CAM function is disabled.
- Disengagement using Digital Input E-CAM engaging control (ID376 (P5.088.U) = 1) — The clutch is disengaged when the digital input (DI:E-CAM engaging control [0x036]) transitions off. It remains disengaged when this DI is OFF.
- Disengagement once ID376 (P5.088.U) = 2 — The clutch is disengaged and stops immediately when the number of master pulses reaches the value in ID377 (P5.089), which is shown in Figure 204. This disengagement condition is suitable for applications where the slave axis must be accurately stopped.

Figure 204 - Immediate Stop After Disengagement




- Deceleration stop after disengagement (ID376 (P5.088.U) = 6) — The clutch is disengaged and decelerates smoothly to stop when the number of pulses of master axis reached the value set by ID377 (P5.089). Then the E-CAM system enters the stop state, as shown in Figure 205. This disengagement condition is suitable for the application where the slave axis must be slowly decelerated to a stop.

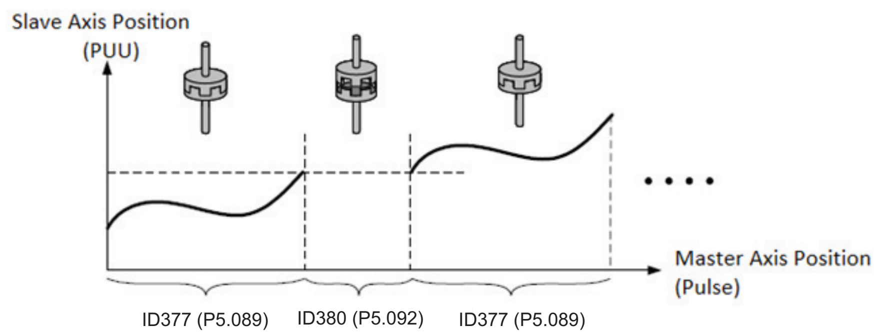
Figure 205 - Deceleration Stop After Disengagement



- Resuming PR Mode control after disengagement (ID376 (P5.088.U) = 4) — slave axis returns to the PR Mode operation after the master pulses have reached the value of ECamMasterPositionToDisengage ID377 (P5.089).

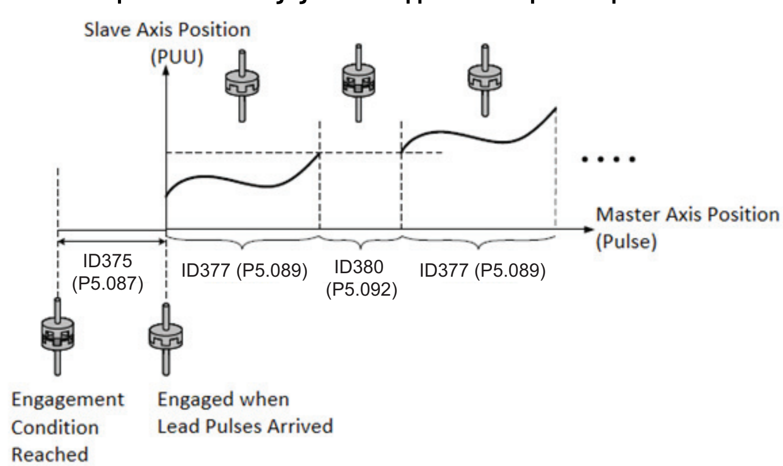
  The E-CAM system enters the pre-engage state, as shown in Figure 206. Once the ECamSkippedMasterPulses ID380 (P5.092) value occurs, the clutch engages and the next cam cycle begins.

**Figure 206 - Loop Mode After Disengagement**




Pay attention to the difference between the lead pulses before engaged ID375 (P5.087) and the skipped master position pulses before re-engage ID380 (P5.092). ID375 (P5.087) takes effect before the first engagement, and, ID380 (P5.092) takes effect for each E-CAM cycle. Figure 207 shows the schematic diagram of the combination of these two.

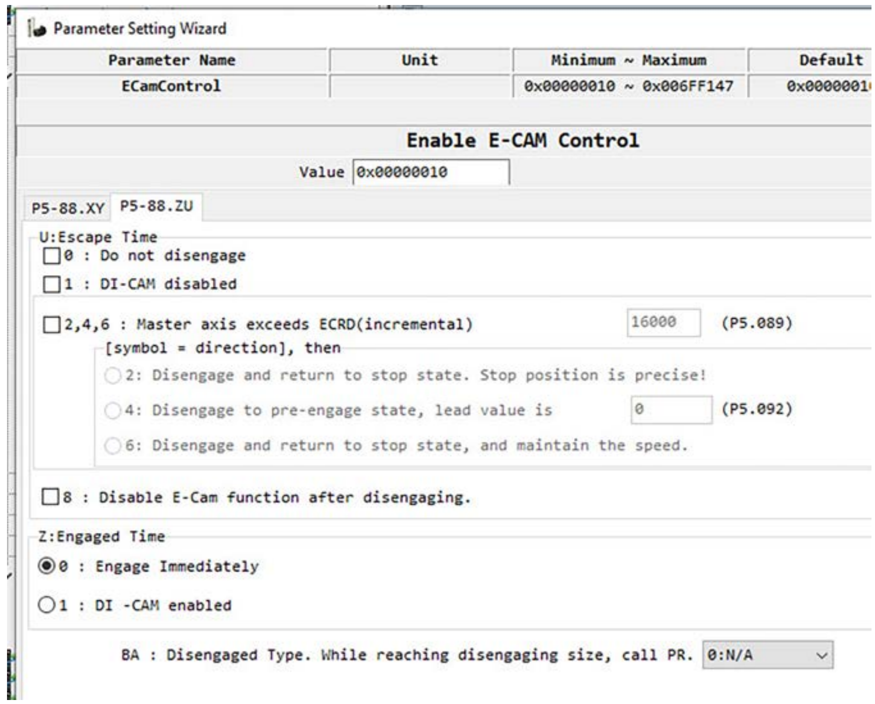
**Figure 207 - Lead pulses before engaged and Skipped master position pulses before re-engage**



These are the disengagement conditions.

- Immediate stop after disengagement
- Deceleration stop after disengagement
- Entering loop mode after disengagement (ID376 (P5.088.U) = 2, 4, 6)

**Figure 208 - Disengagement Dialog Box**




You can set the PR command after the disengagement condition is immediate stop after disengagement, deceleration stop after disengagement, or entering PR control mode after disengagement (ID376 (P5.088.U) = 2, 4, 6). When there is a non-zero value in instance ID376 (P5.088.BA), that PR command is executed. (ID376 (P5.088.U) = 4), the slave axis continues in the next motion cycle after PR command complete. That is because the E-CAM function doesn't support interrupt.

## E-CAM Alignment

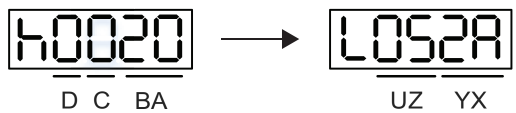
E-CAM phase alignment is a cam compensation method provided by the servo drive. You must first set the phase of the cam alignment and the position of the external sensor. Each time the cam runs to the position of the external sensor, the drive compares the difference between the actual phase and the correct phase. The difference is stored in the PR program. You can choose to compensate immediately or later.

**Table 123 - E-CAM Alignment Settings**

| Parameter | Name |
|---|---|
| ID245 (P2.073) | ECamConfiguration |
| ID246 (P2.074) | ECamDIDelayTimeCompensation |
| ID247 (P2.075) | ECamAlignementTargetPosition |

*E-CAM Alignment Operation Setting*

The settings for ID245 (P2.073)ECamConfiguration are described below.




| | | | |
|---|---|---|---|
| BA | PR number | YX | Range of filter (0…95%) |
| DC | Masking range (0 … 95%) | UZ | Maximum allowable correction rate (0…100%) |
| h | High bit | L | Low bit |

- YX - range of filter (0…95%)

  When the DI.ALGN Electronic cam phase alignment [0x35] signal is triggered, the E-CAM alignment function is enabled. The system detects the current E-CAM position. When the difference between the current E-CAM position and its previous alignment position is less than the parameter's range as a percentage, the filter function is enabled. Otherwise, the system uses the new position to do the alignment.

| YX | 00 | 01…5F |
|---|---|---|
| Function | Filter disabled | \| Error \| <= (1 to YX)%: filter enabled |

Using the filter allows the alignment to be more stable and reduces any position errors caused by DI noise and results in smoother operation.

- UZ - maximum allowable correction rate (0…100%)

  When alignment correction is enabled, the limitation of the maximum allowable correction rate (C) is defined as follows:

  |C|<= [(ID372) (P5.084) / ID371 (P5.083)] x ID245 (P2.073.UZ) %

  When the alignment error is too large, correcting this error once may cause motor vibration or overloading. Using this parameter can divide the alignment correction into several stages to smooth the process, but it may need more time to complete the alignment correction.

- BA: PR number (PR#0…PR#99)

  After each alignment, any shortage of pulse numbers from the slave axis is stored in a specified PR. This PR can compensate for the slave position at the appropriate timing point. If BA is set to 0, any shortage of pulse numbers is not stored in PR.

The format of this parameter is HEX. Thus, to set PR#11, write 0B to BA.

- DC: masking range (0…95%)

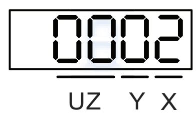
  When the DI.ALGN signal is triggered, the next alignment action is allowed only after the increasing pulses of the master axis are greater than the distance (M) masking.

  M >= ((ID372) (P5.084) / ID371 (P5.083)) x ID245 (P2.073.DC) %

**IMPORTANT** This masking function only works with increasing master pulses, and does not work for decreasing master pulses.

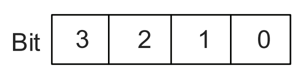
*E-CAM Alignment Control Switch*

The settings for ID248 (P2.076)ECamControlConfiguration are described below.




| | | | |
|---|---|---|---|
| X | E-CAM alignment control | UZ | Alignment forward direction allowable rate (0…100%) |
| Y | Filter intensity (0 - F) | - | - |

- X: E-CAM alignment control




| Bit | Function | Description |
|---|---|---|
| 0 | Enable alignment | Set this bit to 0 to disable this function; set this bit to 1 to enable this function. If enabled, the E-CAM alignment correction is executed when DI.ALGN is on. |
| 1 | Trigger PR immediately | Set this bit to 1 to enable this function. When the E-CAM alignment is executing, the correction is stored in the PR data location specified by ID245 (P2.073), which triggers the PR immediately.<br>Set this bit to 0 to disable this function. When the E-CAM alignment is executing, it does not trigger PR immediately to compensate the correction. You must use the PR ID376 (P5.088.BA) when E-CAM disengages in order to execute it. |
| 2 | Position of the mark | 0: if the mark is on the master axis, the position of the mark is not affected when aligning.<br>1: if the mark is on the slave axis, the position of the mark is affected when aligning. |
| 3 | Reserved | - |

- Y: filter intensity (0…F)

  Indicates average of 2^(value). Set to 0 to disable the filter. When the value of Y increases, the correction is slower which can avoid large amounts of correction during E-CAM adjustment.

  This can also avoid disturbances caused by sensor noise for a smoother operation. Setting ID248 (P2.076) too high causes the alignment to not work properly. The recommended value is 3.

  Example: when the filter intensity value is 3, the actual filter intensity = 2^3 = 8.
- UZ: alignment forward direction allowable rate (0…100%)

| Value | Alignment direction | Value | Alignment direction |
|---|---|---|---|
| 0 | Backward alignment only | 80 | Forward 80%, backward 20% |
| 30 | Forward 30%, backward 70% | >= 100 | Forward alignment only |
| 50 | Alignment with the shortest distance | - | - |

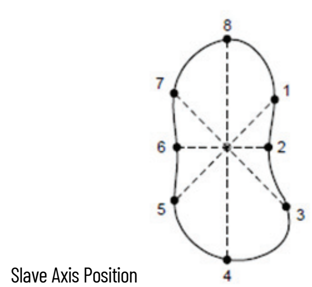
## E-CAM Profile Types

The electronic cam profile is a variable relationship between a master and slave signal. The cam profile can be built in a variety of ways and can be built using other mathematical software tools. The KNX5100C software uses the E-CAM editor to create and edit different types of profiles. Once the profile is created, it is stored in the Data Array. The following are some important considerations:

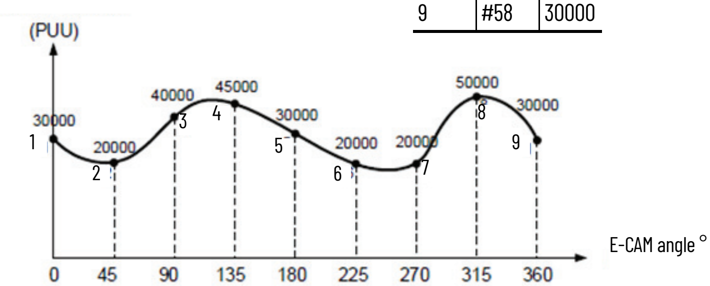
- One single profile can have up to 720 points.
- The Master data must all be within a value of 360. It is typical to think of this value as degrees because the drive does not use Position Units as scaling. This value can later be normalized in the E-CAM configuration to match your application, for example, pulses required for one machine cycle.
- The master data is not changeable when it is entered into the data table and is evenly spaced depending on the amount of points that are entered.

Take Figure 209 as an example, if a mechanical cam is to be replaced by an electronic cam, the mechanical cam must be divided into several equal parts. The more granular the divisions, the higher the accuracy. This example divides it into 8 equal parts. Each part is separated by 45 degrees (for example, the actual application may have finer definition (and granularity). The starting point of 0 degrees and the last point of 360 degrees is the same point. It is typical for these points to be used to define an entire machine cycle. Therefore, a total of 9 point pairs of data must be filled in to create the table of the electronic cam curve.

**Figure 209 - E-CAM Curve Table Creation**



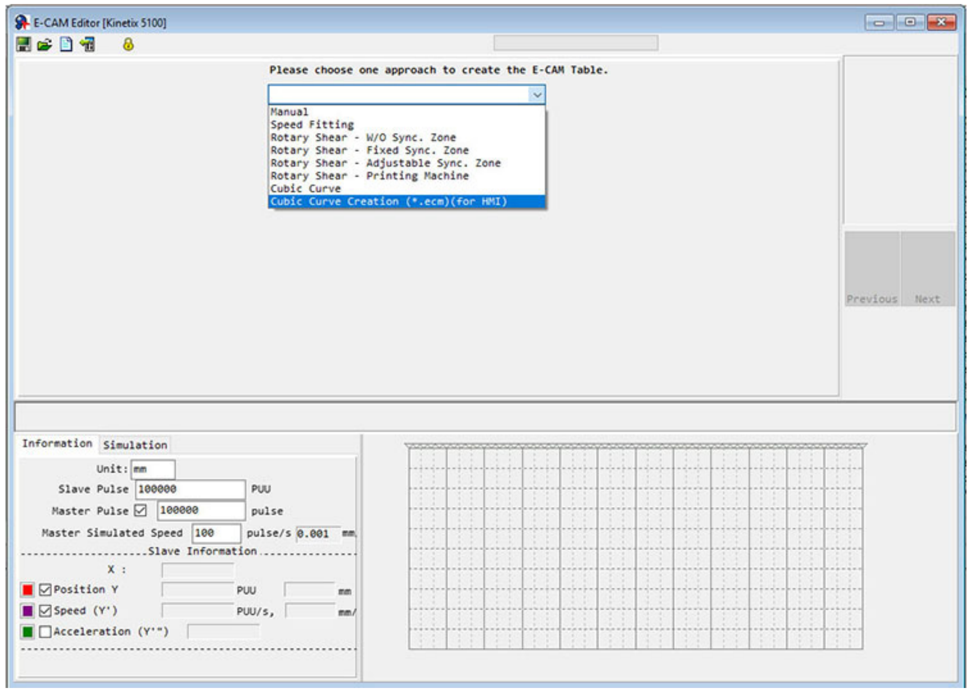

| | Data Array | |
|---|---|---|
| 1 | #50 | 30000 |
| 2 | #51 | 20000 |
| 3 | #52 | 40000 |
| 4 | #53 | 45000 |
| 5 | #54 | 30000 |
| 6 | #55 | 20000 |
| 7 | #56 | 20000 |
| 8 | #57 | 50000 |
| 9 | #58 | 30000 |



You can use KNX5100C software to create electronic cam curves. Navigate to Motion Control>E-CAM editor, shown in Figure 210.

The E-CAM editor contains a wizard that uses 4 steps to complete the E-CAM configuration. Step 1 is used to choose the approach to use for your E-CAM.

**Figure 210 - E-CAM Edit Dialog Box**




*Manual*

If the E-CAM table is already known, you can enter the points to complete the cycle profile. As shown in Figure 209, the E-CAM curve is created based on the cam curve-to-edge distance corresponding to each angle of the mechanical cam, which is relationship between the angle and the slave axis position. You must use your master machine cycle profile as degrees. These values can be normalized back into counts in the E-CAM editor Parameter Setting Step. The KNX5100C software E-CAM table manual creation interface is shown in Figure 211. The following are the steps to manually create the table:

1. Set the number of E-CAM segments.

   A single cam can be divided into up to a maximum of 720 segments (721 points). For a period of 360 degrees, every 0.5 degrees corresponds to a slave axis position. The more points, the higher the resolution. To select the most suitable number of segments, consider the resolution of the curve and the resource usage of the data array.

2. When the number of E-CAM segments is set, click Create Table.

   The software automatically divides the table evenly into 360 degrees by using the total number of segments.

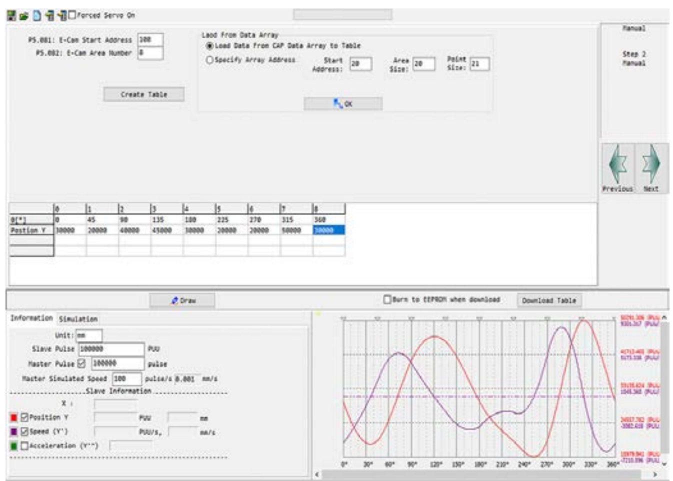
3. Fill in the position (Position Y) of the slave axis.

   The position corresponding to each segment angle is filled in the table in units of PUU. When you click Draw, the software automatically plots the E-CAM simulation curve and the position, velocity and acceleration curves. Pay special attention to the continuity of the slave axis speed in manual creation to use manageable axis dynamics.

4. After confirming that the curve is correct, click Download Table, to write the E-CAM curve to the data array.

   Because the E-CAM data is stored in the Data Array, it is volatile, which means that it does not persist through a power cycle. Once your E-CAM table is finalized, check 'Burn to EEPROM when download' and click Download. The data is saved and persists through a power cycle.

**Figure 211 - E-CAM Table Manual Creation**



### *Import Points*

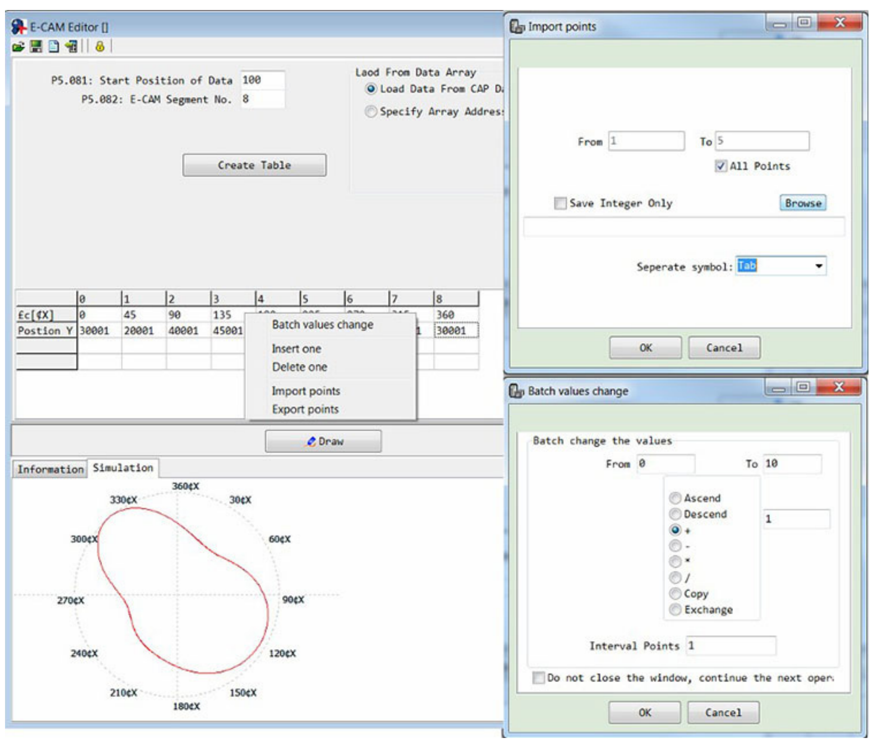
If you use the third-party software (such as: Excel) to create the table, you must save the position of each point as a text file (.txt). Separator symbol between each point should be indicated by Space, Tab, Enter, '|' or comma. Figure 212 illustrates the following steps.

1. Open the E-CAM editor in KNX5100C software, selecting the manual table and specify the number of E-CAM segments (ID370 (P5.082)).
2. Click Create Table, the table displays the E-CAM phase corresponding to each E-CAM segment.
3. Right-click the form and select Import Points.

   The import points dialog box appears.
4. Click Browse to open the stored text file, and select the separator symbol you used in the text file.
5. Click OK, to import the data points in the text file.
6. Click Draw and the software draws the designed E-CAM curve according to the data points.

You can also export the data points to text files by selecting 'Export Points'. The KNX5100C software provides a Batch Values Change feature, which includes functions of increment, decrement, add, subtract, multiply, divide, copy and exchange for you to quickly adjust the E-CAM curve. You can also right-click to insert and delete single-position positions.

**Figure 212 - E-CAM Import or Export Points**



*Speed Fitting*

This method creates a custom index profile on the slave that is based on the motion of the master. This method works best when the master is moving at a constant velocity. This method divides an E-CAM cycle into five zones: waiting zone, acceleration zone, constant speed zone, deceleration zone, and stop zone, as shown in Figure 213. The proportion of each zone can be adjusted. The E-CAM curve is designed from the position point of view. The corresponding speed to the master-slave axis is determined by the position change per time unit. The KNX5100C E-CAM table creation by using the speed fitting method is shown in Figure 214.

1. To plan the E-CAM curve, determine the proportion of waiting zone, acceleration zone, constant speed zone, deceleration zone, and stop zone in one cycle according to the required distribution.
2. Set the motion distance.

   The total travel distance of the slave axis in one cycle, the unit is PUU.
3. Set the smoothness of the position curve at the turning point.

   The larger the set value, the smoother the motor change during acceleration and deceleration. A smoother curve extends the running time in one cycle. The value of the S curve is usually the same as the number of data points in the stop zone or less than the number of data points in the stop zone.
4. After confirming that the curve is correct, click Download Table, then the E-CAM curve is written to the data array.

   Because the E-CAM data is stored in the Data Array, it is volatile, which means that it does not persist through a power cycle. Once your E-CAM table is finalized, check 'Burn to EEPROM when download' and click Download. The data is saved and persists through a power cycle.

**Figure 213 - Speed Zone Definition**

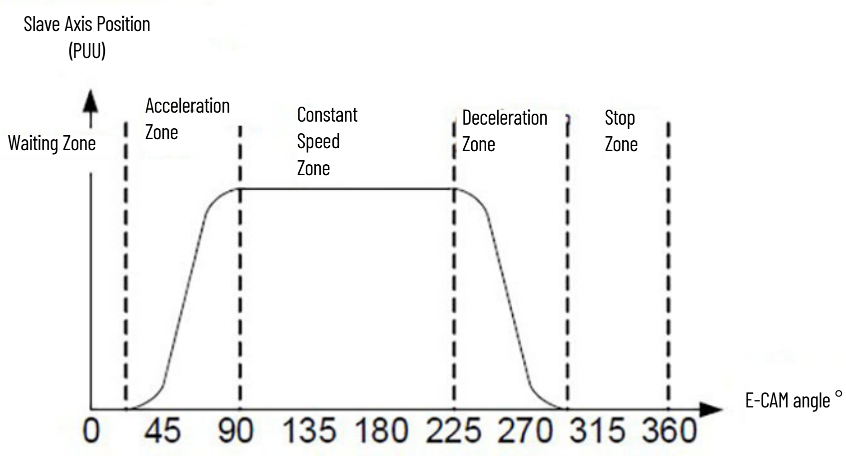
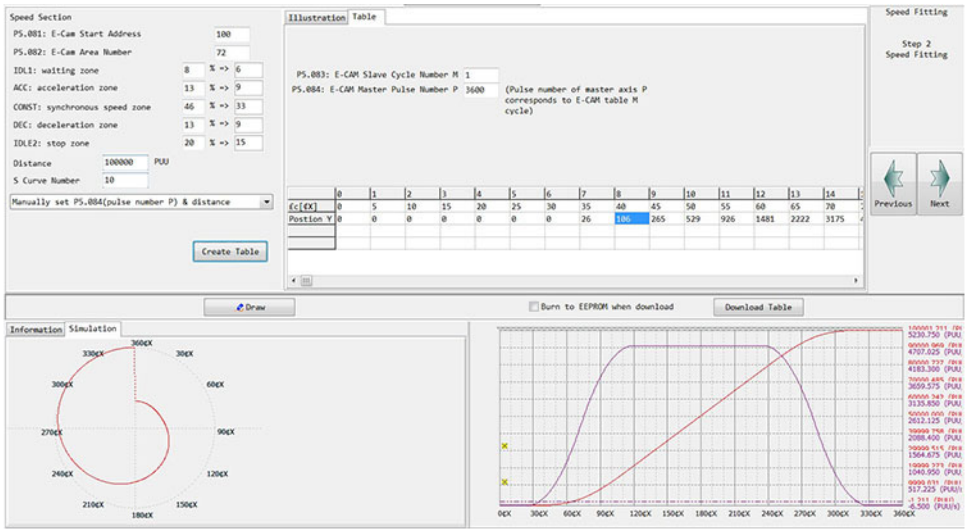


**Figure 214 - E-CAM Speed Fitting Table**



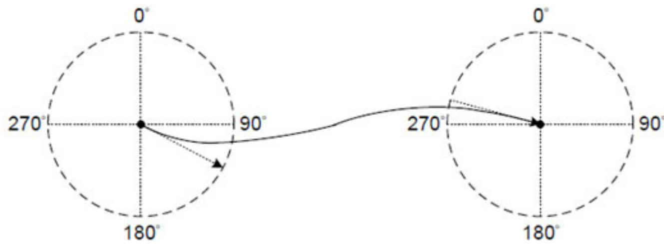

*Cubic Curve*

When the master-slave axis only has position correspondence, such as point-to-point correspondence, then the cubic curve can be used to create an electronic cam curve. When using the cubic curve to create a table, you only need to fill in the phase angle with the corresponding slave axis position. The software automatically draws and optimizes the curve. Some applications require a point-to-point motion trajectory, such as a straight line or a curve. The E-CAM curve creation is simplified by the cubic curve creation method. As shown in Figure 215, the starting angle N1 (the angle from the starting point) and the ending angle N2 (the angle of entering the target point) can be set according to the application requirements. There are three different types of curve:

- Straight line — There is a straight line between the two data points of the cam. The starting angle and the ending angle are not adjustable.
- Constant acceleration — A unidirectional increasing or decreasing curve with an equal acceleration and deceleration. Only the starting angle can be adjusted.

- Cubic curve — Both the starting angle and the ending angle can be adjusted. The change of the angle will affect the speed change when leaving the starting point and entering the target point. Improper angle setting causes the speed to change sharply.

**Figure 215 - Starting and Ending Angle**




The KNX5100C software E-CAM table creation by cubic curve method is shown in Figure 216. The following is the operation steps of the cubic curve table creation:

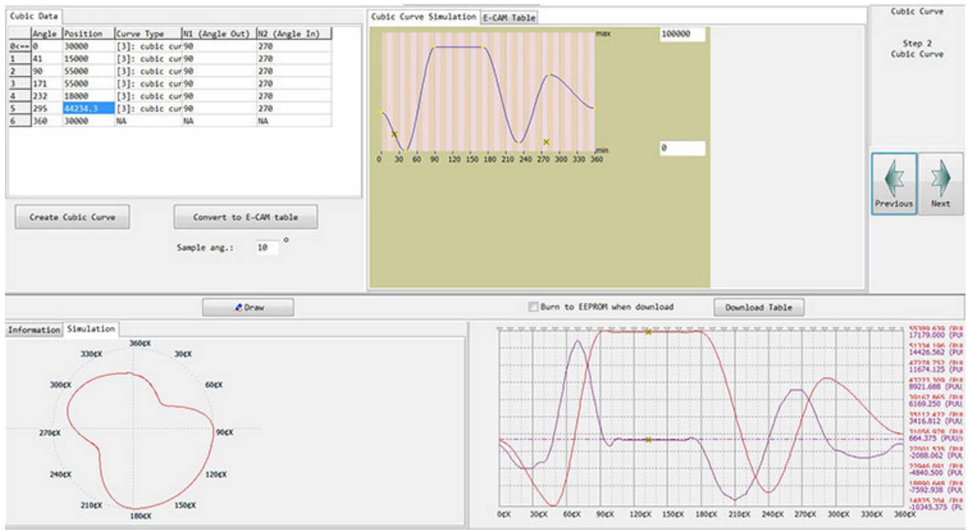
1. Set E-CAM curve.

   The cubic curve table data includes angle, slave axis position, curve type, starting angle and ending angle. You can change the data corresponding to each point by dragging the turning point in the Cubic Curve Simulation diagram, and can also insert or delete a specific turning point. When dragging, inserting, or deleting a turning point, the data content in the Cubic Data changes accordingly. However, when directly inputting the desired content into Cubic Data, click Create Cubic Curve to see the cubic curve simulation.
2. After completing the setting of the turning point, set the sample angle (Sample ang.) and click Convert to E-CAM table.

   The software automatically fills the data of each sampling point into the E-CAM table according to the curve. The more points, the more precise the E-CAM curve. If the position of the slave axis is too small, that can cause the speed jitter. You can adjust the parameter instance ID311 (P5.019) ECamCurveScale to enlarge the value in the table to improve the speed jitter.
3. After confirming that the curve is correct, click Download Table.

   The E-CAM curve is written to the data array. If you have selected 'Burn to EEPROM when download', when you click the download button, the data array is written to the EEPROM that can be held after the power is turned off.

**Figure 216 - E-CAM Cubic Curve Table**



### Table 124 - E-CAM Wizard Parameter Definitions

| ID | Parameter | Name | Description |
|---|---|---|---|
| 369 | P5.081 | E-CAMStart Address | This is the starting address of the Data Array that is used as the first point in the E-CAM profile. |
| 370 | P5.082 | E-CAM Area Number | This is the length of the Cam profile - this value uses the data array (max 720). |
| 373 | P5.085 | E-CAM Engaged Area Number | Data Array index value used as the first cam point to be executed. |
| 374 | P5.086 | E-CAM Master Axis position | Displays the feedback Position of the Master feedback source. |
| 375 | P5.087 | E-CAM Lead Pulse Before Engaged | Master Offset Position - from when the enable permissives are met and the E-CAM is ready to execute, this number of pulses occurs before the slave begins following. |
| 378 | P5.090 | E-CAM DO.CAM_Area Valid Start Angle | Specify the rising edge of the DO that can be used to show the E-CAM is engaged (Master pulses). |
| 379 | P5.091 | E-CAM DO.CAM_Area Valid End Angle | Specify the falling edge of the DO that can be used to show E-CAM is Engaged (Master units). |
| 311 | P5.019 | E-CAM Curve Scale | Used to change the amplitude of the cycle profile in terms of speed (positioning follows the cycle profile). |
| 371 | P5.083 | E-CAM SlaveCycleNumber M | This profile is executed according to this value. If 2 is entered, the entire cycle profile executes 2 times and the speed is also 2x as fast. If 3 is entered, the cycle profile is executed 3 times and the speed is 3 times as fast |
| 372 | P5.084 | E-CAM MasterPulseNumber P | The E-CAM editor uses 0…360 for master units and is not changeable. If your machine cycle is not representative within the 0…360 units; for example, using time and 4000 ms for one machine cycle, enter the value used to represent one machine cycle. This value is the normalizing parameter used for the E-CAM. |

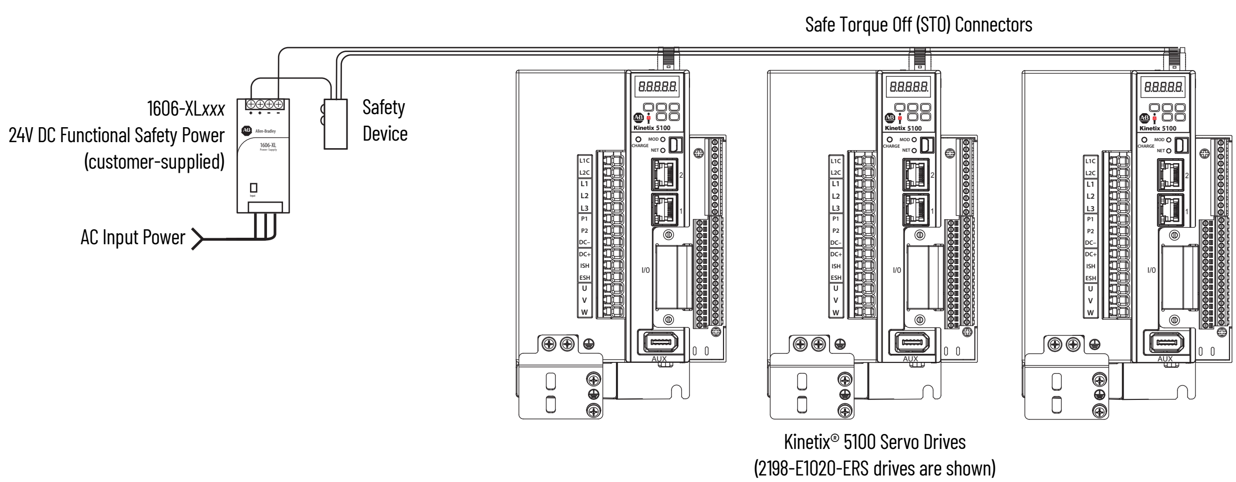
# Kinetix 5100 Safe Torque Off (STO) Feature

The 2198-E*xxxx*-ERS servo drives are equipped for hardwired Safe Torque Off (STO). The hardwired STO function meets the requirements of Performance Level d (PLd) and safety category 3 (CAT 3) per ISO 13849-1 and SIL 2 per IEC 61508, IEC 61800-5-2 and IEC 62061.



The 2198-E*xxxx*-ERS servo drives use the STO connector for wiring external safety devices and cascading hardwired safety connections from one drive to another.

**Figure 217 - Hardwired Safe Torque Off**



## Certification

The TÜV Rheinland group has approved 2198-E*xxxx*-ERS servo drives with hardwired safe torque-off for use in safety-related applications up to ISO 13849-1, Performance Level d (PL d) and Category 3, SIL CL 2 per IEC 61508, IEC 61800-5-2, and IEC 62061, in which removing the motion producing power is considered to be the safe state.

For product certifications currently available from Rockwell Automation, go to website rok.auto/certifications.

### Important Safety Considerations

The system user is responsible for the following:

- Validation of any sensors or actuators connected to the system
- Completing a machine-level risk assessment
- Certification of the machine to the desired ISO 13849-1 performance level or IEC 62061 SIL level
- Project management and proof testing in accordance with ISO 13849

### Category 3 Requirements According to ISO 13849-1

Safety-related parts are designed with these attributes:

- A single fault in any of these parts does not lead to the loss of the safety function.
- A single fault is detected whenever reasonably practicable.
- Accumulation of undetected faults can lead to the loss of the safety function and a failure to remove motion producing power from the motor.

### Stop Category Definition

Stop Category 0 as defined in IEC 60204 or Safe Torque Off (STO) as defined by IEC 61800-5-2 is achieved with immediate removal of motion producing power to the actuator.

| | |
|---|---|
| **IMPORTANT** | In the event of a malfunction, the most likely stop category is Stop Category 0. When designing the machine application, timing and distance must be considered for a coast to stop. For more information regarding stop categories, refer to IEC 60204-1. |

### Performance Level (PL) and Safety Integrity Level (SIL)

For safety-related control systems, Performance Level (PL), according to ISO 13849-1, and SIL levels, according to IEC 61508 and IEC 62061, include a rating of the systems ability to perform its safety functions. All of the safety-related components of the control system must be included in both a risk assessment and the determination of the achieved levels.

Refer to the ISO 13849-1, IEC 61508, and IEC 62061 standards for complete information on requirements for PL and SIL determination.

## Description of Operation

The Safe Torque Off (STO) feature provides a method, with sufficiently low probability of failure, to force the power-transistor control signals to a disabled state. When disabled, or any time power is removed from the safety enable inputs, all of the drive output-power transistors are released from the ON-state. This results in a condition where the drive performs a Category 0 Stop. Disabling the power transistor output does not provide mechanical isolation of the electrical output that is required for some applications.

For hardwired control of the safe torque-off function, the appropriate wiring must be connected to the Safety connector plug. Refer to Safe Torque Off Specifications on page 410 for more information on the safety inputs.

Under normal operation, the safe torque-off inputs are energized. If an STO fault is detected, then all of the output power transistors turn off. The safe torque-off response time is less then 20 ms.

**ATTENTION:** Permanent magnet motors can, in the event of two simultaneous faults in the IGBT circuit, result in a rotation of up to 180 electrical degrees.

**ATTENTION:** If either of the safety enable inputs are de-energized for more than 1 second, or both inputs are in the OFF state simultaneously for more than 10 ms, a fault condition results.

The ServoOutputStatus parameter represents various drive status values. Bit 0 (Servo Ready) is used to indicate the status of the Safe Torque Off inputs. This bit can be monitored in KNX5100C software.

**Figure 218 - ServoOutputStatus Parameter Setting**

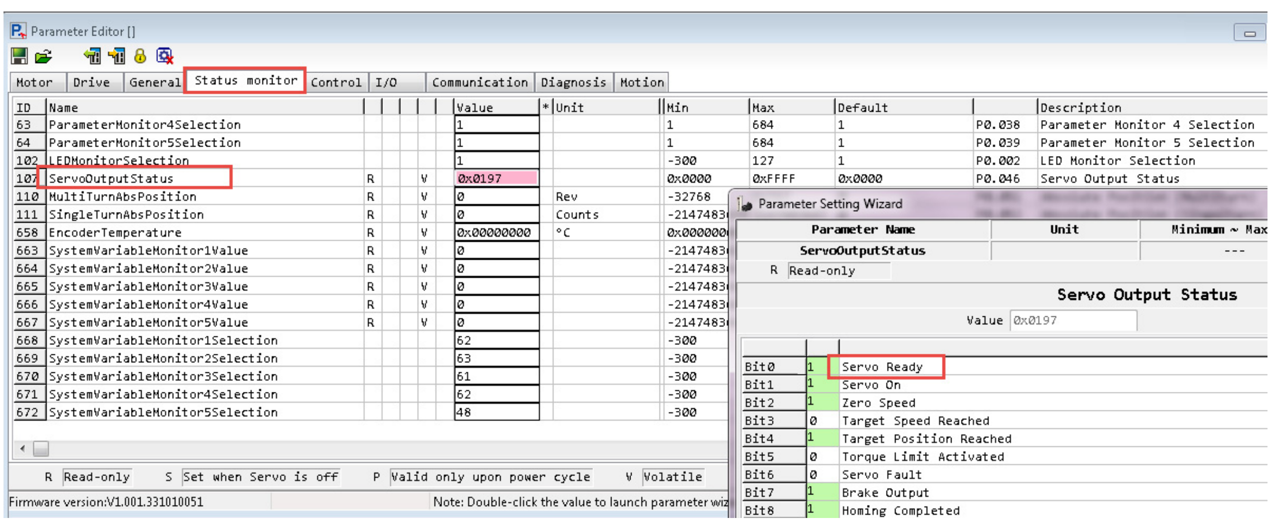
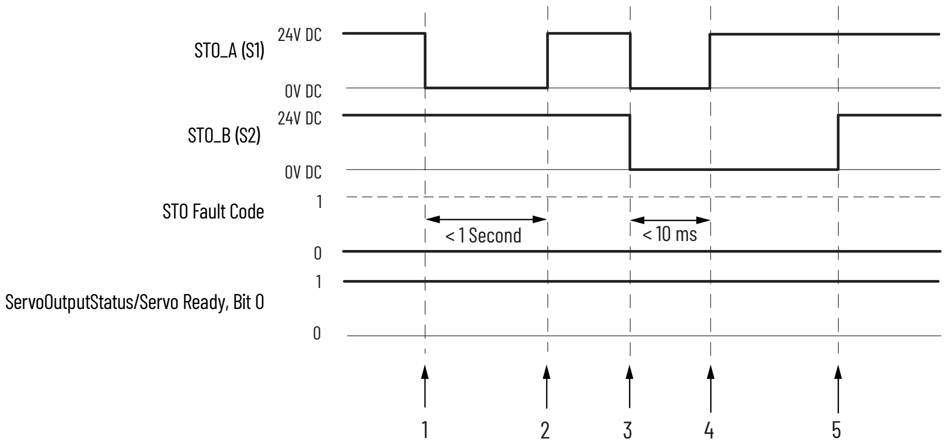


Table 125 - ID107 (P0.046) ServoOutputStatus

| Channel | Status of Output (1) | | | |
|---|---|---|---|---|
| STO_A | ON | ON | OFF | OFF |
| STO_B | ON | OFF | ON | OFF |
| Status | Ready (2) | Torque off (3) | Torque off (4) | Torque off (5) |

(1) ServoOutputStatus is located in KNX5100C software>Parameter Editor>Status Monitor.
(2) Kinetix 5100 drive is Ready and able to produce torque (current) to the motor. ServoOutputStatus/Servo Ready (Bit 0) = 1.
(3) When STO_B is lost for more than 1 second, with STO_A high, the Kinetix 5100 drive faults (E 502) and has no motor torque (current). ServoOutputStatus/Servo Ready (Bit 0) = 0.
(4) When STO_A is lost for more than 1 second, with STO_B high, the Kinetix 5100 drive faults (E 501) and has no motor torque (current). ServoOutputStatus/Servo Ready (Bit 0) = 0.
(5) When both STO_A and STO_B are lost for more than 10 ms, the Kinetix 5100 drive faults (E 500) and has no motor torque (current). ServoOutputStatus/Servo Ready (Bit 0) = 0.

Figure 219 - System Operation when Inputs are Meeting Timing Requirements




| Event | Description |
|---|---|
| 1 | One input is switched-off and second input is on. |
| 2 | First input is switched-on within 1 second. |
| 3 | Both inputs are switched-off. |
| 4 | Both inputs are in OFF state simultaneously within 10 ms. |
| 5 | Second input is switched-on within 1 second of event 4. |

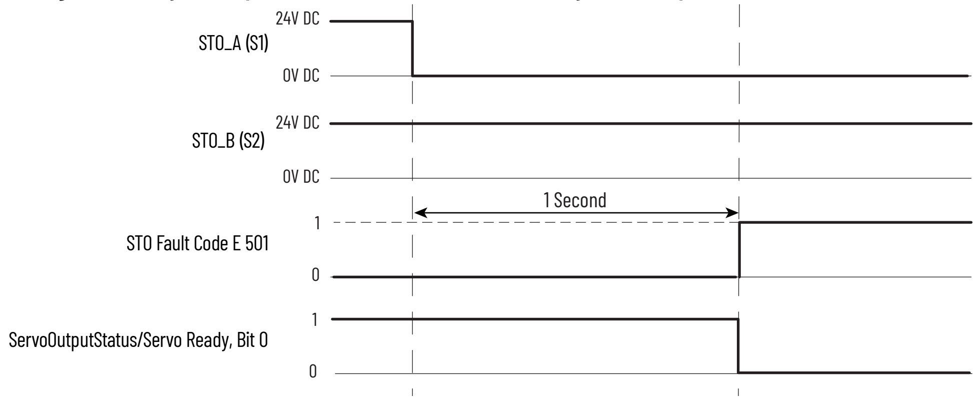
## STO-related Fault Codes

This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

For information on how to clear faults, see Clear Faults on page 444.

Figure 220 demonstrates when the safe torque-off mismatch is detected and fault E 501 (STO_A signal loss) or E 502 (STO_B signal loss) is posted.

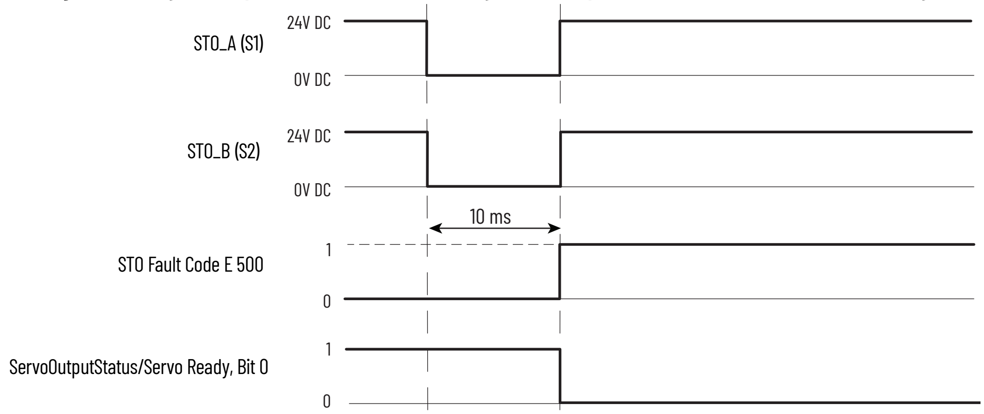
**Figure 220 - System Operation in the Event that the Safety Enable Inputs Mismatch**




When the STO self-diagnostic (STO circuit and wiring, for example) fails, fault E 503 is posted.

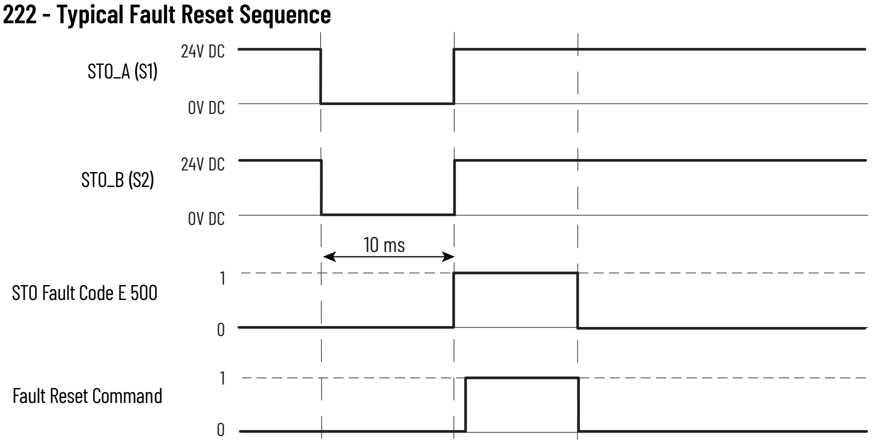
Figure 221 demonstrates when both inputs in the OFF state are detected and fault E 500 (STO enabled) is posted.

**Figure 221 - System Operation When Both Safety Enable Inputs are in OFF State Simultaneously**




**ATTENTION:** The safe torque-off fault is detected upon demand of the Safe Torque Off (STO) function. After troubleshooting the STO function or performing maintenance that might affect the STO function, the STO function must be executed to verify correct operation.

**Figure 222 - Typical Fault Reset Sequence**



**IMPORTANT** The STO fault (E 500) can be reset only if both inputs are in the ON state. After the fault reset requirement is satisfied, a Fault Reset (AOI: raC_xxx_K5100_MAFR instruction) command in the application software or DI.ARST (physical input) must be issued to reset the E 500 fault. You can reset faults E 501, E 502, and E 503 with power cycle.

For Safety Status (SS), you can configure one parameter/attribute, ID252 (P2.093) STOFeedbackConfiguration and determine whether SS will latch, if an STO fault occurs. If SS signal is latched when STO fault occurs, the status of SS signal remains even when the fault has been cleared.

**Figure 223 - Parameter Format Legend**

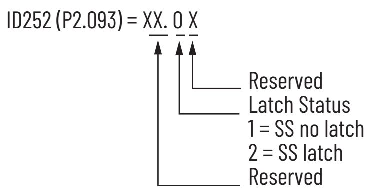



**Table 126 - SS Signal Status/Behavior for STO Faults**

| Servo Drive Status | | SS Signal Status (1) | |
|---|---|---|---|
| Parameter ID252 (P2.093) | | XX1X | XX2X |
| SS signal behavior | | No latch | Latch |
| No STO fault occurs | | Open | |
| STO fault occurs | E 500 | Close | |
| | E 501 | Open | |
| | E 502 | Open | |
| | E 503 | Open | |

(1) Open indicates no continuity between SS+ and SS- an open circuit. Close indicates continuity between SS+ and SS- is a short circuit.

## Average Frequency of a Dangerous Failure per Hour

Safety-related systems are classified as operating in a High-demand/continuous mode. The SIL value for a High-demand/continuous mode safety-related system is directly related to the probability of a dangerous failure occurring per hour (PFH).

PFH calculation is based on the equations from IEC 61508 and show worst-case values. Table 127 provides data for a 20-year proof test interval and demonstrates the worst-case effect of various configuration changes on the data.

**IMPORTANT** Determination of safety parameters is based on the assumptions that the system operates in High-demand mode and that the safety function is requested at least once every three months.

**Table 127 - PFH for 20-year Proof Test Interval**

| Attribute | Value |
|---|---|
| PFH (1e-9) | 0.96 |
| Proof test (years) | 20 |

## Safe Torque Off Connector Data

The Kinetix 5100 drive ships with the (8-pin) wiring-plug header that connects your safety circuit to the Kinetix 5100 drive Safe Torque Off (STO) connector. The header includes jumper wires that by-pass the safety function for drives that do not use the Safe Torque Off feature. Remove the jumper wires when the Safe Torque Off feature is used.

Figure 224 - Pin Orientation for 8-pin Safe Torque-off Connector

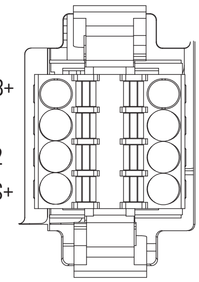



Table 128 - Kinetix 5100 Drive Safe Torque Off Connector Pinout

| Description | Signal |
|---|---|
| Used for safety jumper + | SB+ |
| Used for safety jumper – | SB– |
| STO_A+ | S1 |
| STO_A- | S1C |
| STO_B+ | S2 |
| STO_B- | S2C |
| Safety status or feedback | SS+ |
| Safety status or feedback | SS– |

**IMPORTANT** Use pins SB+ and SB– only for the by-pass jumpers to defeat the Safe Torque Off function. When the Safe Torque-off function is in operation, the 24V supply must come from an external source.

## Wire the Safe Torque Off Circuit

This section provides guidelines for wiring your Kinetix 5100 Safe Torque Off (STO) drive connections.

**IMPORTANT** The National Electrical Code and local electrical codes take precedence over the values and methods provided.

**IMPORTANT** To improve system performance, run wires and cables in the wireways as established in Establish Noise Zones beginning on page 37.

**IMPORTANT** Pins SB+ and SB– are used to disable the safe torque-off function. When wiring to the STO connector, use an external 24V supply for the external safety device that triggers the safe torque-off request. To avoid jeopardizing system performance, do not use pin SB+ as a power supply for the external safety device.

## Safe Torque Off Wiring Requirements

The Safe Torque Off (STO) connector uses spring tension to secure the wire. Depress the orange tab along side each pin to insert or release the wire. Wire must be copper with 75 °C (167 °F) minimum rating.

**IMPORTANT** Stranded wires must terminate with ferrules to prevent short circuits, per table D.4 of ISO 13849-2:2012.

**Figure 225 - Safe Torque Off Terminal Plug**

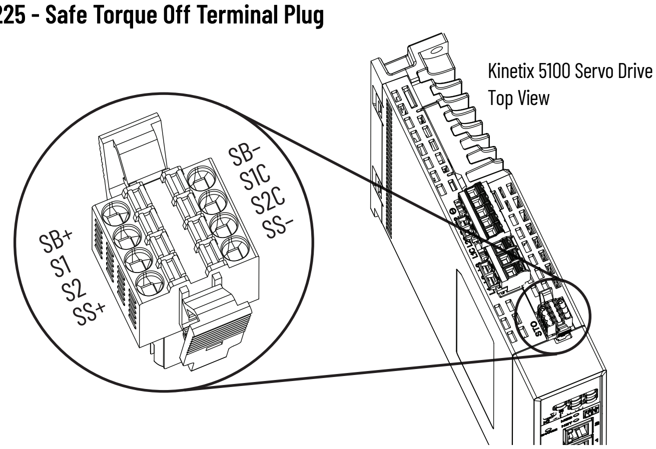



**Table 129 - Safe Torque Off Terminal Plug Wiring**

| Signal | Recommended Wire Size<br>mm² (AWG) | Strip Length<br>mm (in.) | Torque Value<br>N•m (lb•in) |
|---|---|---|---|
| SB+<br>SB-<br>S1<br>S1C<br>S2<br>S2C<br>SS+<br>SS- | 0.75 (18))<br>(stranded wire with ferrule)<br><br>1.5 (16)<br>(solid wire) | 8.0 (0.31) | N/A (1) |

(1) This connector uses spring tension to hold the wires in place.

## Safe Torque Off Feature

The Safe Torque Off (STO) circuit, when used with suitable safety components, provides protection according to ISO 13849-1 (PLd), Category 3 or according to IEC 61508, IEC 61800-5-2, and IEC 62061 (SIL CL2). All components in the system must be chosen and applied correctly to achieve the desired level of operator safeguarding.

The Safe Torque Off circuit is designed to safely turn off all of the output-power transistors. You can use the Safe Torque Off circuit in combination with other safety devices to achieve Stop Category 0 and protection-against-restart as specified in IEC 60204-1.

**ATTENTION:** This option is suitable only for performing mechanical work on the drive system or affected area of a machine. It does not provide electrical safety.

**SHOCK HAZARD:** In Safe Torque Off mode, hazardous voltages can still be present at the drive. To avoid an electric shock hazard, disconnect power to the system and verify that the voltage is zero before performing any work on the drive.

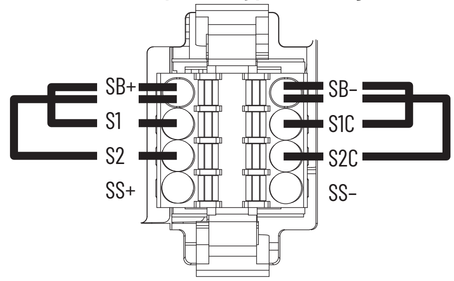
**ATTENTION:** Personnel responsible for the application of safety-related programmable electronic systems (PES) shall be aware of the safety requirements in the application of the system and shall be trained in using the system.

## Safe Torque Off Feature Bypass

The 2198-E*xxxx*-ERS drives do not operate without a safety circuit or safety bypass wiring. For applications that do not require the Safe Torque Off (STO) feature you must install jumper wires (included with the drive) to bypass the safe torque-off circuitry.

Each 2198-E*xxxx*-ERS drive includes one 8-pin wiring plug for wiring to safety devices. Jumper wires are installed by default to bypass the safety function, as shown in Figure 226. With the jumper wires installed, the Safe Torque Off feature is not used.

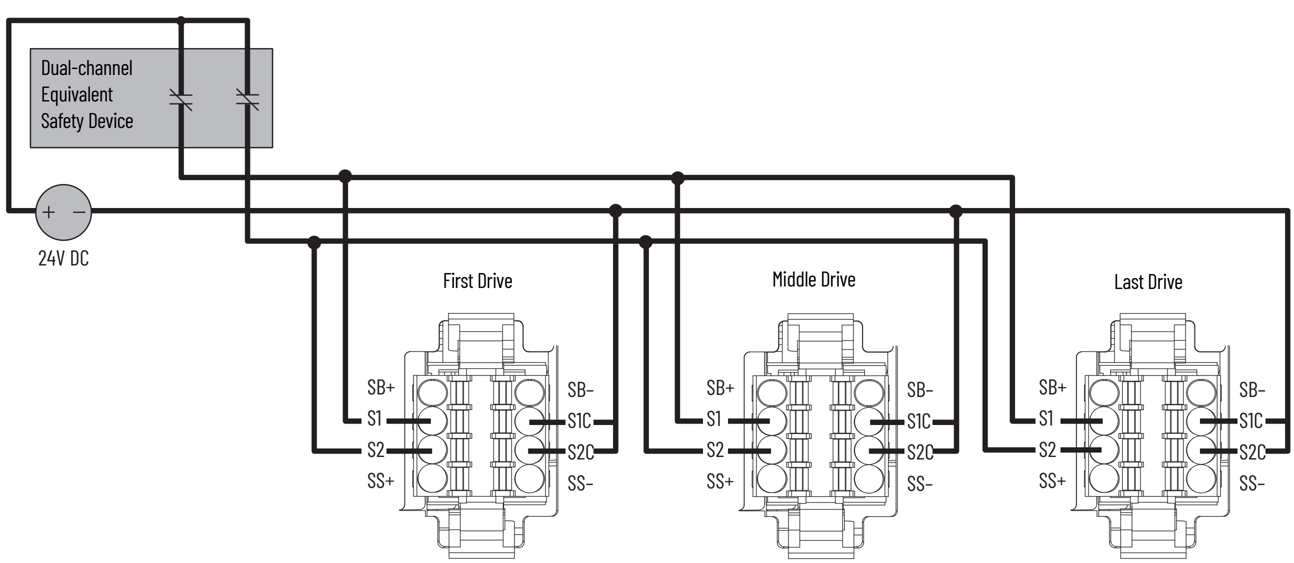
**Figure 226 - Safe Torque Off Bypass Wiring**




## Cascade the Safe Torque Off Signal

The total number of drives in a single cascaded safety circuit is limited by the current carrying capacity of the cascaded safety circuit. Refer to Table 130 for current rating per channel, per drive.

**Figure 227 - Cascaded Safe Torque Off Wiring**



## Safe Torque Off Specifications

To maintain the safety rating, Kinetix 5100 drives must be installed inside protected control panels or cabinets appropriate for the environmental conditions of the industrial location. The protection class of the panel or cabinet must be IP54 or higher.

**Table 130 - Safe Torque Off Signal Specifications**

| Attribute | | Value |
|---|---|---|
| Safety inputs (per channel) | Input ON voltage | 11…30V DC |
| | Input OFF voltage, max | 5V DC |
| | Input ON current, per input, max | 7.34 mA |
| | Input OFF current, max (@ V in < 5V DC) | 2.9 mA |
| | Pulse rejection width | 60 µs |
| | Feedback output OFF current, max | 100 µA |
| | Feedback output ON current, max | 40 mA |
| | Feedback output OFF voltage, max | 30V DC |
| | Feedback output ON voltage, max | 1.5 V @ 40 mA |
| | External power supply | SELV/PELV |
| | Input type | Optically isolated and reverse voltage protected |

## Safe Torque Off Wiring Diagrams

This section provides a typical wiring diagram for the Kinetix 5100 Safe Torque Off (STO) feature with other Allen-Bradley® safety products.

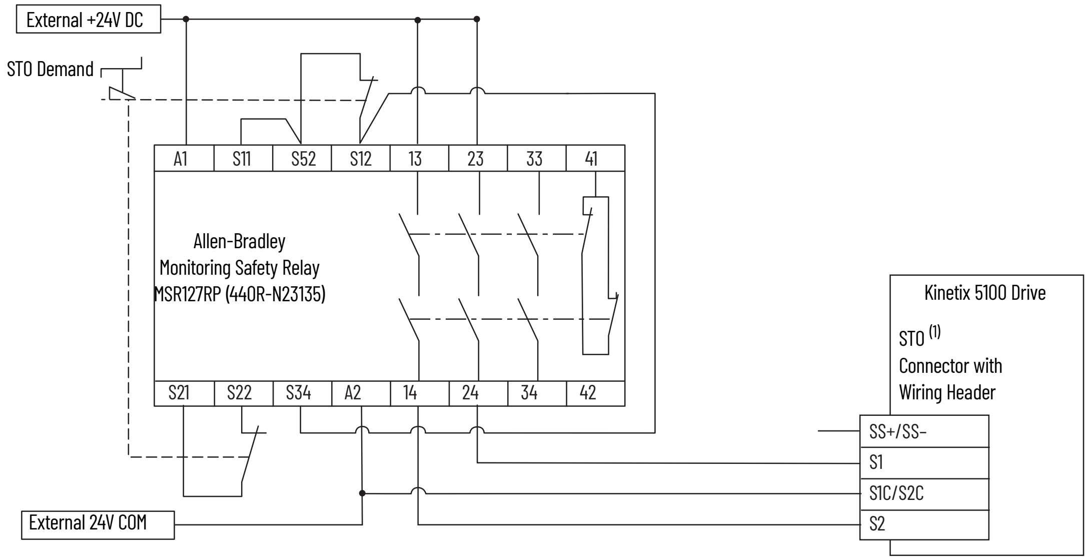
For additional information regarding Allen-Bradley safety products, including safety relays, light curtain, and gate interlock applications, see the Safety Components, webpage https://www.rockwellautomation.com/en_NA/products/safety-components/overview.page.

The drive is shown in a single-axis relay configuration for Stop Category 0 per IEC-60204-1 Safety of Machinery Directive. This is an example, however, and your application can differ based on the required overall machine performance level requirements.

**IMPORTANT** The Kinetix 5100 drive has been qualified and rated as a component to meet ISO 13849-1 performance level d (PLd), category 3.

It is suggested to evaluate the entire machine performance level required with a risk assessment and circuit analysis. Contact your local distributor or Rockwell Automation Sales for more information.

**Figure 228 - Single-axis Relay Configuration (Stop Category 0)**

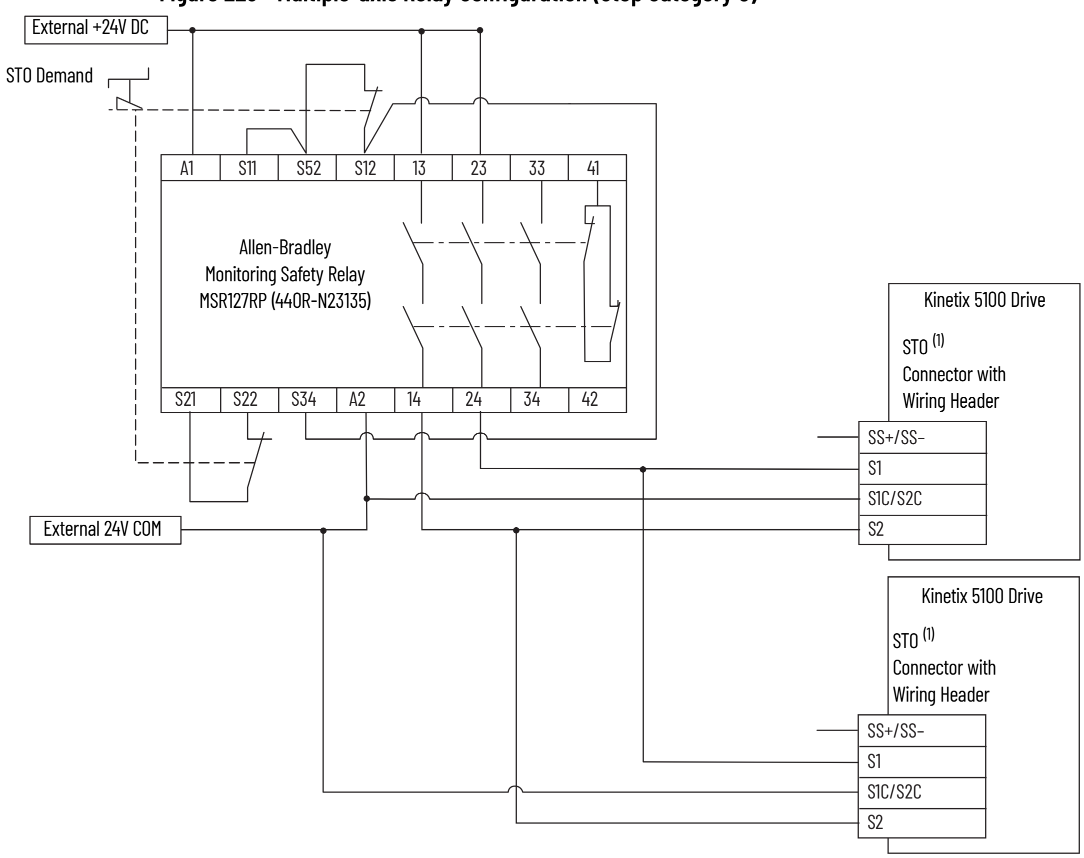



(1) Bypass Jumper is removed from SB+ and SB-.
Sinking output status is true (=1) when the drive displays E 500 status (SS+ and SS- are closed).

| **IMPORTANT** | Reset of the STO fault is required via digital input DI.ARST or raC_*xxx*_5100_MAFR instruction. |
|---|---|

In this example, the drive is shown with two axes configuration in a relay configuration for Stop Category 0 per IEC-60204-1 Safety of Machinery Directive.

**Figure 229 - Multiple-axis Relay Configuration (Stop Category 0)**

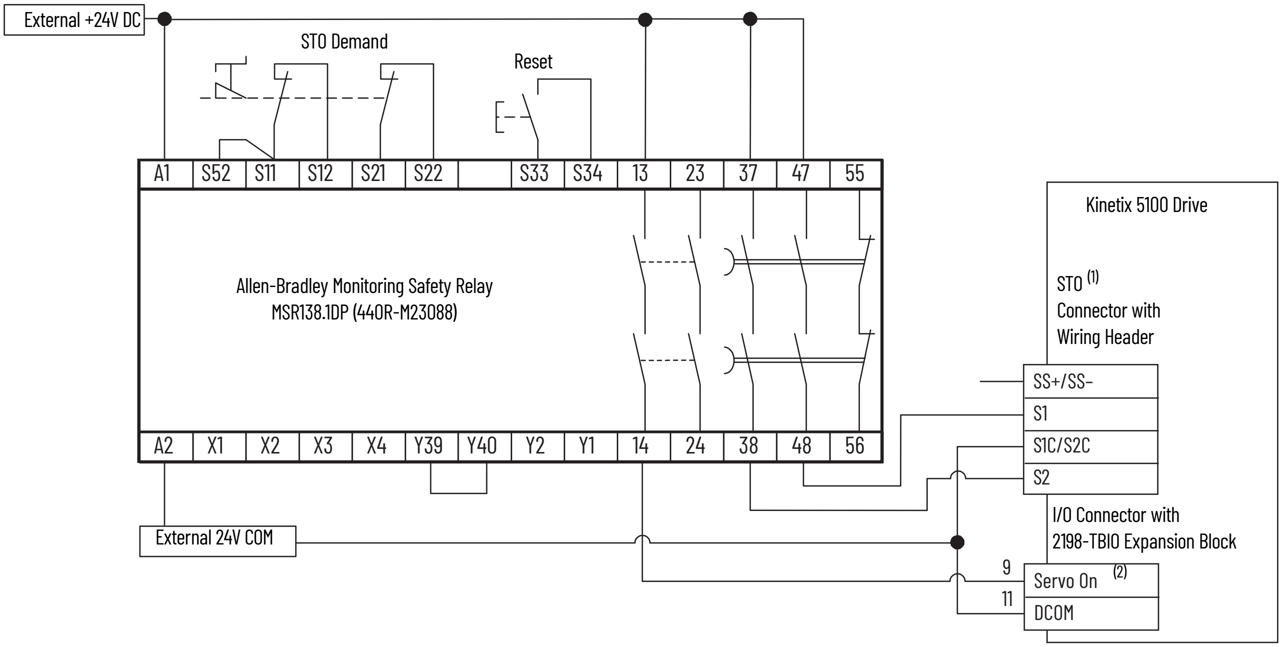



(1) Bypass Jumper is removed from SB+ and SB-.
Sinking output status is true (=1) when the drive displays E 500 status (SS+ and SS- are closed)

| | |
|---|---|
| **IMPORTANT** | Reset of the STO fault is required via digital input DI.ARST or raC_Dvc_5100_MAFR instruction. |

In this example, the drive is shown in a single-axis relay configuration for Stop Category 1 per IEC-60204-1 Safety of Machinery Directive.

**Figure 230 - Single-axis Relay Configuration (Stop Category 1) - PR Operation Mode**




(1) Bypass Jumper is removed from SB+ and SB-.
Sinking output status is true (=1) when the drive displays E 500 status (SS+ and SS- are closed).
(2) You can use the 'Servo on with Holding Brake' input as well, depending on the timing required and if your load uses a holding brake. See Table 71 on page 155 for detailed descriptions.

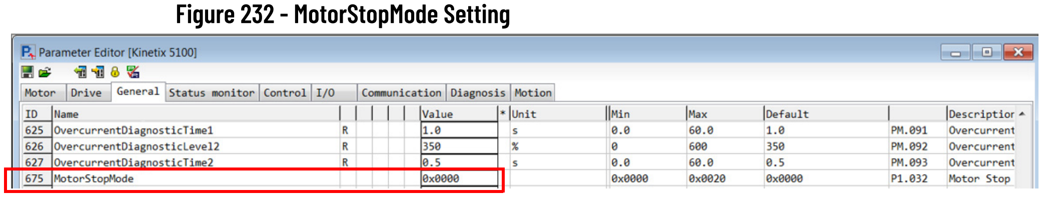
The MotorStopMode parameter is used to determine the type of stop in the drive. Upon removal of digital input Servo On, the drive behavior in Table 131 executes.

**Table 131 - MotorStopMode Settings in Drive Firmware**

| ID675 (P1.032) MotorStopMode Setting | Drive Behavior |
|---|---|
| 0000 (default) | Dynamic brake stop |
| 0010 | Disable and coast |
| 0020 | Dynamic brake stop first, when motor speed is slower than ID145 (P1.038), then coast stop |
| 0030 | Ramped decel |

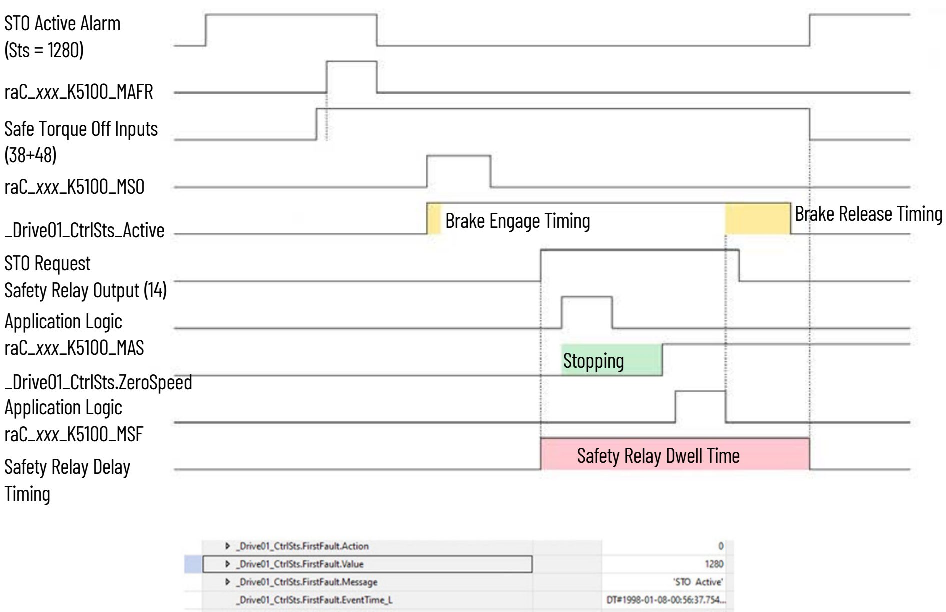
**Figure 231 - Digital Input Servo On**


**Figure 232 - MotorStopMode Setting**



The Safety Relay output (14) in Figure 230 is wired to a 24V DC input module in the controller and evaluated in the logic. The Motion Operation Add-On Instructions are used to stop and disable the motor before the Safety Relay Dwell Time expires.

**Figure 233 - Single Axis Timing Diagram: Category 1 - Using IO Operation Mode**



# Notes:

# Absolute Position Recovery

This section introduces the absolute positioning feature of the Kinetix® 5100 drive, the steps to set up the feature, and the procedures for initializing and operating the feature for the first time.



This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

## System Requirements

A complete absolute servo system should include a Kinetix 5100 servo drive, motor with absolute feedback device, and when a Kinetix TLP motor is present, a backup battery box containing a battery (see page 67 for battery specifications). When the battery supplies power to the motor feedback device, the encoder is able to retain position throughout a power cycle event. Moreover, an absolute type encoder records the motor position, including when the motor shaft is rotated while the power is removed. A configured absolute servo system must work with an absolute encoder. If the system is configured with an incremental encoder and the related parameters of an absolute system are enabled, E 069 Wrong motor encoder error occurs.

## Compatible Servo Motors

The following motors are compatible with Kinetix 5100 drives. They are listed with variables, but include the appropriate encoder (V/E/M/S/D) types. See the Motor and Auxiliary Feedback Configurations on page 14 for information about encoder types.

| Kinetix TL Servo Motor(1) |
|---|
| TL-A1xxx-B |
| TL-A2xxx-B |
| TL-A25xxx-B |
| TL-A4xxx-B |

(1) Battery backup is required for -B encoders.

| Kinetix TLY Servo Motor |
|---|
| TLY-A1*xxx*-B |
| TLY-A2*xxx*-B |
| TLY-A25*xxx*-B |
| TLY-A3*xxx*-B |

| Kinetix TLP Servo Motor (1) |
|---|
| TLP-A046-*xxx*-D |
| TLP-A/B070-*xxx*-D |
| TLP-A/B090-*xxx*-D |
| TLP-A100-*xxx*-D |
| TLP-A/B115-*xxx*-D |
| TLP-A/B145-*xxx*-D |
| TLP-A/B200-*xxx*-D |
| TLP-A/B235-*xxx*-D |

(1) Battery backup is required for -D encoders when the system is configured as an Absolute system.

All MPL absolute encoders provide absolute positioning without requiring a battery backup and when configured as an Absolute system.

| Kinetix MPL Low Inertia Motors (200V-class) |
|---|
| MPL-A15*xxx*-V/E |
| MPL-A2*xxx*-V/E |
| MPL-A3*xxx*-M/S |
| MPL-A4*xxx*-M/S |
| MPL-A45*xxx*-M/S |
| MPL-A5*xxx*-M/S |

| Kinetix MPL Low Inertia Motors (400V-class) |
|---|
| MPL-B15*xxx*-V/E |
| MPL-B2*xxx*-V/E |
| MPL-B3*xxx*-M/S |
| MPL-B4*xxx*-M/S |
| MPL-B45*xxx*-M/S |
| MPL-B5*xxx*-M/S |
| MPL-B6*xxx*-M/S |
| MPL-B8*xxx*-M/S |
| MPL-B9*xxx*-M/S |

| Kinetix MPM Medium Inertia Motors (200V-class) |
|---|
| MPM-A115*xx*-M/S |
| MPM-A130*xx*-M/S |
| MPM-A165*xx*-M/S |
| MPM-A215*xx*-M/S |

| Kinetix MPM Medium Inertia Motors (400V-class) |
| --- |
| MPM-B115*x*-M/S |
| MPM-B130*x*-M/S |
| MPM-B165*x*-M/S |
| MPM-B215*x*-M/S |

| Kinetix MPF Food Grade Motors (200V-class) |
| --- |
| MPF-A3*xxx*-M/S |
| MPF-A4*xxx*-M/S |
| MPF-A45*xxx*-M/S |
| MPF-A5*xxx*-M/S |

| Kinetix MPF Food Grade Motors (400V-class) |
| --- |
| MPF-B3*xxx*-M/S |
| MPF-B4*xxx*-M/S |
| MPF-B45*xxx*-M/S |
| MPF-B5*xxx*-M/S |

| Kinetix MPS Stainless Steel Motors (200V-class) |
| --- |
| MPS-A3*xxx*-M/S |
| MPS-A45*xxx*-M/S |

| Kinetix MPS Stainless Steel Motors (400V-class) |
| --- |
| MPS-B3*xxx*-M/S |
| MPS-B45*xxx*-M/S |
| MPS-B5*xxx*-M/S |

## Install the Battery

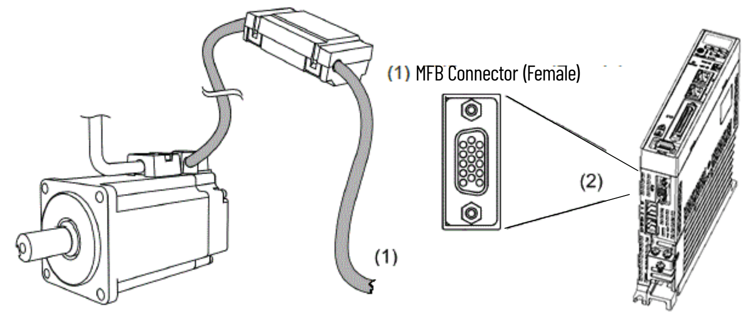
When using a Kinetix TLP motor, a battery is required to make absolute position retention operate properly. For instructions on the motor feedback cable preparation, see Wire the Motor Feedback Connector on page 94.

Installation of a battery within the battery box is required for using the Absolute system with Kinetix TLP motors.

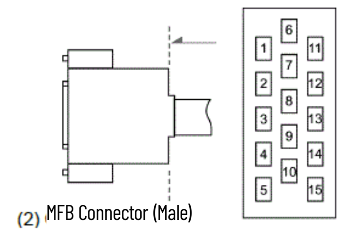
If you are using the pre-assembled TLP motor feedback cables, see the Kinetix 5100 Feedback Battery Box Installation Instructions, publication 2198-IN022, for information on how to install or replace a battery box, install a battery, and prepare a feedback cable for a battery box installation.

For information on wiring flying-lead feedback cables, see Chapter 4. That chapter provides information on motor feedback cables and provides wire terminations for encoder signals to the motor feedback (MFB) connector on Kinetix 5100 drives.

**Figure 234 - Battery box that is connected to Kinetix 5100 system**




The system that is shown is an example.
Your system can be different.




## System Initialization

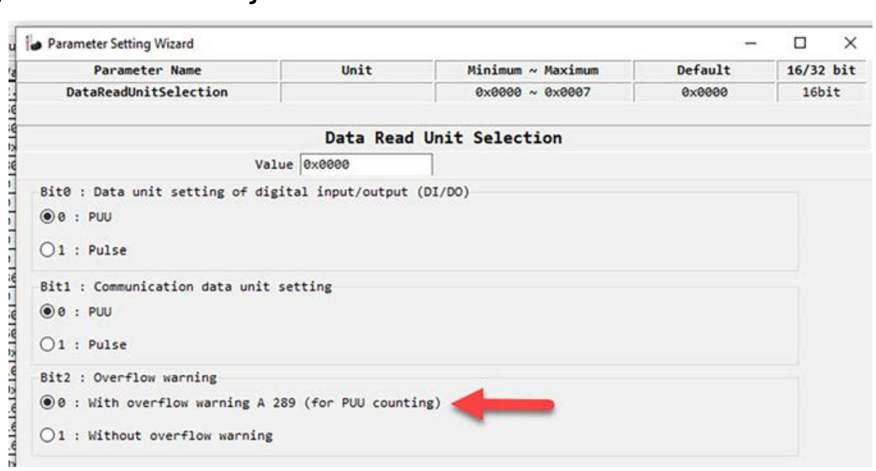
When you initialize the absolute system for the first time, a fault (A 060 Absolute Position Lost) occurs because the axis has not been homed. Clear the fault by configuring homing and homing the axis successfully. See Homing on page 292 to configure and perform homing on your axis. Additional causes of an A060 (Absolute Position Lost) alarm can be:

- Backup battery failure (insufficient charge)
- Main power supply failure
- Incorrect motor feedback detected

When the PUU feedback value range exceeds -214748346…214783647, A289 (Feedback position (PUU) counter overflow) alarm occurs.

When your system is configured as incremental or absolute and the PUU counts exceeds the range -2147483648…2147483647, the A289 alarm occurs. This alarm can occur with a constant movement application (like a conveyor). To avoid this alarm, you can set DataReadUnitSelection ID243 (P2.070) bit 2 = 0. See Figure 235.

**Figure 235 - Overflow Warning**



1. Initialize the absolute coordinates (Home the axis).

   When the coordinate setting is complete, A 06A (or A 060) is automatically cleared. There are three ways for you to initialize the Kinetix 5100 drive: by using the Enable Homing Input (DI), setting the parameters below, or in IO Mode by using the AOI Homing Command (raC_*xxx*_K5100_MAH).

| Homing Parameters | Name |
|---|---|
| ID269 (P5.004) | HomingMode |
| ID298 (P5.005) | HomingSpeed |
| ID299 (P5.006) | HomingCreepSpeed |
| ID397 (P6.000) | HomingSetting |
| ID398 (P6.001) | HomePosition |

2. When the system is power cycled, the absolute position can be accessed using KNX5100C software or via Ethernet/IP communication.

   Based on the setting of ID243 (P2.070), the Kinetix 5100 drive can select either the PUU or the pulse value, within one turn.

## Pulse Number

When the motor is running in the clockwise direction, MultiTurnAbsPosition ID110 (P0.051) is expressed as a positive value. When the motor runs in the counterclockwise direction, MultiTurnAbsPosition ID110 (P0.051) is expressed as a negative value.

### Table 132 - Relevant Parameters and Faults

| Fault code | Name |
|---|---|
| A 060 | Absolute Position Lost |
| A 06A | Absolute Position is not Initialized |
| A 289 | Feedback Position [PUU] Counter Overflow |

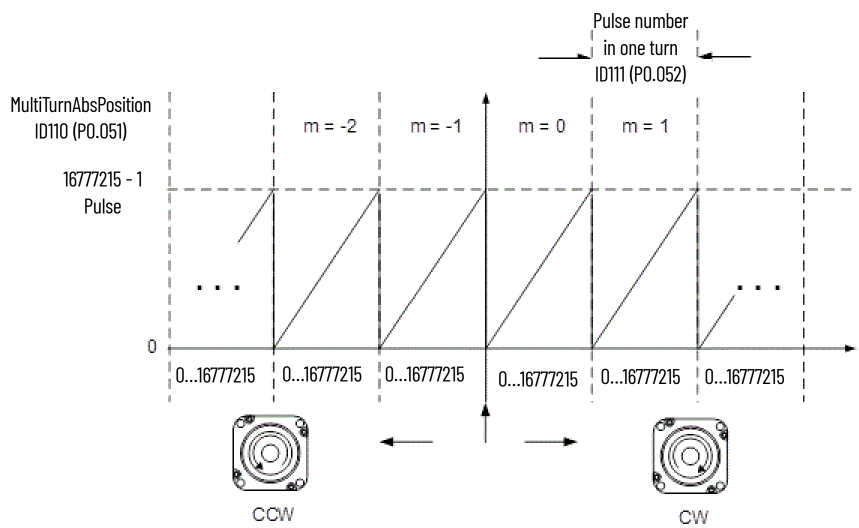
| Parameters | Name |
|---|---|
| ID110 (P0.051) | MultiTurnAbsPosition |
| ID117 (P1.001) | ControlMode |
| ID151 (P1.044) | GearRatioSlaveN1 |
| ID152 (P1.045) | GearRatioMasterCounts |
| ID194 (P2.009) | DIDebounceTime |
| ID243 (P2.070) | DataReadUnitSelection |
| ID398 (P6.001) | HomePosition |

In these examples, an example Kinetix TLP motor with the encoder resolution of 16777216 (single turn) is used. In addition to the cycle counter (MultiTurnAbsPosition ID110 P0.051), there are 16,777,216 pulses (0…16777215) in one rotation. Pay attention to the motor's running direction.

Pulse number = m (cycle number) x 16777216 + pulse number (0 … 16777215). The conversions between pulse number and PUU are as follows:

When the rotation direction is defined as clockwise (CW) in ID117 (P1.001.Z=0), then the PUU number =
pulse number × [ID152 (P1.045) / ID151 (P1.044)] + ID398 (P6.001).

When the rotation direction is defined as counter-clockwise (CCW) in ID117 (P1.001.Z=1), then the PUU number =
(-1) × pulse number × [ID152 (P1.045) / ID151 (P1.044)] + ID398 (P6.001).

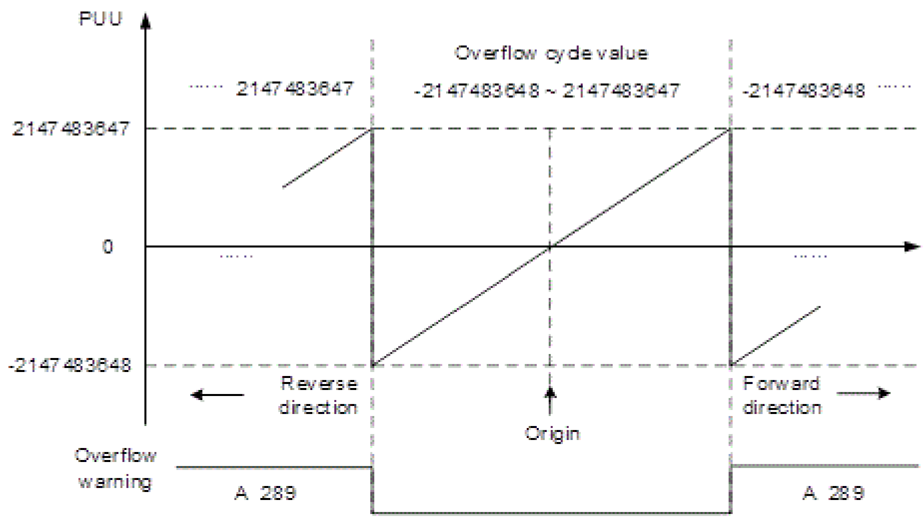


## PUU Number

The PUU number is a signed 32-bit value. When the motor is running in the forward direction, the PUU number increases; when the motor is running in the reverse direction, the PUU number decreases. The forward direction is determined in KNX5100C software Function List>Settings>General Setting: Rotation Direction ID117 (P1.001 Z). The following example shows how the overflow is used in the Kinetix 5100 drive.

Example:

When the E-Gearing Ratio (Position scaling) is set for 16777216/100000, the motor needs 100,000 PUU to complete a motor revolution. To determine the maximum number of motor revolutions: 2,147,483,647 ÷ 100,000 = 21,474.8, when the motor exceeds 21,474.8 motor revolutions in the forward direction, A 289 alarm occurs.




After initializing the absolute coordinate system (homing is completed), any change to ID117 (P1.001.Z) or the E-Gear ratio [ID151 (P1.044) and ID152 (P1.045)] changes the original setting of the absolute coordinate system. The system must be re-initialized (Homed).

## Initializing the Absolute Coordinates with Parameters

It is not common to reset the absolute coordinates with parameters. It is typical to reset the coordinates by using the homing operation in PR Mode, or raC_*xxx*_K5100_MAH Add-On Instruction in IO Mode. The Absolute Coordinates are write protected. In the remote case that you must perform an initialization without the ability to use these two methods, the sequence to initialize the absolute coordinates is:

- ForceFunction (ID193, P2.008) = 271
- ResetAbsolutePosition (ID244, P2.071) = 1

# Notes:

Chapter 15

# Programming via Drive Parameters



## Organization of Parameters

This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

### Parameter Groups

Parameters are listed across 26 functional groups. Some parameters have dual functions and appear in multiple groups. The primary groups are listed in the parameter spreadsheet in the Kinetix 5100 Servo Drive Parameter Data and Fault Codes. The additional groups to which the parameters belong are listed in the Additional Groups column of that spreadsheet and are identified in the table.

**Table 133 - Parameters and the Functional Groups**

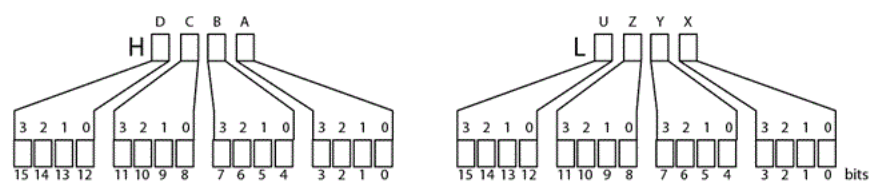
| Primary Group Number | Group Name | Additional Group Number | Group Name |
|---|---|---|---|
| 1 | Motor | 11 | System |
| 2 | Drive | 12 | BRK_RegResistor |
| 3 | General | 13 | Pulse Setting |
| 4 | Status Monitor | 14 | Gear Ratio |
| 5 | Control | 15 | Filter |
| 6 | I/O | 16 | Limit |
| 7 | Communication | 17 | Position Loop |
| 8 | Diagnosis | 18 | Velocity Loop |
| 9 | Motion_1 | 19 | Current Loop |
| 10 | Motion_2 | 20 | Tuning |
| | | 21 | Speed Setting |
| | | 22 | Event Setting |
| | | 23 | Homing |
| | | 24 | E-CAM |
| | | 25 | Capture |
| | | 26 | Compare |

*Numeric/Decimal Parameters*

These parameters are integer based, with no decimal or negative sense.

*Parameters in Hexadecimal Format*

The drive has some parameters that are 16-bits or 32-bits in size and are represented in hexadecimal format. The settings for these parameters are defined either by the value of each bit or by the value of each hexadecimal digit, represented by D, C, B, A (high) and U, Z, Y, X (low).




For example, ID230 (P2.047) is a 16-bit parameter that translates to one hexadecimal number with four digits. This settings for this parameter are defined both by the actual value of the X hexadecimal digit and by the values of the individual bits in the Y and Z digits.

| ID230 (P2.047) Auto resonance suppression mode setting | | | |
|---|---|---|---|
| X | Auto resonance suppression function | Z | Fixed resonance suppression parameter |
| Y | Fixed resonance suppression parameter | U | Reserved |

The setting for Auto resonance suppression is defined by the value of X as follows:

- X = 0: Disable auto resonance suppression
- X = 1: Enable auto resonance suppression

The fixed resonance suppression parameter is defined by the value of the bits that make up the Y digit, as follows:

| Y(1) | Function | Description |
|---|---|---|
| Bit 0 | Notch 1 auto / manual setting | 0: Auto resonance suppression<br>1: Manually set the first set of resonance suppression |
| Bit 1 | Notch 2 auto / manual setting | 0: Auto resonance suppression<br>1: Manually set the second set of resonance suppression |
| Bit 2 | Notch 3 auto / manual setting | 0: Auto resonance suppression<br>1: Manually set the third set of resonance suppression |
| Bit 3 | Notch 4 auto / manual setting | 0: Auto resonance suppression<br>1: Manually set the fourth set of resonance suppression |

(1) Bit 0…3 of digit Y correspond to Bits 4…7 of the 16-bit parameter.

## Description of Digital Input Functions

The Kinetix 5100 drive provides 10 physical digital inputs and three virtual digital inputs. These digital inputs are primarily configured in KNX5100C software from Function List>Settings>Digital IO/Jog Control.

These inputs can be forced (when the drive is online and Enable is checked) to be On or Off.

In the Digital Input dialog box, Status represents the logical level of the input that is based on the use of N.O. and N.C. configurations. The Status (in the KNX5100C software window) is NOT necessarily the actual voltage level on the terminals (0V DC = OFF, 24V DC = ON) but rather the logical level of the digital input. When N.O. is used, the relationship between input voltage and Status matches (Status = ON = 24V DC, OFF = 0V DC). When N.C. is used, this relationship is reversed. See Digital I/O and Jog Function in KNX5100C Software on page 177 for more information.

**Table 134 - Relevant Parameters**

| Parameter | Name |
|---|---|
| ID195 (P2.010) | DI1Configuration |
| ID196 (P2.011) | DI2Configuration |
| ID197 (P2.012) | DI3Configuration |
| ID198 (P2.013) | DI4Configuration |
| ID199 (P2.014) | DI5Configuration |
| ID200 (P2.015) | DI6Configuration |
| ID201 (P2.016) | DI7Configuration |
| ID202 (P2.017) | DI8Configuration |
| ID220 (P2.036) | DI9Configuration |
| ID221 (P2.037) | DI10Configuration |
| ID222 (P2.038) | VirtualDI11Configuration |
| ID223 (P2.039) | VirtualDI12Configuration |
| ID224 (P2.040) | VirtualDI13Configuration |

The available digital input functions are listed in Table 135.

## Table 135 - Digital Inputs

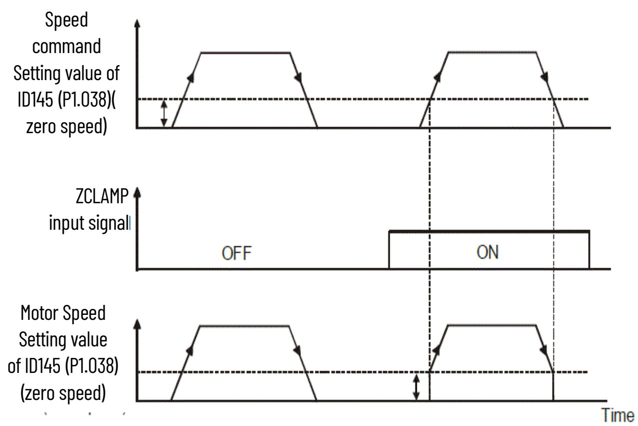
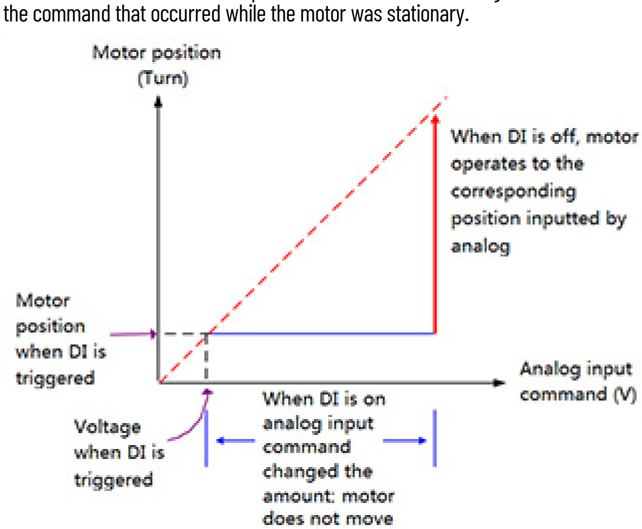
| Setting | DI Description | Trigger Method | Control Mode |
|---|---|---|---|
| 0x01 | Servo On<br>When this DI is on, servo is activated (Servo On). When this DI is off, the servo is deactivated the default deceleration profile is dynamic brake type (similar to a current decel profile). Always configure this DI as N.O. | Level triggered | All except I/O |
| 0x02 | Alarm/Fault Reset<br>When the DI transitions on, any faults are cleared. If the fault is still active, this reset does not clear the fault. | Rising-edge triggered | All |
| 0x03 | Gain Switching<br>In speed and position mode, when this DI is on and GainSwitchingSelection ID212 (P2.027) X= 1 and the Gain Switching Method = 0, the original gains are multiplied by Position /Velocity Gain Changing Rate ID186/ID190 (P2.001/P2.005). | Level triggered | PT, PR, S |
| 0x04 | Pulse Clear<br>This input can be configured for Edge/Level trigger by changing PulseClearMode ID233 (P2.050). When this input is on, any accumulated position error is cleared (set to zero). | Rising-edge triggered, level triggered | PT |
| 0x05 | Zero Speed Threshold (ZClamp)<br>When the speed is below the setting of ZeroSpeedWindow ID145 (P1.038), the motor stops moving when this DI is on.<br><br>See Zero Speed Threshold Function on page 243 for additional information. | Level triggered | S, I/O (Speed) |
| 0x06 | Reverse Direction of Input Command<br>In speed mode, the input command reversed when this DI is on. | Level triggered | S, Sz, T, I/O (Speed, Gear Mode ) |
| 0x08 | Command Triggered<br>In PR Mode, after selecting the PR command (POS0…POS6), this DI is the signal to carry out the execution of the selected PR. Once the rising edge transition occurs, the selected PR will execute. This DI needs to transition off to on for execution. | Rising-edge triggered | PR |
| 0x09 | Torque Limit<br>When this DI is on and VelocityTorqueLimitAction ID118 (P1.002 Y) is enabled, the selected torque limit is applied. | Level triggered | PT, PR, S, I/O (Position, Index, Gear, Speed) |
| 0x0C | Latch Function of Analog Position Command<br>While this DI is on, the motor is held at its current position, even if there is a change in command. When this DI is off, the motor completes the command that occurred while the motor was stationary.<br> | Level triggered | PT, I/O (Gear) |

**Table 135 - Digital Inputs (Continued)**

| Setting | DI Description | Trigger Method | Control Mode |
|---|---|---|---|
| 0x10 | Speed Limit<br>In torque mode, the motor speed will be limited when this DI is on, and the limited speed command is the internal register or analog voltage command. | Level triggered | T, I/O (Torque) |
| 0x11 | Register Position Command Selection 1…99 Bit 0.<br>See Digital Input (DI) Trigger on page 347 for more information. | Level triggered | PR |
| 0x12 | Register Position Command Selection 1…99 Bit 1.<br>See section Digital Input (DI) Trigger on page 347 for more information. | Level triggered | PR |
| 0x13 | Register Position Command Selection 1…99 Bit 2.<br>See section Digital Input (DI) Trigger on page 347 for more information. | Level triggered | PR |
| 0x1A | Register Position Command Selection 1…99 Bit 3.<br>See section Digital Input (DI) Trigger on page 347 for more information. | Level triggered | PR |
| 0x1B | Register Position Command Selection 1…99 Bit 4.<br>See section Digital Input (DI) Trigger on page 347 for more information. | Level triggered | PR |
| 0x1C | Register Position Command Selection 1…99 Bit 5.<br>See section Digital Input (DI) Trigger on page 347 for more information. | Level triggered | PR |
| 0x1E | Register Position Command Selection 1…99 Bit 6.<br>See section Digital Input (DI) Trigger on page 347 for more information. | Level triggered | PR |
| 0x1F | Set Up or Clear Absolute System Coordinates<br>When the DI.ABSC signal is on, the number of turns data stored in absolute encoder will be cleared. But this DI is only valid when the DI.ABSE signal is on. | Rising-edge triggered | All |
| 0x14 | Register Speed Command Selection 1…4 Bit 0.<br>See Configure and Select the Preset Speeds on page 240 for more information. | Level triggered | S<br>T, I/O (Torque) for speed limit function |
| 0x15 | Register Speed Command Selection 1…4 Bit 1.<br>See Configure and Select the Preset Speeds on page 240 for more information. | Level triggered | S<br>T, I/O (Torque) for speed limit function |
| 0x16 | Register Torque Command Selection 1…4 Bit 0.<br>See Configure and Select the Preset Speeds on page 240 for more information. | Level triggered | T<br>PR, PT, S, I/O (Position, Index, Gear, Speed) for torque limit function |
| 0x17 | Register Torque Command Selection 1…4 Bit 1.<br>See Configure and Select the Preset Speeds on page 240 for more information. | Level triggered | T<br>PR, PT, S, I/O (Position, Index, Gear, Speed) for torque limit function |

**Table 135 - Digital Inputs (Continued)**

| Setting | DI Description | Trigger Method | Control Mode |
|---|---|---|---|
| 0x18 | Position/Speed Modes Selection<br>When the operation mode is dual mode (PR or PT / S) and this DI is off, the operation mode is positioning (PT or PR). When this DI is on, the operation mode is Speed control. In multi-mode, this input is used with PT/PR Mode Selection DI to give multi-mode selections. | Level triggered | Dual Mode |
| 0x19 | Torque/Speed Modes Switching<br>When the operation mode is dual mode (S/T) and this DI is off, the operation mode is speed control. When this DI is on, the operation mode is torque control. | Level triggered | Dual Mode |
| 0x20 | Torque/Position Mode<br>When the operation mode is dual mode (any mode using Torque and Position, PT or PR) and this DI is off, the operation mode is torque control. When this DI is on, the operation mode uses the Position control operation mode. In multi-mode, this input is used with PT/PR Mode Selection DI to give multi-mode selections. | Level triggered | Dual Mode |
| 0x21 | Emergency Stop<br>When this DI is on, the drive decelerates and disables the motor. MotorStopMode ID 675 (P1.032) is used to define the deceleration profile. If a holding brake is used, this stop uses the configured brake timing. This stop issues E013 when its complete.<br>**IMPORTANT**: This stop type has no safety implications. It is not a safety rated input. | Level triggered | All |
| 0x22 | Reverse Limit Switch (NL) - This sensor indicates the most negative point of travel for the axis. When this DI is on (typically configured as N.C. - and Status displays Off), this setting means that there is no active Overtravel condition. When this DI is off, the A015 alarm is issued (Status shows On) and motion is allowed only in the forward direction (to move away from the limit), once the limit transitions back to on, the alarm is cleared automatically. | Level triggered | All |
| 0x23 | Forward Limit Switch (PL) - This sensor indicates the most positive point of travel for the axis. When this DI is on (typically configured as N.C. - and Status displays Off), this setting means that there is no active Overtravel condition. When this DI is off, the A014 alarm is issued (Status shows On) and motion is allowed only in the reverse direction (to move away from the limit), once the limit transitions back to on, the alarm is cleared automatically. | Level triggered | All |
| 0x24 | Homing Switch (ORG) -<br>This DI represents the Homing Switch when the configurable Homing Method uses a switch.<br>See Setting Homing Mode ID297 (P5.004) - PR Mode on page 292 for additional information. | Rising- and falling-edge triggered | PR, I/O (Index) |
| 0x27 | Enable Homing<br>This input executes the configured Homing Method.<br>See Setting Homing Mode ID297 (P5.004) - PR Mode on page 292 for additional information. | Rising-edge triggered | PR |
| 0x2B | PT/PR Modes Selection<br>When the operation mode is dual mode (PT/PR) and this DI is off, the operation mode is positioning (PT). When this DI is on, the operation mode is positioning (PR). In multi-mode, this input is used with PR /S/T Mode Selection DI to give multi-mode selections. | Level triggered | Dual Mode |
| 0x35 | Electronic Cam Phase Alignment<br>When this DI is on, and the E-CAM is enabled ECamControlConfiguration ID248 (P2.076 Bit0 = 1) the Alignment index is executed ECamAlignmentTargetPosition ID247 (P2.075). | Rising-edge triggered | PR, I/O (Position, Index ) |
| 0x36 | E-CAM Engaging Control<br>This DI is used when the E-CAM is configured as DI-CAM enabled. When this DI is on, the E-CAM function, as configured, is executed. Once the E-CAM is executing, this DI can be off until the E-CAM is complete.<br>See E-CAM on page 378. | Rising- and falling-edge triggered | PR, I/O (Position, Index ) |
| 0x37 | Motor JOGs in the Forward Direction<br>When this DI is on, the motor jogs in a forward direction. | Level triggered | All except I/O |
| 0x38 | Motor JOGs in the Reverse Direction<br>When this DI is on, the motor jogs in a reverse direction. | Level triggered | All except I/O |
| 0x39 | Event Trigger Command 1<br>When this DI is triggered, the configured Event (EV1) PR is executed<br>(KNX5100C software, Function List>Motion Control>PR Mode Editor>General Parameter Setting).<br>Note that this input can be configured to execute events on a rising or falling edge trigger. | Rising- and falling-edge triggered | PR, I/O (Index) |
| 0x3A | Event Trigger Command 2<br>When this DI is triggered, the configured Event (EV2) PR is executed<br>(KNX5100C software, Function List>Motion Control>PR Mode Editor>General Parameter Setting).<br>Note that this input can be configured to execute events on a rising or falling edge trigger. | Rising- and falling-edge triggered | PR, I/O (Index) |
| 0x3B | Event Trigger Command 3<br>When this DI is triggered, the configured Event (EV3) PR is executed<br>(KNX5100C software, Function List>Motion Control>PR Mode Editor>General Parameter Setting).<br>Note that this input can be configured to execute events on a rising or falling edge trigger. | Rising- and falling-edge triggered | PR, I/O (Index) |
| 0x3C | Event Trigger Command 4<br>When this DI is triggered, the configured Event (EV4) PR is executed<br>(KNX5100C software, Function List>Motion Control>PR Mode Editor>General Parameter Setting).<br>Note that this input can be configured to execute events on a rising or falling edge trigger. | Rising- and falling-edge triggered | PR, I/O (Index) |
| 0x43 | E-Gear Ratio (Numerator) Selection 0<br>See Configure Electronic Gear (E-Gear) Ratio on page 162 for additional information. | Level triggered | PR, PT |
| 0x44 | E-Gear Ratio (Numerator) Selection 1<br>See Configure Electronic Gear (E-Gear) Ratio on page 162 for additional information. | Level triggered | PR, PT |

**Table 135 - Digital Inputs (Continued)**

| Setting | DI Description | Trigger Method | Control Mode |
|---|---|---|---|
| 0x45 | Disable External pulse<br>When using PT Operation mode and this DI is on, the drive stops responding to commands using external pulses. The motor does not move while this DI is on. This function only works when configured with DI8. | Level triggered | PT |
| 0x46 | Stop<br>When this DI is on, the drive decelerates the motor. AutoProtectionDecelTime ID 296 (P5.003) is used to define the deceleration profile. This DI only stops PR command types (including positioning and constant velocity; Jog). This command does not stop Jog commands (outside of a PR command) or E-CAM commands. | Rising-edge triggered, level triggered | PR |
| 0x47 | Profile Quick Stop<br>When this DI is on, the drive decelerates and disables the motor. AutoProtectionDecelTime ID 296 (P5.003) is used to define the deceleration profile. If a holding brake is used, this stop uses any configured brake timing. This stop issues alarm: A35F when its complete. | Rising-edge triggered | PT, PR, T, S |
| 0x48 | Servo On with holding brake<br>Use this DI when a holding brake is used. When this DI is on, the drive is activated (Servo On). When this DI is off, the drive decelerates and disables the motor. AutoProtectionDecelTime ID 296 (P5.003) STP is used to define the deceleration profile. This DI is used with Vertical Load Control and this DI setting uses any configured brake timing. Always configure this DI as N.O. | Level triggered | All except I/O |

## Description of Digital Output Functions

The Kinetix 5100 drive provides six physical digital outputs. These digital outputs are primarily configured in KNX5100C software from Function List>Settings>Digital IO/Jog Control.

You can force these outputs (when the drive is online and the Enable DO Override is checked) to be On or Off.

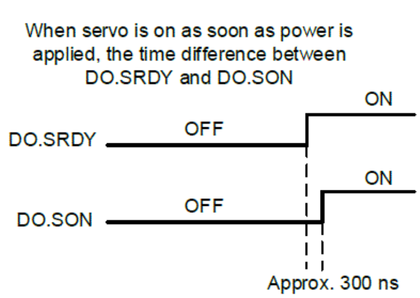
In the Digital Input dialog box, Status represents the logical level of the output.

**Table 136 - Relevant Parameters**

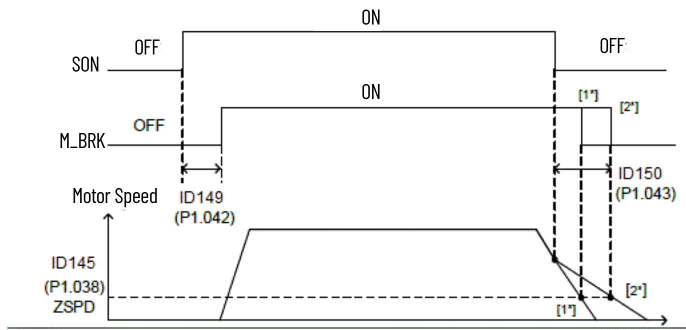
| Parameter | Name |
|---|---|
| ID203 (P2.018) | DO1Configuration |
| ID204 (P2.019) | DO2Configuration |
| ID205 (P2.020) | DO3Configuration |
| ID206 (P2.021) | DO4Configuration |
| ID207 (P2.022) | DO5Configuration |
| ID225 (P2.041) | DO6Configuration |

The available digital output functions are listed in the following table.

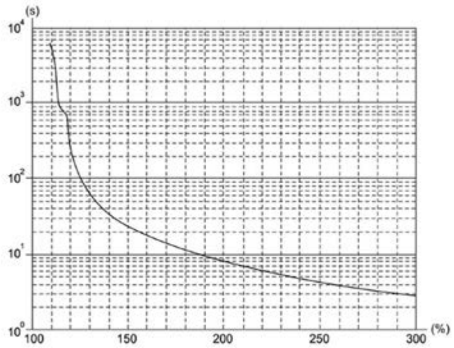
**Table 137 - Digital Outputs**

| Setting | DO Description | Triggering Method | Control Mode |
|---|---|---|---|
| 0x01 | Servo Ready<br>This DO is on when both the control and main power is applied to the drive and the drive is not faulted. | Level triggered | All |
| 0x02 | Servo On<br>This DO is on when the servo is activated (enabled) and the drive is not faulted.<br> | Level triggered | All |
| 0x03 | Motor is at zero speed<br>This DO is on whenever the motor is within the ZeroSpeedWindow ID145 (P1.038). | Level triggered | All |

## Table 137 - Digital Outputs (Continued)

| Setting | DO Description | Triggering Method | Control Mode |
|---|---|---|---|
| 0x04 | Motor reaches the target speed<br>This DO is on whenever the motor reaches UpToSpeedLimit ID146 (P1.039). | Level triggered | All |
| 0x05 | Motor reaches target position<br>This DO is on whenever the motor position is within InPositionWindow ID159 (P1.054). | Level triggered | PT, PR, I/O (Position, Gear) |
| 0x06 | Torque Limit Activated<br>This DO is on whenever the drive is in a torque limited condition. | Level triggered | All (Except for T and Tz) |
| 0x07 | Servo Alarm<br>This DO is on whenever an alarm or fault condition is active. This DO does not turn on when: forward or reverse limits are active, communication error, undervoltage, and fan error. | Level triggered | All |
| 0x08 | Brake Control<br>This DO is on whenever an alarm or fault condition is active. This DO does not turn on when: forward or reverse limits are active, communication error, undervoltage, and fan error.<br><br><br>See Motor Brake Circuit on page 62. | Level triggered | All |
| 0x09 | Homing Completed<br>This DO is on when homing is successfully completed on the axis. When Motor Feedback>Startup Method is:<br>• Incremental: This DO is off when control/main power is cycled.<br>• Absolute: This DO is on when control/main power is cycled.<br>• If the position cycle counts overflow occurs, this DO is off. | Level triggered | PR |
| 0x0B | At Home Position<br>This DO is on when:<br>• Homing is complete<br>• The Command Position is equal to the Home Position<br>• The difference between Feedback Position and the Home Position is within InPositionWindow ID 159 (P1.054) | Level triggered | PR |
| 0x0D | Absolute Type System Error<br>This DO is on when a fault occurs while the Absolute Homing is in process. | Level triggered | All |
| 0x0E | Indexing Coordinate is defined<br>The indexing coordinate is defined when homing is completed. This DO is on when homing is complete. | — | PR |

## Table 137 - Digital Outputs (Continued)

<table>
<tr><th>Setting</th><th>DO Description</th><th>Triggering Method</th><th>Control Mode</th></tr>
<tr><td>0x10</td><td>Early Warning for Overload<br>

<table>
<tr><th>Load</th><th>Operating Time</th></tr>
<tr><td>120%</td><td>263.8 s</td></tr>
<tr><td>140%</td><td>35.2 s</td></tr>
<tr><td>160%</td><td>17.6 s</td></tr>
<tr><td>180%</td><td>11.2 s</td></tr>
<tr><td>200%</td><td>8 s</td></tr>
<tr><td>220%</td><td>6.1 s</td></tr>
<tr><td>240%</td><td>4.8 s</td></tr>
<tr><td>260%</td><td>3.9 s</td></tr>
<tr><td>280%</td><td>3.3 s</td></tr>
<tr><td>300%</td><td>2.8 s</td></tr>
</table>
When the output average load (Load) is > 100%, this load can be applied for a period (Operating time) before the drive faults (tOL).<br>The OverloadWarningUserThreshold ID 161 (P1.056) value (max 120%) is used with this Operating time, so that:<br>tOLW = (OverloadWarningUserThreshold x Operating time)<br>During any excess load condition, this DO is on when tOLW is exceeded but before the Operating time (tOL) is reached. When the Operating time is met, Servo Alarm E006-Motor Overload is on and the DO Servo Alarm is on.<br>For example: When the output average load of the servo drive is 200% and the Operating time exceeds 8 seconds, the overload fault E 006 Motor overload occurs.<br>When OverloadWarningUserThreshold = 60%, tOLW = 60% x 8sec = 4.8 seconds. When this output average load of 200% exceeds 4.8 sec, this DO is on. When this load of 200% exceeds 8 seconds, the E006 Motor overload occurs and the DO Servo Alarm is on.</td><td>Level triggered</td><td>All</td></tr>
<tr><td>0x11</td><td>Warning<br>This DO is on for the exceptions of the Alarm DO: forward/reverse limit, communication error, undervoltage, or fan error.</td><td>Level triggered</td><td>All</td></tr>
<tr><td>0x12</td><td>Position Command Overflows<br>Position command / feedback exceeds limit range.</td><td>Level triggered</td><td>PT, PR</td></tr>
<tr><td>0x13</td><td>Reverse Software Limit (NL)<br>This DO is on when the Reverse software limit is active.</td><td>Level triggered</td><td>PR</td></tr>
<tr><td>0x14</td><td>Forward Software Limit (PL)<br>This DO is on when the Forward software limit is active.</td><td>Level triggered</td><td>PR</td></tr>
<tr><td>0x15</td><td>PR Command Completed<br>This DO is off when a PR is executing. When the PR is completed, this DO is on. This DO only indicates that the command is complete but not necessarily that the motor is in the target position, it could be still reaching its target position.</td><td>Level triggered</td><td>PR</td></tr>
<tr><td>0x16</td><td>CAP Procedure Completed<br>Capture procedure is completed.</td><td>Level triggered</td><td>All</td></tr>
<tr><td>0x17</td><td>PR Procedure Completed<br>This DO is on when DO PR command completed and DO Motor reaches the target position are on. This DO can remain on after being triggered, this setting is in ToSpeedAction ID155 (P1.048).</td><td>Level triggered</td><td>PR, I/O (Index when the PR command type is not Speed)</td></tr>
<tr><td>0x18</td><td>Master position of the E-CAM is in the Setting Area<br>This DO is on when the E-CAM is active and the master position falls between:<br>ECamDOCamArea1RisingEdgeAngle ID378 (P5.090) and<br>ECamDOCamArea1FallingEdgeAngle ID379 (P5.091).</td><td>Level triggered</td><td>PR, I/O (Position, Index)</td></tr>
<tr><td>0x19</td><td>Speed reaches the Target Speed<br>When you use a speed command, this DO is on when the motor speed is within the SpeedWindow ID250 (P2.079) of the Speed command.</td><td>Level triggered</td><td>S, Sz, I/O (Speed)</td></tr>
<tr><td>0x1A</td><td>Master position of the E-CAM is in the Setting Area 2<br>This DO is on when the E-CAM is active and the master position falls between:<br>ECamDOCamArea2RisingEdgeAngle ID249 (P2.078) and<br>ECamDOCamArea2FallingEdgeAngle ID250 (P2.079).</td><td>Level triggered</td><td>PR</td></tr>
<tr><td>0x1D</td><td>Second CAP procedure completed<br>The second capture procedure is completed.</td><td>Level triggered</td><td>All</td></tr>
<tr><td>0x2C</td><td>P0.009 'ON' between ID113 (P0.054) and ID114 (P0.055)<br>This DO is on after SystemVariableMonitorFilterTime ID112 (P0.053) elapses and: SystemVariableMonitorLowerLimit ID113 (P0.054) ≤ SystemVariableMonitor1Value ID663 (P0.009) ≤ SystemVariableMonitorUpperLimit ID114 (P0.055)</td><td>Level triggered</td><td>All</td></tr>
<tr><td>0x30</td><td>Output Bit 00 of ID283 (P4.006)<br>This DO is on when Bit 00 of DOStatus ID283 (P4.006) is on.</td><td>Level triggered</td><td>PR</td></tr>
<tr><td>0x31</td><td>Output Bit 01 of ID283 (P4.006)<br>This DO is on when Bit 01 of DOStatus ID283 (P4.006) is on.</td><td>Level triggered</td><td>PR</td></tr>
</table>

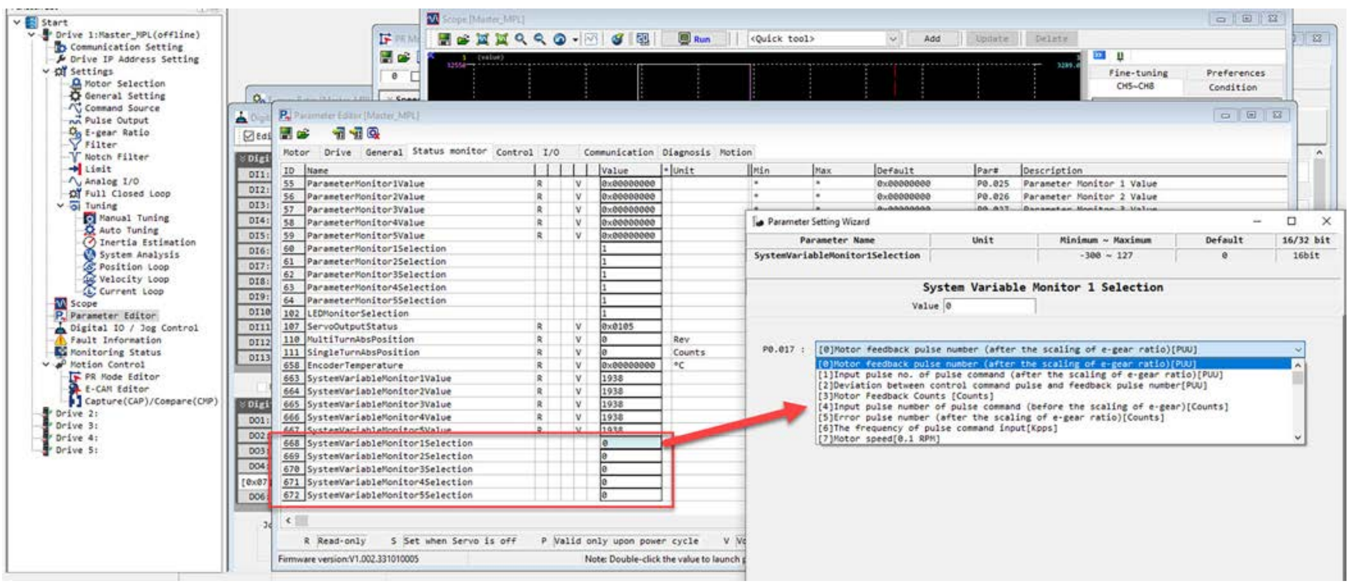
**Table 137 - Digital Outputs (Continued)**

| Setting | DO Description | Triggering Method | Control Mode |
|---|---|---|---|
| 0x32 | Output Bit 02 of ID283 (P4.006)<br>This DO is on when Bit 02 of DOStatus ID283 (P4.006) is on. | Level triggered | PR |
| 0x33 | Output Bit 03 of ID283 (P4.006)<br>This DO is on when Bit 03 of DOStatus ID283 (P4.006) is on. | Level triggered | PR |
| 0x34 | Output Bit 04 of ID283 (P4.006)<br>This DO is on when Bit 04 of DOStatus ID283 (P4.006) is on. | Level triggered | PR |
| 0x35 | Output Bit 05 of ID283 (P4.006)<br>This DO is on when Bit 05 of DOStatus ID283 (P4.006) is on. | Level triggered | PR |

## Description of System Variable Monitoring

You can use the five available SystemVariableMonitorSelection values to store the values of the selected parameters, see Figure 236. These selections can be used in the scope tracing or when using Statements in the PR commands.

**Figure 236 - System Variable Monitoring**




There are two ways to monitor the system variables. You can monitor via the panel display or you can monitor via the system variable monitoring parameters.

### Panel Display

When the panel is in Real Time Data Display mode, press the UP / DOWN keys to select the variable to be monitored. See Chapter 6, Use the Keypad Interface.

### System Variable Monitoring Parameters

The following parameters are used to support system variable monitoring.

**Table 138 - System Variable Monitoring Parameters**

| Parameter | Name | Description |
|---|---|---|
| ID663 (P0.009) | SystemVariableMonitor1Value | The value to be monitored can be set by using ID668 (P0.017) SystemVariableMonitor1Selection. Set ID102 (P0.002) LEDMonitorSelection to 23 to display the value of this parameter on the panel display. |
| ID664 (P0.010) | SystemVariableMonitor2Value | The value to be monitored can be set by ID 669 (P0.018). Set ID102 (P0.002) to 24 to display the value of this parameter on the panel display. |
| ID665 (P0.011) | SystemVariableMonitor3Value | The value to be monitored can be set by ID670 (P0.019). Set ID102 (P0.002) to 25 to display the value of this parameter on the panel display. |
| ID666 (P0.012) | SystemVariableMonitor4Value | The value to be monitored can be set by ID671 (P0.020). Set ID102 (P0.002) to 26 to display the value of this parameter on the panel display. |
| ID667 (P0.013) | SystemVariableMonitor5Value | The value to be monitored can be set by ID672 (P0.021). Set ID102 (P0.002) to 27 to display the value of this parameter on the panel display. |
| ID668 (P0.017) | SystemVariableMonitor1Selection | Use the pull-down menu in the parameter editor to choose the parameter to map. |
| ID669 (P0.018) | SystemVariableMonitor2Selection | Use the pull-down menu in the parameter editor to choose the parameter to map. |
| ID670 (P0.019) | SystemVariableMonitor3Selection | Use the pull-down menu in the parameter editor to choose the parameter to map. |
| ID671 (P0.020) | SystemVariableMonitor4Selection | Use the pull-down menu in the parameter editor to choose the parameter to map. |
| ID672 (P0.021) | SystemVariableMonitor5Selection | Use the pull-down menu in the parameter editor to choose the parameter to map. |

## System Variables List

The property code of each system variable is described as follows:

| Property | Description |
|---|---|
| B | BASE: Basic variables, can be selected via the UP / DOWN keys on the panel. |
| Dec, Hex | Display format on panel. Dec indicated Decimal, Hex indicates Hexadecimal. Currently all the system variables are displayed in the Dec format. |

Monitoring variables are described in the following table according to the code sequence:

**Table 139 - System Variables Code**

| Code | Variable name | Property | Description | User Unit(1) |
|---|---|---|---|---|
| 000 (00h) | Feedback position (PUU) | B, DEC | Current feedback position of the motor encoder. | PUU |
| 001 (01h) | Position command (PUU) | B, DEC | Current coordinate of the position command.<br>PT Mode: Number of pulse commands received by the drive.<br>PR Mode: Absolute coordinates of the position command. | PUU |
| 002 (02h) | Position deviation (PUU) | B, DEC | Error between the Command position and Feedback position. | PUU |
| 003 (03h) | Feedback position (count) | B, DEC | Current feedback position of the motor encoder. | count |
| 004 (04h) | Position command (count) | B, DEC | Value of the Position command.<br>This value is after the E-Gear ratio conversion. | count |
| 005 (05h) | Position deviation (count) | B, DEC | Error between the Command position and Feedback position. | count |
| 006 (06h) | Pulse command frequency | B, DEC | Frequency of the pulse command received by the drive.<br>Applicable to PT, PR and I/O (Gear) modes | KHz |
| 007 (07h) | Speed feedback | B, DEC | Motor speed. This is the speed after applying the low-pass filter. | 0.1 rpm |
| 008 (08h) | Speed command (analog) | B, DEC | Speed command derived from the analog speed terminals. | 0.01 Volt |

## Table 139 - System Variables Code (Continued)

| Code | Variable name | Property | Description | User Unit[1] |
|---|---|---|---|---|
| 009 (09h) | Speed command (integrated) | B, DEC | Integrated Speed command. Source includes analog, register, or position loop. | 0.1 rpm |
| 010 (0Ah) | Torque command (analog) | B, DEC | Torque command derived from the analog torque terminals. | 0.01 Volt |
| 011 (0Bh) | Torque command (integrated) | B, DEC | Integrated Torque command. Source includes analog, register, or speed loop. | percentage (%) |
| 012 (0Ch) | Average load rate | B, DEC | Average load rate (moving average every 20 ms) from the servo drive. | percentage (%) |
| 013 (0Dh) | Peak load rate | B , DEC | This can be used to monitor a motor overload condition. | percentage (%) |
| 014 (0Eh) | DC Bus voltage | B, DEC | Rectified capacitor voltage. | Volt |
| 015 (0Fh) | Load inertia ratio | B, DEC | Ratio of the load inertia to the motor inertia. | 0.1 times |
| 016 (10h) | IGBT temperature | B, DEC | Temperature of IGBT. | °C |
| 017 (11h) | Resonance frequency | B, DEC | Resonance frequency of the system consists of two groups of frequencies: F1 and F2. The low word is frequency F2, when the high word is frequency F1. | Hz |
| 018 (12h) | Z phase offset | B, DEC | Offset value between motor position and Z phase; range: -4999…+5000 (-180 degrees to 180 degrees). Where it overlaps with Z phase, the value is 0; the greater the value, the greater the offset. | 180/5000 degree |
| 019 (13h) | Mapping parameter content #1 | B, DEC | Returns the value of P0.025, which is mapped by P0.035. | — |
| 020 (14h) | Mapping parameter content #2 | B, DEC | Returns the value of P0.026, which is mapped by P0.036. | — |
| 021 (15h) | Mapping parameter content #3 | B, DEC | Returns the value of P0.027, which is mapped by P0.037. | — |
| 022 (16h) | Mapping parameter content #4 | B, DEC | Returns the value of P0.028, which is mapped by P0.038. | — |
| 023 (17h) | Mapping monitoring variable #1 | B, DEC | Returns the value of P0.009, which is mapped by P0.017. | — |
| 024 (18h) | Mapping monitoring variable #2 | B, DEC | Returns the value of P0.020, which is mapped by P0.018. | — |
| 025 (19h) | Mapping monitoring variable #3 | B, DEC | Returns the value of P0.011, which is mapped by P0.019. | — |
| 026 (1Ah) | Mapping monitoring variable #4 | B, DEC | Returns the value of P0.012, which is mapped by P0.020. | — |
| 027 (1Bh) | Z phase offset (PUU Unit) | B, DEC | Offset value between motor position and Z phase (panel only) | PUU |
| 028 (1Ch) | Alarm code | B, DEC | The Error Code (Reserved for future release). | — |
| 029 (1Dh) | Auxiliary encoder feedback | DEC | Position feedback from the auxiliary encoder. | PUU |
| 030 (1Eh) | Position error (PUU) | DEC | Error from the position command and feedback position of the auxiliary encoder. | PUU |
| 031 (1Fh) | Main / auxiliary encoder position deviation (PUU) | DEC | Error between the feedback position of the main encoder and auxiliary encoder. | PUU |
| 035 (23h) | Indexing coordinate command | DEC | Current command for the indexing coordinates. | PUU |
| 037 (25h) | Compare data of COMPARE | DEC | The actual Compare data is the Compare data plus a specified value: CMP_DATA = DATA_ARRAY[*] + P1.023 + P1.024. | PUU |
| 039 (27h) | DI status (integrated) | DEC | Integrated DI status of the drive. Each bit corresponds to one DI channel. Source includes Hardware channel / ID281 (P4.007), which is determined by ID268 (P3.006). | — |
| 040 (28h) | DO status (hardware) | DEC | Actual status from the DO hardware. Each bit corresponds to one DO channel. | — |
| 041 (29h) | Status of the drive | DEC | Returns ID280 (P4.006) Refer to the description of this parameter. | — |
| 043 (2Bh) | Latest capture data | DEC | The latest data captured by CAP hardware. CAP can continuously capture multiple points. | PUU |
| 048 (30h) | Auxiliary encoder CNT | DEC | Pulse counts from the auxiliary encoder. | count |
| 049 (31h) | Pulse command CNT | DEC | Pulse counts from the pulse command (I/O Terminal block input). | count |
| 050 (32h) | Speed command (integrated) | DEC | Integrated Speed command. Source includes analog, register, or position loop. | 0.1 rpm |
| 051 (33h) | Speed feedback (immediate) | DEC | Actual motor speed. | 0.1 rpm |
| 053 (35h) | Torque command (integrated) | DEC | Integrated Torque command. Source includes analog, register, or speed loop. | 0.1% |
| 054 (36h) | Torque feedback | DEC | Actual motor torque. | 0.1% |
| 055 (37h) | Current feedback | DEC | Actual motor current. | 0.01 A (ampere) |

## Table 139 - System Variables Code (Continued)

| Code | Variable name | Property | Description | User Unit(1) |
|---|---|---|---|---|
| 056 (38h) | DC Bus voltage | DEC | Rectified capacitor voltage. | 0.1 Volt |
| 057(39h) | ECAM engage status | DEC | 0-stop, 1-engaged, 2-pre-engaged | — |
| 059 (3Bh) | Pulse from E-CAM master axis (accumulative) | DEC | Accumulative pulse number of the E-CAM master axis. Same as ID374 (P5.086). | Same as the master axis pulse |
| 060 (3Ch) | Pulse from E-CAM master axis (incremental) | DEC | Incremental pulse number of the E-CAM master axis. The increment per ms. | Same as the master axis pulse |
| 061 (3Dh) | Pulse from E-CAM master axis (lead pulse) | DEC | The lead pulse of the E-CAM master axis which determines the engagement condition.When disengaged: lead pulse = ID375 (P5.087) or ID380 (P5.092); when the value is 0, E-CAM engages.When engaged: lead pulse = ID377 (P5.089); when the value is 0, it disengages. | Same as the master axis pulse |
| 062 (3Eh) | Position of E-CAM master axis | DEC | Position of the E-CAM which corresponds to the master axis pulse, and can be used to find the phase of the E-CAM. when the incremental pulse number of the master axis is P, E-CAM rotates M cycles, where ID371 (P5.083) = M, ID372(P5.084) = P. | Same as the master axis pulse |
| 063 (3Fh) | Position of E-CAM slave axis | DEC | Position of the E-CAM slave axis and can be found from the E-CAM table.Unit: unit used in the E-CAM table. | PUU |
| 064 (40h) | Endpoint register of PR command | DEC | In PR Mode, the endpoint of the Position command (Cmd_E). | PUU |
| 065 (41h) | Output register of PR command | DEC | In PR Mode, the accumulative output of the Position command. | PUU |
| 067 (43h) | PR target speed | DEC | Target speed specified in the PR command. | 0.1 RPM or PPS (pulse per second) |
| 068 (44h) | S-curve (input) | DEC | Input data of the S-curve filter.Effective in PR Mode, E-CAM, and register Speed command. | PUU |
| 069 (45h) | S-curve (output) | DEC | Output data of the S-curve filter.Effective in PR Mode, E-CAM, and register Speed command. | PUU |
| 072 (48h) | Speed command (analog) | DEC | Speed command from the analog channel. | 0.1 rpm |
| 085 (55h) | E-CAM alignment deviation percentage | DEC | The alignment error rate after filtering. 10 indicates 1% and the angle conversion is 360° × 1% = 3.6°. | 0.1% |
| 091 (5Bh) | Indexing coordinate feedback | DEC | Immediate feedback position of the indexing coordinates. | PUU |
| 096 (60h) | Drive firmware version | DEC | Includes 2 versions: DSP and CPLD.<br>• Low word returns the DSP version number<br>• High word returns the CPLD version number | — |
| 111 (6Fh) | Error code of the servo drive | DEC | Error code from the servo drive: control loop of the servo only, not including the motion controller. | — |
| 112 (70h) | Encoder communication error rate | DEC | When this value continues to increase, it indicates that there is communication interference. In an interference-free environment, this value should not increase. | — |
| 113 (71h) | Overload (E006) protection counter | DEC | Displays the motor load during operation. When the value reaches 100%, E006 occurs. | — |
| 114 (72h) | Encoder temperature | DEC | Monitor the encoder temperature. | °C |
| 115 (73h) | Encoder type | DEC | Displays the encoder type. | — |
| 116 (74h) | Deviation between position and Z phase of auxiliary encoder (pulse) | DEC | Distance between the current feedback position of the auxiliary encoder and the Z phase position of the auxiliary encoder. | count |
| 117 (75h) | Hall sensor phase sequence and Z pulse data from auxiliary encoder feedback | DEC | Use the bit to determine the UVW phase sequence of the Hall sensor and Z pulse from auxiliary encoder feedback. Bit 0: Z pulse, Bit 1: U phase, Bit 2: V phase, Bit 3: W phase. | |
| 118 (76h) | Hall sensor phase sequence and Z pulse data from main encoder feedback | DEC | Use the bit to determine the UVW phase sequence of the Hall sensor and Z pulse from main encoder feedback. Bit 0: Z pulse, Bit 1: U phase, Bit 2: V phase, Bit 3: W phase. | |
| 123 (7Bh) | Value returned when monitoring by panel | — | Monitoring value displayed when returned to the monitoring panel. | — |

(1) PUU is Position of User Unit; count is encoder unit.

## Description of Parameter Monitoring

These parameter values are used in IO operation mode to pass parameter values from the drive to the Logix controller as part of the input assembly. These parameters are configured in KNX5100C software from Function List > Parameter Editor > Status Monitor > ID060…ID064. These parameters cannot be modified if there is an active Ethernet/IP network connection between the drive and controller. These configurations must be made before the connection is established, or while the connection is inhibited.

Parameters can be monitored by using ID55(P0.025)…ID59(P0.029), which contents are specified by ID60(P0.035)…ID64(P0.039).

**Table 140 - Relevant Parameters**

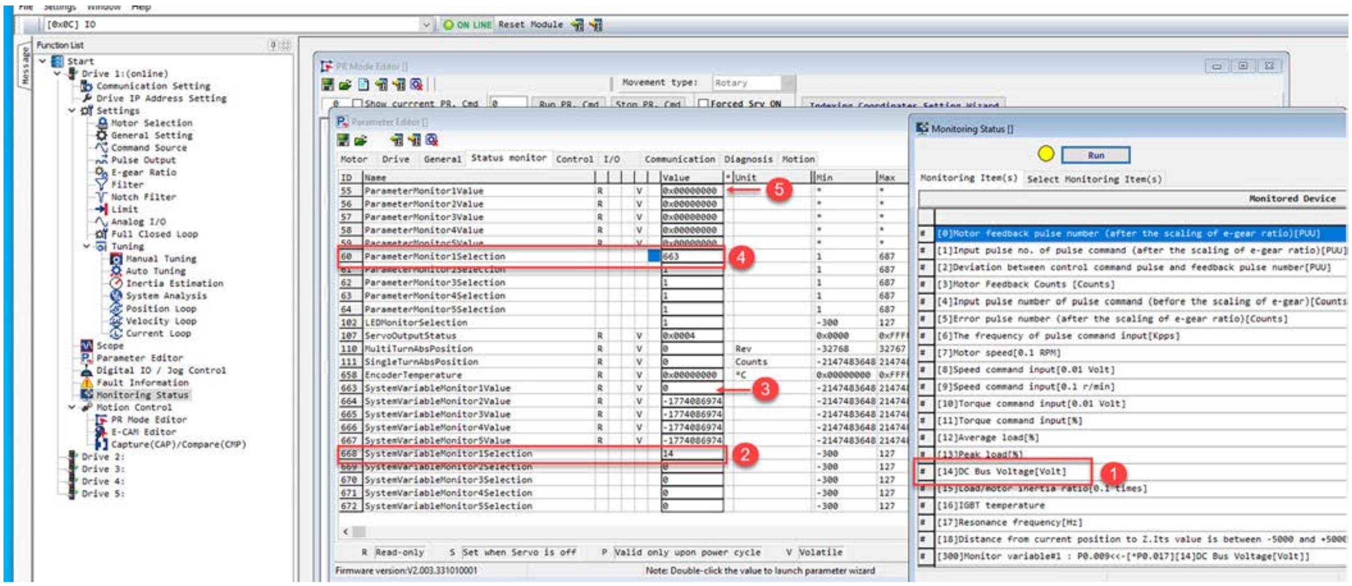
| Parameter | Name | Description |
|---|---|---|
| ID55 (P0.025) | ParameterMonitor1Value | Parameter Monitor 1 Value<br>You can use ID60 (P0.035) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID60 (P0.035) is shown in ID55 (P0.025). |
| ID56 (P0.026) | ParameterMonitor2Value | Parameter Monitor 2 Value<br>You can use ID61 (P0.036) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID61 (P0.036) is shown in ID56 (P0.026). |
| ID57 (P0.027) | ParameterMonitor3Value | Parameter Monitor 3 Value<br>You can use ID62 (P0.037) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID62 (P0.037) is shown in ID56 (P0.027). |
| ID58 (P0.028) | ParameterMonitor4Value | Parameter Monitor 4 Value<br>You can use ID63 (P0.038) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID63 (P0.038) is shown in ID57 (P0.028). |
| ID59 (P0.029) | ParameterMonitor5Value | Parameter Monitor 5 Value<br>You can use ID64 (P0.039) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID64 (P0.039) is shown in ID57 (P0.028). |
| ID60 (P0.035) | ParameterMonitor1Selection | The content of the parameter that is specified by ID60 (P0.035) is shown in ID55 (P0.025). |
| ID61 (P0.036) | ParameterMonitor2Selection | The content of the parameter that is specified by ID61 (P0.036) is shown in ID56 (P0.026). |
| ID62 (P0.037) | ParameterMonitor3Selection | The content of the parameter that is specified by ID62 (P0.037) is shown in ID57 (P0.027). |
| ID63 (P0.038) | ParameterMonitor4Selection | The content of the parameter that is specified by ID63 (P0.038) is shown in ID58 (P0.028). |
| ID64 (P0.039) | ParameterMonitor5Selection | The content of the parameter that is specified by ID64 (P0.039) is shown in ID59 (P0.029). |

Example 1: When ID60 (P0.035) is 1, then the value of ID55 (P0.025) is equal to ID1 (PM.000). When you monitor ID55 (P0.025) in Logix, the value of ID60 (P0.035) (mapped to ID1) is passed at the drive update.

Example 2: When ID60(P0.035) is 4, then the value of ID55 (P0.025) is equal to ID4 (PM.029). When you monitor ID55 (P0.025) in Logix, the value of ID60 (P0.035) (mapped to ID4) is passed at the drive update.

This example describes the passing of the DC Bus voltage parameter, which is only represented as a SystemVariable, to the ParameterMonitor variable so it can be monitored within the Logix tag structure.

**Figure 237 - Parameter Monitoring**



1. Navigate to Function List>Settings>Monitoring Status.

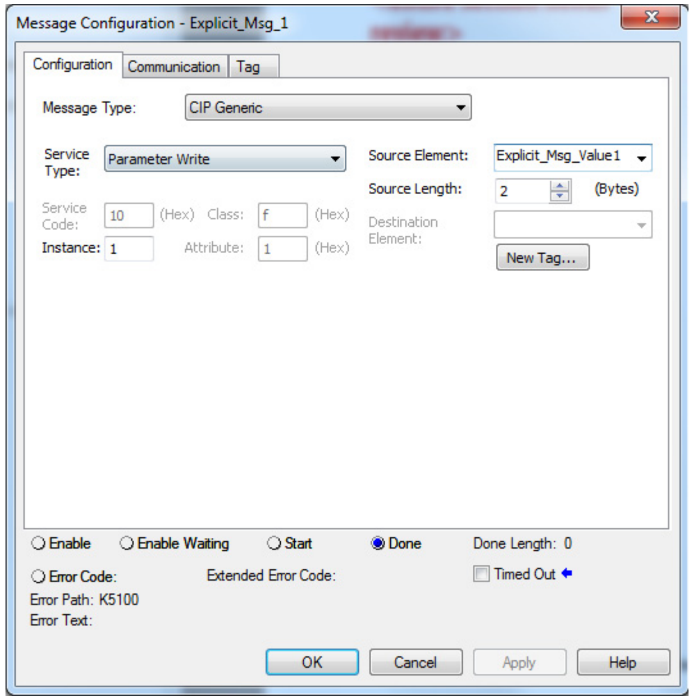
   By default, setting (14) is the DC Bus Voltage value.
2. Find an available SystemVariableMonitorxSelection placeholder; enter the numerical value of the DC Bus Voltage (14).
3. This present DC Bus Voltage appears in the SystemVariableMonitorxValue when this is downloaded to the drive.
4. Enter the ID of the SystemVariableMonitorxValue you setup in Step 3 (663).

   The SystemVariables are not accessible in the Logix tag subsystem. The ParameterMonitor values are accessible.
5. When there is an active connection wtih Logix, you can monitor the Input Assembly (or Device Object Add-On Instruction) and see the value of the ParameterxMonitorValue.

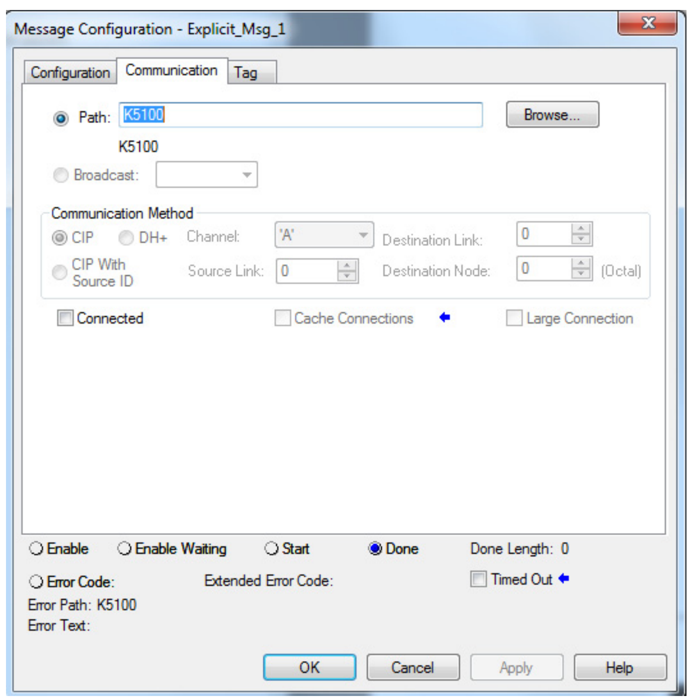
## Use a MSG Instruction to Set Parameters

When the drive is not using IO operation mode, Class 3 EtherNet/IP™ messaging is allowed and some Parameter IDs can be read/written. Below is an example of a write operation that is performed in the Logix Designer application. Alternately, you can use a MSG instruction to set parameters by following these steps.

1. Create a Parameter Write MSG instruction in the ladder logic program.




2. Use the parameter ID as the instance.
3. Select or create a Source Element, and specify the length of it.
4. Configure the communication path.



# Troubleshoot the Kinetix 5100 Drive System



## Safety Precautions

Observe the following safety precautions when you troubleshoot your Kinetix® 5100 drive.

**ATTENTION:** DC bus capacitors may retain hazardous voltages after input power has been removed. Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval listed on the drive warning label. When the DC bus voltage is above 50V DC, the charge LED light on the drive must be on. Failure to observe this precaution could result in severe bodily injury or loss of life.
Do not attempt to defeat or override the drive fault circuits. You must determine the cause of a fault and correct it before you attempt to operate the system. If you do not correct a drive or system malfunction, it could result in personal injury and/or damage to the equipment as a result of uncontrolled machine system operation.

Test equipment (such as an oscilloscope or chart recorder) must be properly grounded. Failure to include an earth ground connection could result in a potentially fatal voltage on the oscilloscope chassis.

## Status Indicators

There are three status indicators on front of the Kinetix 5100 drive: module (MOD), network (NET), and CHARGE.

**Table 141 - MOD LED Status Indicators**

| Operation Mode | LED Color | Status | Description |
|---|---|---|---|
| I/O | Steady off | No power | If no power is supplied to the device, the module status indicator shall be steady off. |
| | Steady green | Device operational | If the device is operating correctly (IO connection is established successfully), the module status indicator shall be steady green. |
| | Flashing green | Standby | If the device has not been configured, the module status indicator shall be flashing green. |
| | Flashing red | Major recoverable fault or Minor recoverable fault | If the device has detected a major or minor recoverable fault, the module status indicator shall be flashing red.<br>**IMPORTANT:** An incorrect or inconsistent configuration could be considered a major recoverable fault. |
| | Steady red | Major unrecoverable fault | If the device has detected a major unrecoverable fault, the module status indicator shall be steady red. |
| | Flashing green/red | Self-test | While the device is performing its power up testing, the module status indicator shall be flashing green/red. |

Table 141 - MOD LED Status Indicators (Continued)

| Operation Mode | LED Color | Status | Description |
|---|---|---|---|
| Standalone | Steady off | No power | If no power is supplied to the device, the module status indicator shall be steady off. |
| | Steady green | Device operational | If the device is operating correctly (after the drive boots successfully), the module status indicator shall be steady green. |
| | Flashing red | Major recoverable fault or Minor recoverable fault | If the device has detected a major or minor recoverable fault, the module status indicator shall be flashing red.<br>**IMPORTANT:** An incorrect or inconsistent configuration could be considered a major recoverable fault. |
| | Steady red | Major unrecoverable fault | If the device has detected a major unrecoverable fault, the module status indicator shall be steady red. |
| | Flashing green/red | Self-test | While the device is performing its power up testing, the module status indicator shall be flashing green/red. |

Table 142 - NET LED Status Indicators

| LED Color | Status | Description |
|---|---|---|
| Steady off | No power or no IP address | The device is powered off, or is powered on but with no IP address configured. |
| Steady green | Connected | An IP address is configured, at least one CIP™ connection (any transport class) is established, and an Exclusive Owner connection has not timed out. |
| Flashing green | Not connected | An IP address is configured but no CIP connections are established, and an Exclusive Owner connection has not timed out. |
| Flashing red | Connection timeout | An IP address is configured, and an Exclusive Owner connection where this device is the target has timed out. |
| Steady red | A duplicate IP address has been identified | The device has detected that (at least one of) its IP address is already in use. |
| Flashing green/red | Self-test | While the device performs its power up testing. |

Table 143 - CHARGE LED Status Indicators

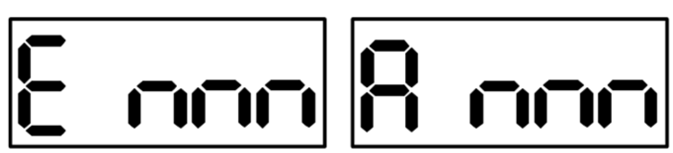
| LED Color | Status | Description |
|---|---|---|
| Steady off | No power | When no power is supplied to the device. |
| Steady orange | DC bus voltage operational | When the DC bus voltage is above 50V DC. |

# View Status and Faults

This manual links to Kinetix® 5100 Servo Drive Fault Codes Reference Data, publication 2198-RD001, for fault codes and Kinetix 5100 Servo Drive Parameters Reference Data, publication 2198-RD002, for parameters. Download the spreadsheets now for offline access.

## Drive Fault Code Display

The drive display panel indicates a fault or warning on the display.



Fault Warning

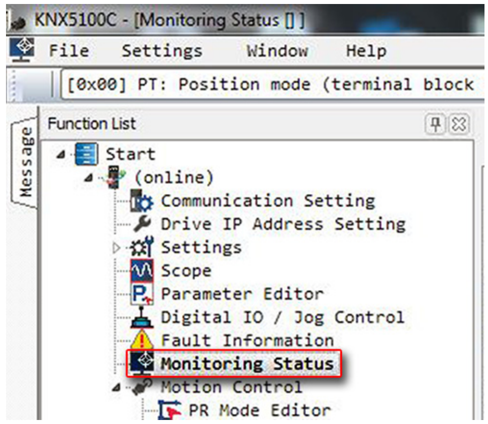
For more information on faults and warnings, see Clear Faults on page 444.

## Monitoring Status in KNX5100C Software

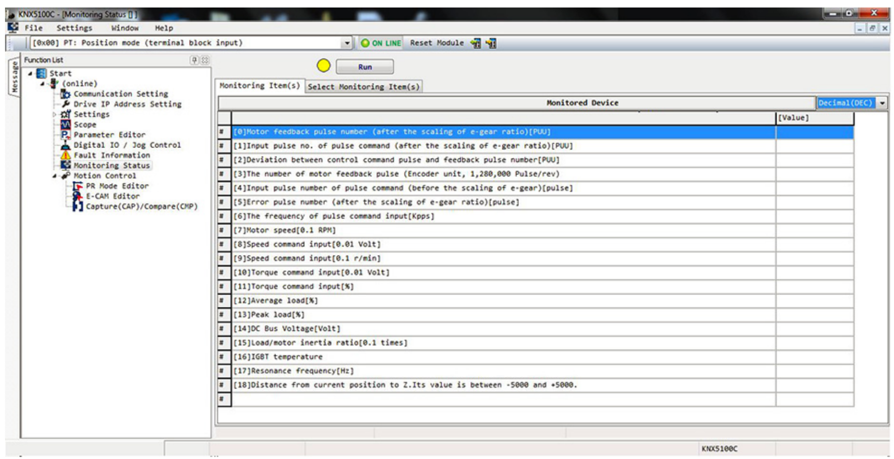
In KNX5100C software, you can monitor the status of the servo drive.

To monitor the servo drive, perform the following steps.

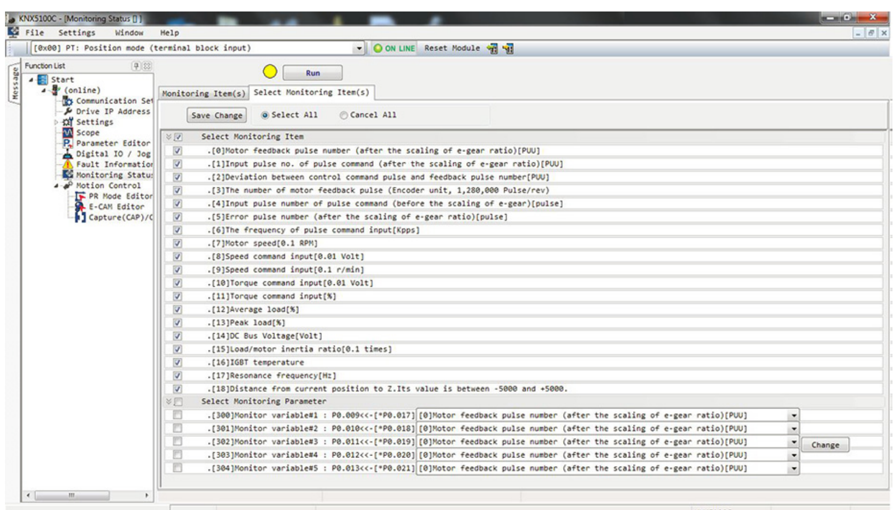
1. In the Function List of the KNX5100C software, click Monitoring Status.




On the Monitoring Items tab, the monitored items and their setting values are shown.




On the Select Monitoring Items tab, you can select what items to monitor.




2. Click Save Changes if any changes are made, which are shown subsequently on the Monitoring Items tab.

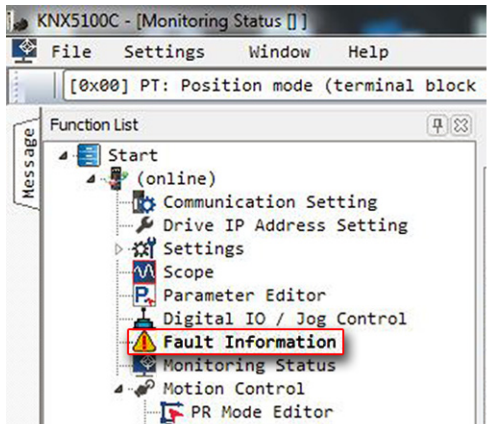
**IMPORTANT** Click Run to run the Monitoring Status function. If you do, the same button toggles to Stop, which you then click when you want to stop the monitoring status.


## Fault Information in the KNX5100C Software

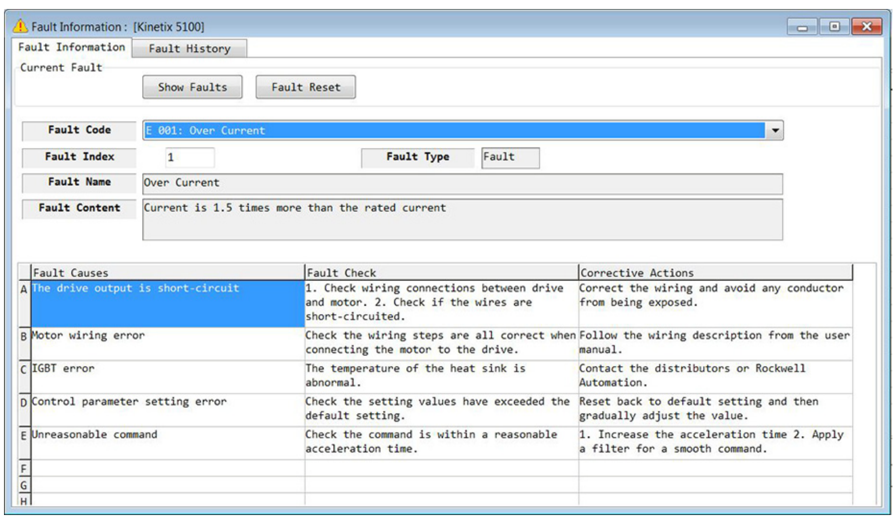
In the KNX5100C software, you can use Fault Information to identify any faults of the servo drive.

To identify any faults, perform the following steps.

1. In the Function List of the KNX5100C software, click Fault Information.

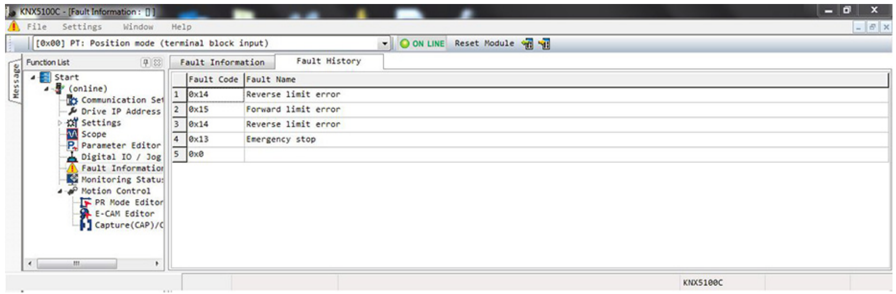



On the Fault Information tab, the most current fault is shown with detailed information, including possible causes and subsequent corrective actions.




2. Click either available button for the following reasons:
   - Click Show Faults to refresh the current fault information.
   - Click Fault Reset to reset fault and remove the current list of fault information if fault is cleared.

Click the Fault History tab to see the latest fault codes recorded in the servo drive.



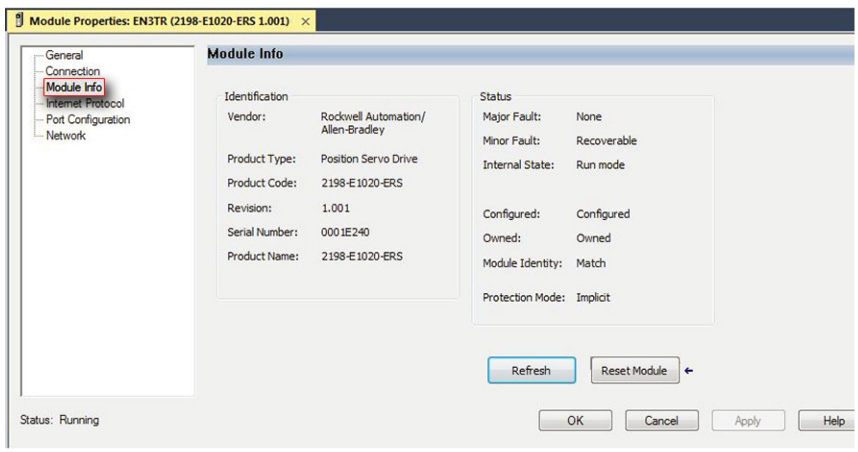

## Fault and Status Information in Studio 5000 Application

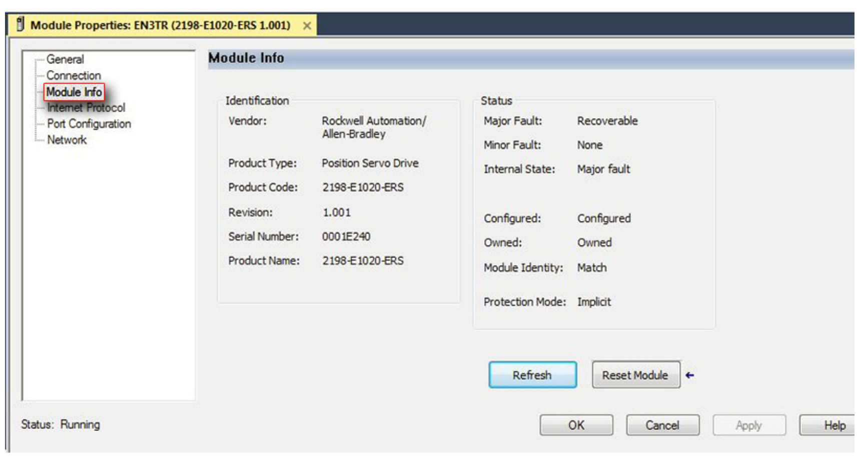
Major faults and minor faults (warnings) are shown on the Module Info tab in the Studio 5000 Logix Designer® application.

To view faults the Studio 5000 Logix Designer application, perform the following steps.

1. Under the hierarchy, click Module Info.

   Any fault is shown in the Status field.




2. If the fault is recoverable, click Reset Module to clear the fault.

## Drive Stopping Behavior

A fault (code E *nnn*) triggers the shutdown (servo off) behavior of the drive.

Parameter ID675 (P1.032), MotorStopMode, configures the drive stopping behavior.

| MotorStopMode Setting | Drive Behavior |
|---|---|
| 0000 (default) | Dynamic brake stop - This stop type is similar to current decel (available torque used to decelerate motor) with an internal regenerative type of stop that stops the motor as quickly as possible. |
| 0010 | Disable and coast. |
| 0020 | Use dynamic brake first, then let the motor run freely once the speed is slower than the value of parameter ID145 (P1.038), ZeroSpeedWindow. |
| 0030 | Enable vertical load control. |

## Clear Faults

The two methods for clearing faults depends on the type.

Warnings (A *nnn*): When the condition that caused the warning is corrected, the warning clears automatically. Warnings can also be referred to as Alarms.

Faults (E *nnn*): Clear the fault by one of the following methods:

- For a major unrecoverable fault, cycle power to clear the fault. If the issue persists, contact your distributor or Rockwell Automation representative.
- For a major recoverable fault:
  - Click Reset Module in the Studio 5000 Logix Designer software. For more information, see Fault and Status Information in Studio 5000 Application on page 443.
  - By using the DI.ARST signal.
  - By clicking Fault Reset in the Fault Information dialog of the KNX5100C software (see Fault Information in the KNX5100C Software on page 442).
  - Set ID101 (P0.001) FltWarnCode to 0.
  - By using the raC_*xxx*_K5100_MAFR add-on instruction in the Studio 5000 Logix Designer software (for more information on add-on instructions, see Appendix C, Use Add-On Instructions).

## General Troubleshooting

The following conditions do not always result in a fault code, but can require troubleshooting to improve performance.

**Table 144 - Troubleshooting**

| Condition | Potential Cause | Possible Resolution |
|---|---|---|
| Axis or system is unstable. | The position feedback device is incorrect or open. | Check wiring. |
| | Unintentionally in torque mode. | Check to see what primary operation mode was programmed. |
| | Motor tuning limits are set too high. | Run Tune by using KNX5100C software or the LED panel.<br>See Tuning Process on page 194. |
| | Position loop gain or position controller acceleration/deceleration rate is improperly set. | Run Tune by using KNX5100C software or the LED panel.<br>See Tuning Process on page 194. |
| | Improper grounding or shielding techniques are causing noise to be transmitted into the position feedback or velocity command lines, causing erratic axis movement. | Check wiring and ground. |
| | Motor select limit is incorrectly set (servo motor is not matched to axis module). | • Check setups.<br>• Run Tune in the Logix Designer application. |
| | Mechanical resonance. | Notch filter or output filter can be required. |
| You cannot obtain the motor acceleration/deceleration that you want. | Torque Limit limits are set too low. | Verify that torque limits are set properly. |
| | Incorrect motor selected in configuration. | Select the correct motor.<br>Run Tune by using KNX5100C software or LED panel. |
| | The system inertia is excessive. | • Check motor size versus application need.<br>• Review servo system sizing. |
| | The system friction torque is excessive. | Check motor size versus application need. |
| | Available current is insufficient to supply the correct acceleration/deceleration rate. | • Check motor size versus application need.<br>• Review servo system sizing. |
| | Acceleration limit is incorrect. | Verify limit settings and correct them, as necessary. |
| | Velocity limits are incorrect. | Verify limit settings and correct them, as necessary. |
| | The motor is operating in the field-weakening range of operation. | Reduce the commanded acceleration or deceleration. |
| Motor does not respond to a command. | The axis cannot be enabled until stopping time has expired. | Disable the axis, wait for 1.5 seconds, and then enable the axis. |
| | The motor wiring is open. | Check the wiring. |
| | The motor cable shield connection is improper. | • Check feedback connections.<br>• Check cable shield connections. |
| | The motor has malfunctioned. | Repair or replace the motor. |
| | The coupling between motor and machine has broken (for example, the motor moves but the load/machine does not). | Check and correct the mechanics. |
| | Primary operation mode is set incorrectly. | Check and properly set the limit. |
| | Velocity or torque limits are set incorrectly. | Check and properly set the limits. |
| | Brake connector not wired. | Check the brake wiring. |
| Presence of noise on command or motor feedback signal wires. | Recommended grounding per installation instructions have not been followed. | • Verify grounding.<br>• Route wire away from noise sources.<br>• Refer to System Design for Control of Electrical Noise, publication GMC-RM001. |
| | Line frequency can be present. | • Verify grounding.<br>• Route wire away from noise sources. |
| | Variable frequency can be velocity feedback ripple or a disturbance caused by gear teeth or ball screw. The frequency can be a multiple of the motor power transmission components or ball screw speeds, resulting in velocity disturbance. | • Decouple the motor for verification.<br>• Check and improve mechanical performance, for example, the gearbox or the ball screw mechanism. |

**Table 144 - Troubleshooting (Continued)**

| Condition | Potential Cause | Possible Resolution |
|---|---|---|
| No rotation | The motor connections are loose or open. | Check motor wiring and connections. |
| | Foreign matter is lodged in the motor. | Foreign matter is lodged in the motor. Remove foreign matter. |
| | The motor load is excessive. | The motor load is excessive. Verify the servo system sizing. |
| | The bearings are worn. | The bearings are worn. Return the motor for repair. |
| | The motor brake is engaged (if supplied). | • Check brake wiring and function.<br>• Return the motor for repair. |
| | The motor is not connect to the load. | Check the coupling. |
| Motor overheating | The duty cycle is excessive. | Change the command profile to reduce acceleration/deceleration, or increase time. |
| | The rotor is partially demagnetized causing excessive motor current. | Return the motor for repair. |
| Abnormal noise | Motor tuning limits are set too high. | Run Tune by using KNX5100C software or the LED panel. See Tuning Process on page 194. |
| | Loose parts are present in the motor. | • Remove the loose parts.<br>• Return motor for repair.<br>• Replace motor. |
| | Through bolts or coupling is loose. | Tighten bolts. |
| | The bearings are worn. | Return motor for repair. |
| | Mechanical resonance. | Notch filter can be required. |
| Erratic operation–Motor locks into position, runs without control, or with reduced torque. | Motor power phases U and V, U and W, or V and W reversed. | Check and correct motor power wiring. |

# Interconnect Diagrams

This appendix provides wiring examples to assist you in wiring the Kinetix® 5100 drive system.



## Interconnect Diagram Notes

These notes apply to the wiring examples on the pages that follow.

**Table 145 - Interconnect Diagram Notes**

| Note | Information |
|---|---|
| 1 | For power wiring specifications, see Wiring Requirements on page 80. |
| 2 | DC–, and P1, P2 terminals are not used. Do not remove the jumper between P1 and P2. |
| 3 | Single-phase control power is not phase limited. You can choose any two inputs (L1, L2, or L3), unless a fan or other item is powered on the AC line bus. |
| 4 | Only the 2198-E1*xxxx*-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, and 2198-E4015-ERS drives have an internal resistor for shunt purposes. A jumper connects the internal shunt resistor, see Passive Shunt Wiring Examples on page 453. Remove jumper only when wiring to an external shunt resistor. |
| 5 | For input fuse and circuit breaker sizes, see Circuit Breaker/Fuse Selection on page 27. |
| 6 | Place the AC (EMC) line filters as close to the drive as possible and do not route very dirty wires in the same wireway. If routing in same wireway is unavoidable, use shielded cable with shields grounded to the drive chassis and filter case. For AC line filter specifications, see Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003. |
| 7 | 2198-TBIO I/O terminal block is required to make connections. Configure a digital output (OUTPUT1…OUTPUT6) as Brake Control in KNX5100C software. For digital output specifications, see Digital Outputs on page 54. |
| 8 | The M1 contactor is optional - customer supplied. It is recommended when independent control of control power and main AC power is desired. Contactor coil (M1) requires integrated surge suppressors for AC coil operation. See Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003. |
| 9 | See Brake Control Circuit Example on page 62 to size the customer-supplied interposing relay for your application. See Figure 30 on page 56 for the diode or MOV suppression device for your application. |
| 10 | Servo On input must be removed when main power is removed or a drive fault occurs. A delay of at least 6.0 seconds must be observed before attempting to enable the drive after main power is restored. The Kinetix 5100 drives are limited to 1 main power cycle per minute. |
| 11 | Ground plate connection must be used to meet CE requirements. The motor ground termination has a direct path to the Kinetix 5100 drive for control of common mode and EMI interference. However, we recommend this grounding practice regardless of CE requirements. No external connection to ground is required. |
| 12 | PE ground point is a mounting screw (see Connect the Braided Ground Strap Example on page 79). |
| 13 | For motor cable specifications, see the Kinetix Motion Accessories Technical Data, publication KNX-TD004. |
| 14 | MPL-B15*xx*-V/E…MPL-B2*xx*-V/E, MPL-B3*xx*-S/M…MPL-B9*xx*-S/M, MPL-A5*xx*, MPM-B*xx*, MPM-A165*xx*…MPM-A215*xx*, MPF-B*xx*, MPF-A5*xx*, and MPS-B*xxx* encoders use the +9V DC supply. |
| 15 | MPL-A/B15*xx*-H…MPL-A/B45*xx*-H, MPL-A15*xx*-V/E…MPL-A2*xx*-V/E, MPL-A3*xx*-S/M…MPL-A5*xx*-S/M, MPM-A115*xx*…MPM-A130*xx*, MPF-A3*xx*…MPF-A45*xx*, and MPS-A*xxx* encoders use the +5V DC supply. |

**Table 145 - Interconnect Diagram Notes (Continued)**

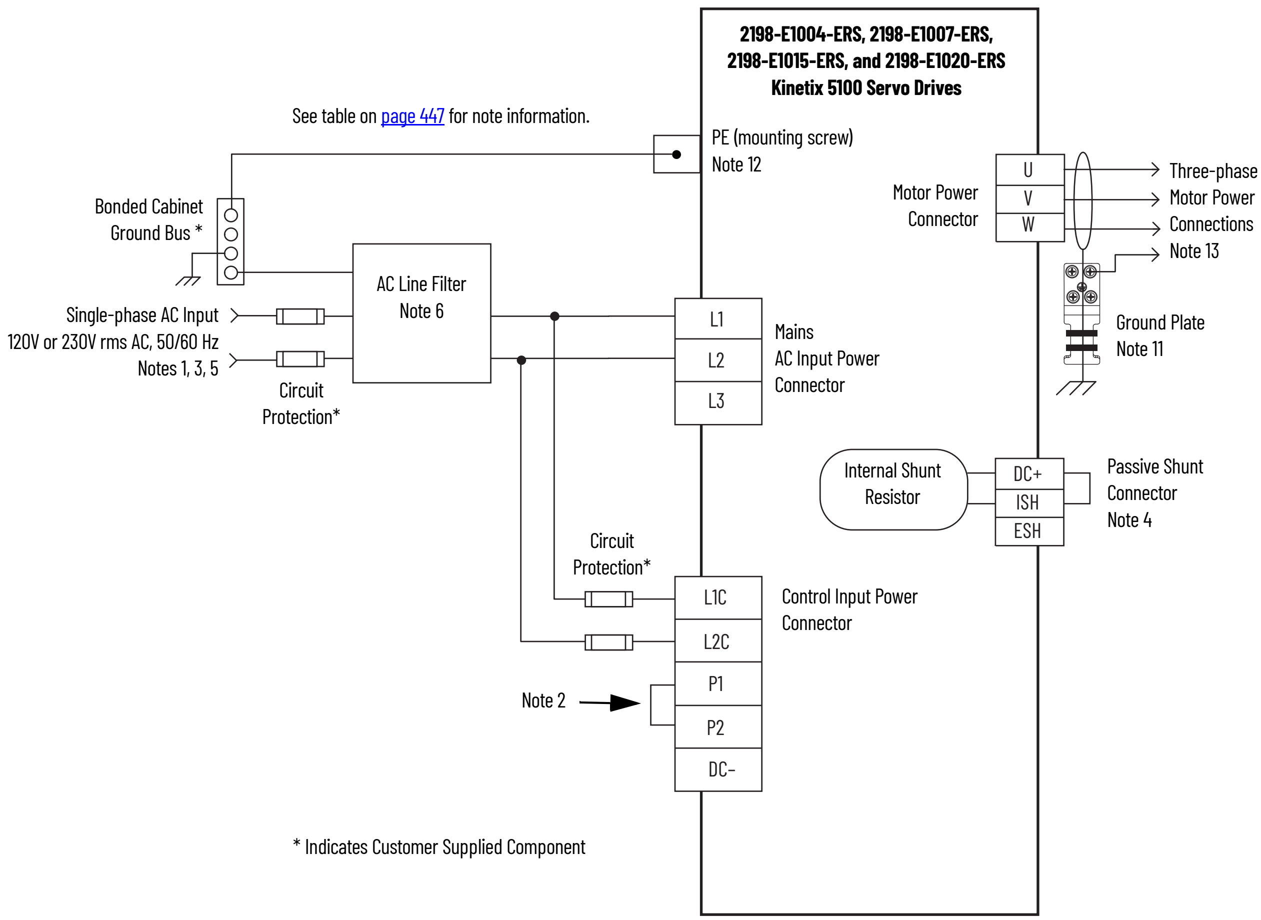
| Note | Information |
|---|---|
| 16 | Motor brake connector pins are labeled plus (+) and minus (-) or F and G, respectively. Motor power connector pins are labeled U, V, W, and GND or A, B, C, and D, respectively. |
| 17 | Kinetix LDAT linear thrusters do not have a brake option, so only the 2090-CPWM7DF-*xx*AA*xx* or 2090-CPWM7DF-*xx*AF*xx* motor power cables apply. |
| 18 | MPAS-B*xxxxx*-VxxSxA (ballscrew) linear stages use the 9V supply. MPAS-B*xxxxx*-ALMx2C (direct-drive) linear stages use the 5V supply. |

## Power Wiring Examples

You must supply input power components. The following diagrams illustrate single-phase and three-phase input power and connections for control power, motor power, AC line filters, and passive shunts.

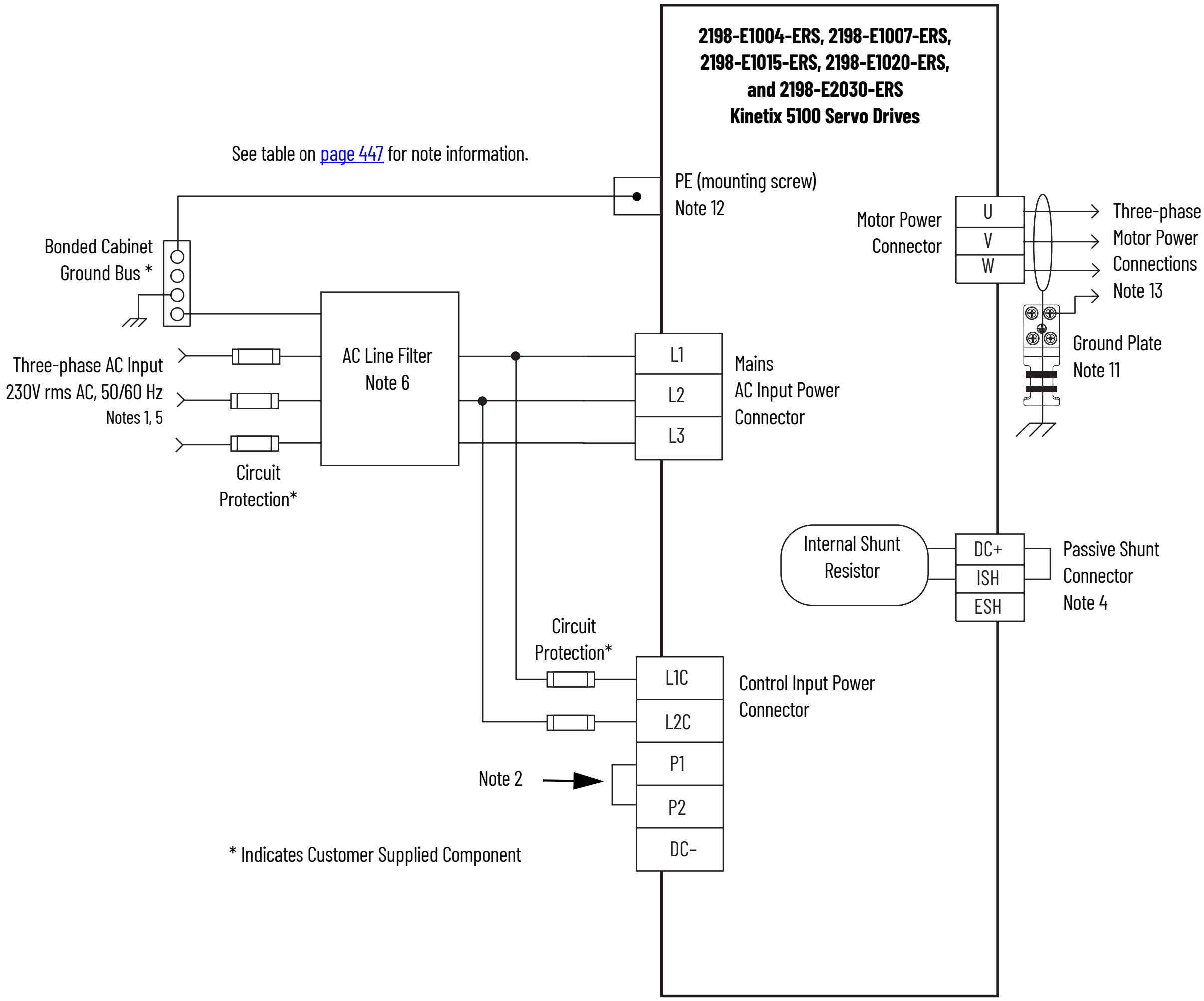
In this example, the 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, and 2198-E1020-ERS drives are wired for 120V or 230V single-phase operation.

**Figure 238 - Kinetix 5100 Drive (120V or 230V Single-phase Input Power)**



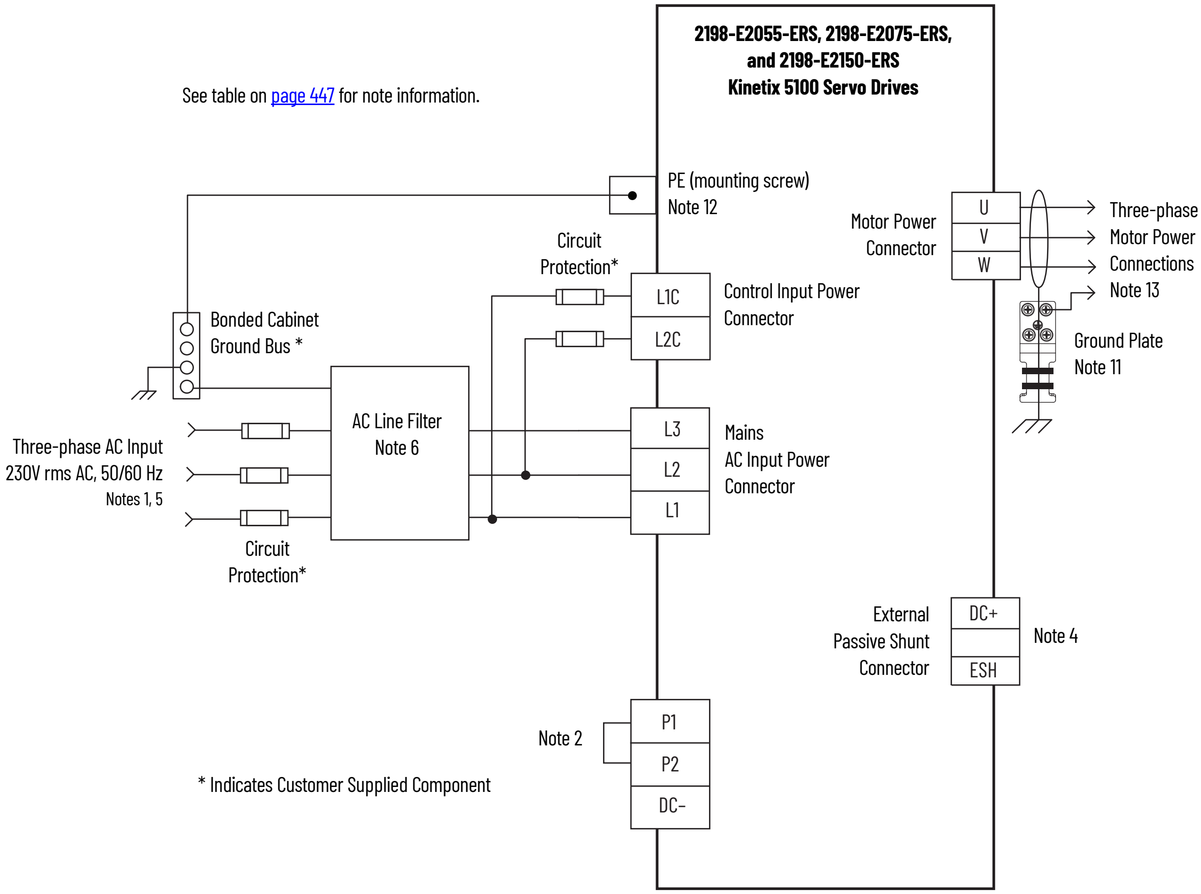
In this example, the 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, 2198-E1020-ERS, and 2198-E2030-ERS drives are wired for 230V three-phase operation.

**Figure 239 - Kinetix 5100 Drive (230V three-phase input power)**



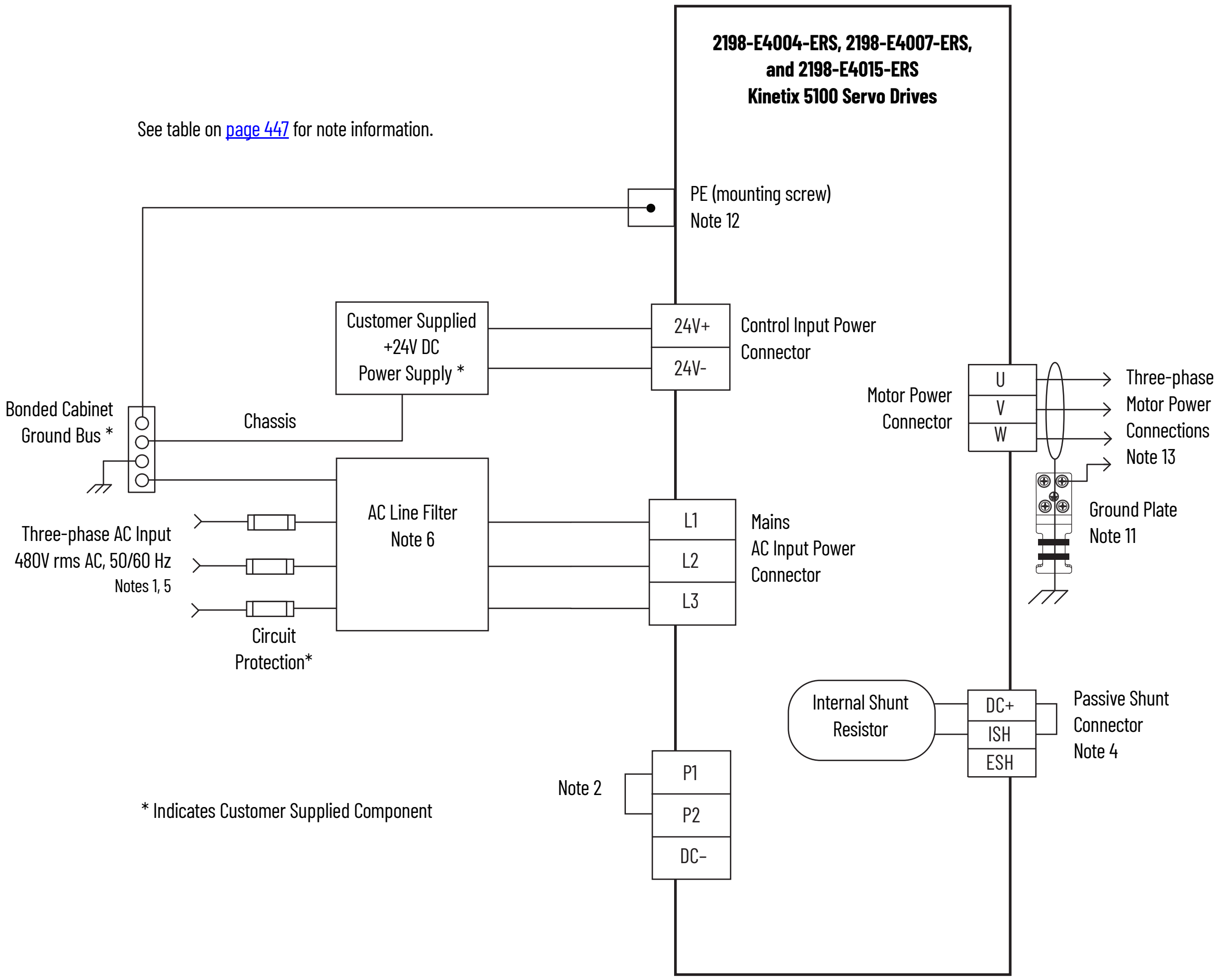
In this example, the 2198-E2055-ERS, 2198-E2075-ERS, and 2198-E2150-ERS drives are wired for 230V three-phase operation.

**Figure 240 - Kinetix 5100 Drive (230V three-phase input power)**



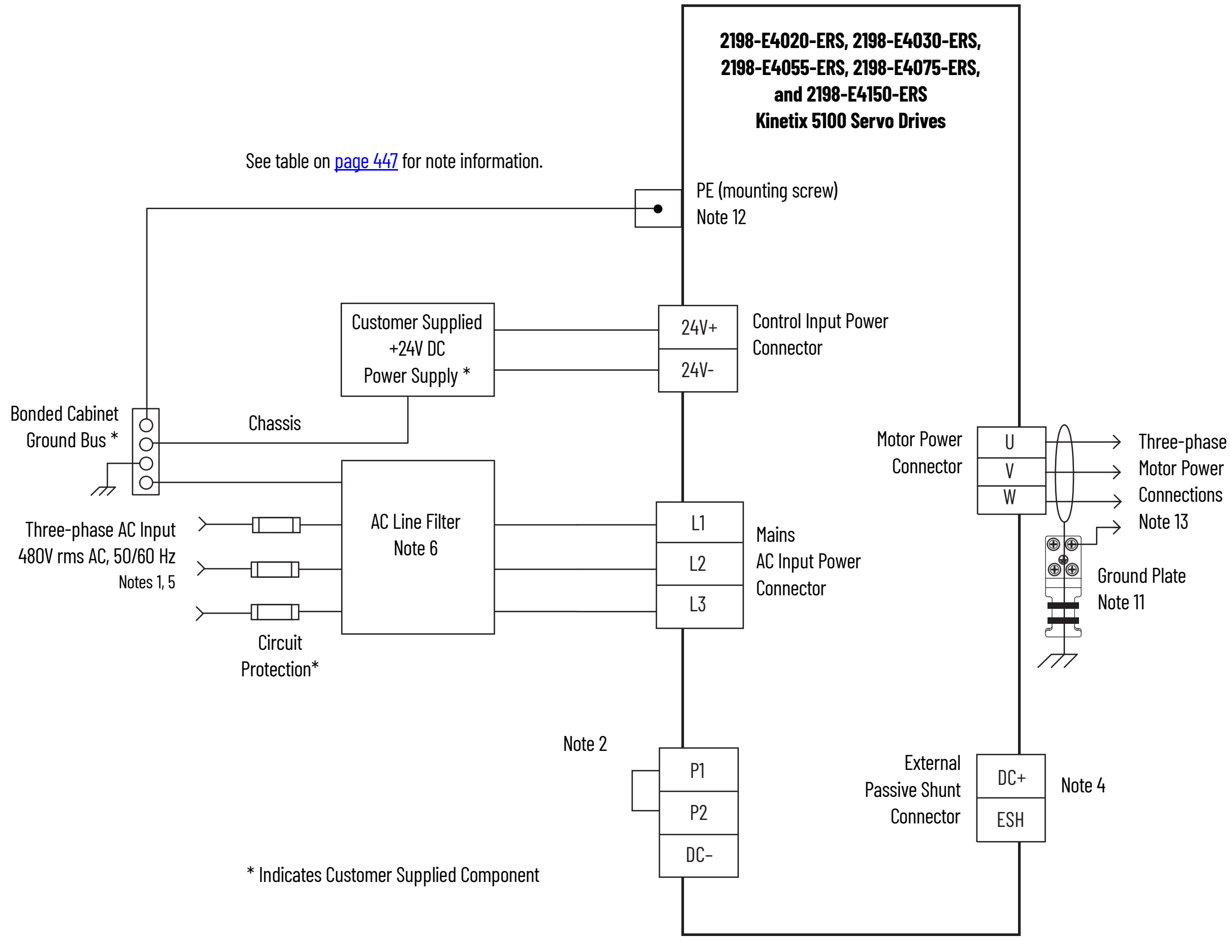
In this example, the 2198-E4004-ERS,2198-E4007-ERS, and 2198-E4015-ERS, drives are wired for 480V three-phase operation.

**Figure 241 - Kinetix 5100 Drive (480V three-phase input power)**



In this example, the 2198-E4020-ERS,2198-E4030-ERS, 2198-E4055-ERS, 2198-E4075-ERS, and 2198-E4150-ERS drives are wired for 480V three-phase operation.

**Figure 242 - Kinetix 5100 Drive (480V three-phase input power)**



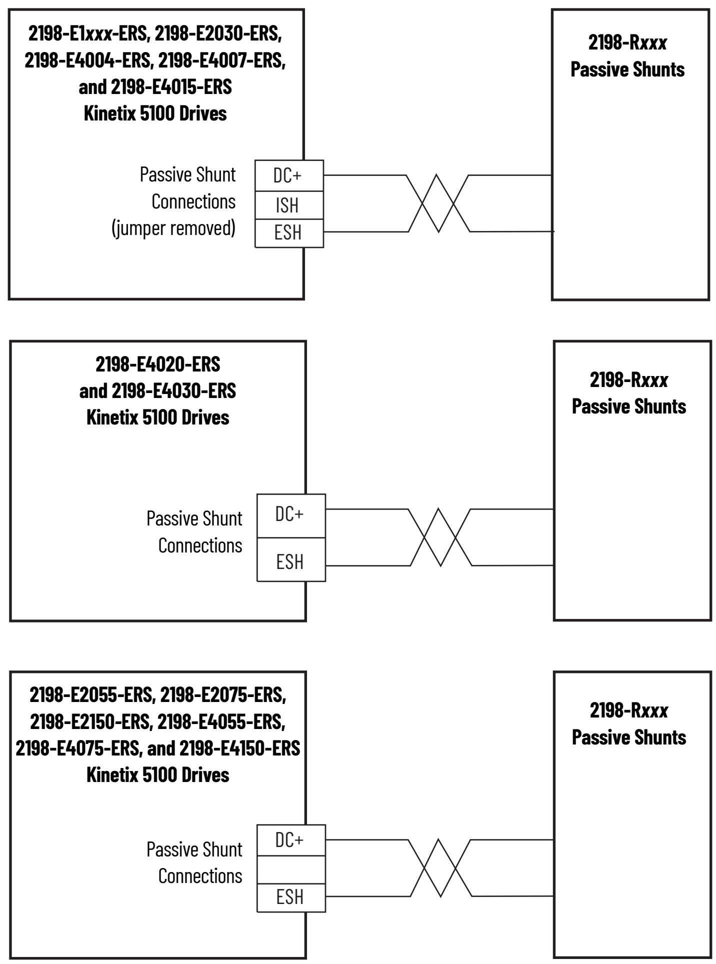
## Passive Shunt Wiring Examples

Bulletin 2198-R*xxxx* shunts and 2097-R*x* shunt resistors are available for the Kinetix 5100 drives. See the Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003, for shunt specifications. See Passive Shunt Considerations on page 29 for specifications specific to your Kinetix 5100 drive application.

See the Kinetix 5700 Passive Shunt Modules Installation Instructions, publication 2198-IN011, for installation information.

**IMPORTANT** When wiring an external shunt to the 2198-E1*xxx*-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, and 2198-E4015-ERS drives you must remove the jumper between terminals DC+ and ISH. Set the ID157 (P1.052) ShuntResistorValue and ID158 (P1.053) ShuntResistorPower accordingly to make the external shunt resistor take effect.

**Figure 243 - Passive Shunt Wiring Examples**



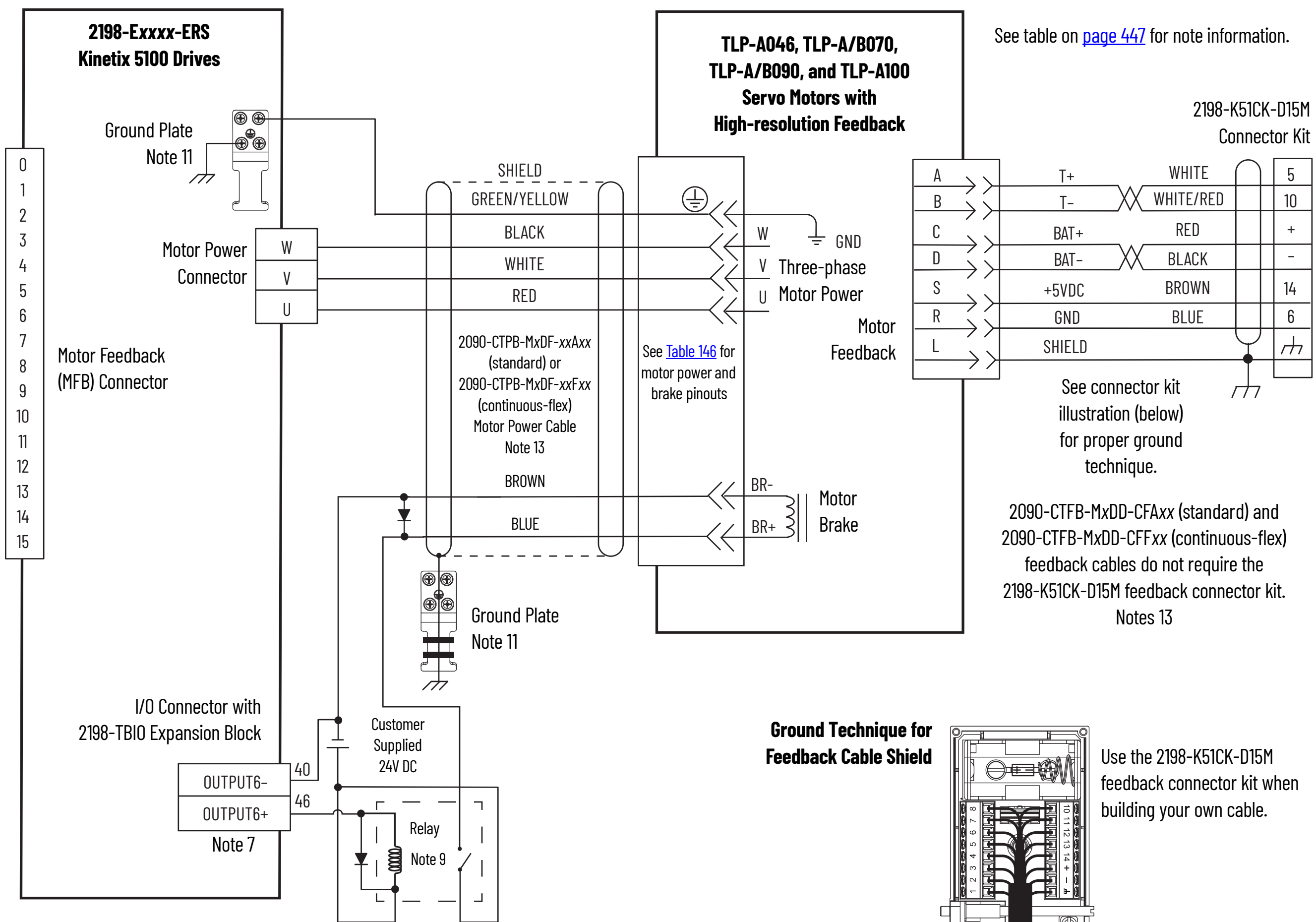

**ATTENTION:** Kinetix 5100 drives are rated for minimum external regenerative resistance. Shunt resistor used must have a rating above this value. See Table 8 on page 29 for these ratings. Using an external shunt resistor below the rated value can result in damage to the drive shunt circuitry.

## Kinetix 5100 Drive/Rotary Motor Wiring Examples

These wiring diagrams apply to Kinetix 5100 drives with compatible rotary motors.

In this example, the Kinetix TLP servo-motor with rectangular connectors uses a power/brake cable and the motor brake is wired to a digital output. Flying-lead feedback connections to the 2198-K51CK-D15M feedback connector kit are made by using bulk cable and building your own cables. See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, for more information.

**Figure 244 - Kinetix 5100 Drives with Kinetix TLP-A/B046...TLP-A/B100 Servo Motors**



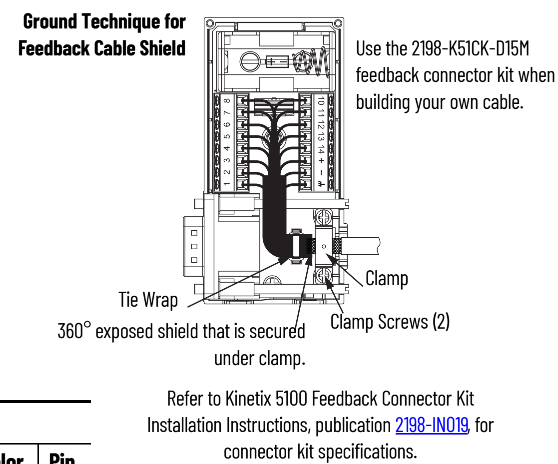




**Table 146 - Motor Power and Brake Cable Pinouts**

| Motor Power/Brake Cable Cat. No. | Motor Power | | | Motor Brake | | |
|---|---|---|---|---|---|---|
| | Signal | Wire Color | Pin | Signal | Wire Color | Pin |
| 2090-CTPx-MADF-16 | U<br>V<br>W<br>PE | RED<br>WHITE<br>BLACK<br>GREEN/YELLOW | 1<br>2<br>4<br>5 | BR+<br>BR- | BROWN<br>BLUE | 3<br>6 |
| 2090-CTPx-MADF-18 | | | | | | 5<br>6 |

In this example, the Kinetix TLP servo-motor with military-style connectors uses a power/brake cable and the motor brake is wired to a digital output. Flying-lead feedback connections to the 2198-K51CK-D15M feedback connector kit are made by using bulk cable and building your own cables. See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, for more information.

**Figure 245 - Kinetix 5100 Drives with Kinetix TLP-A/B115...TLP-A/B200 Servo Motors**

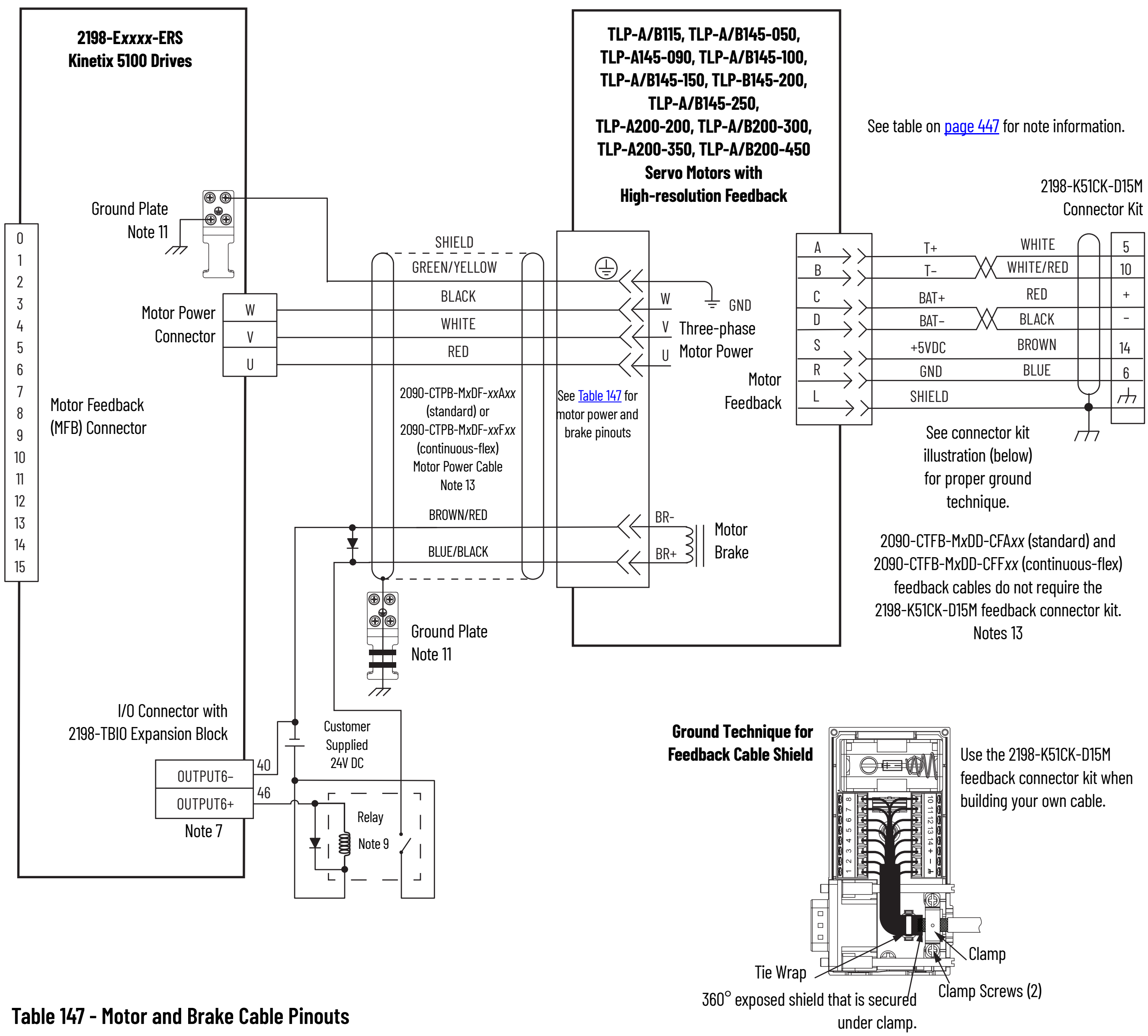
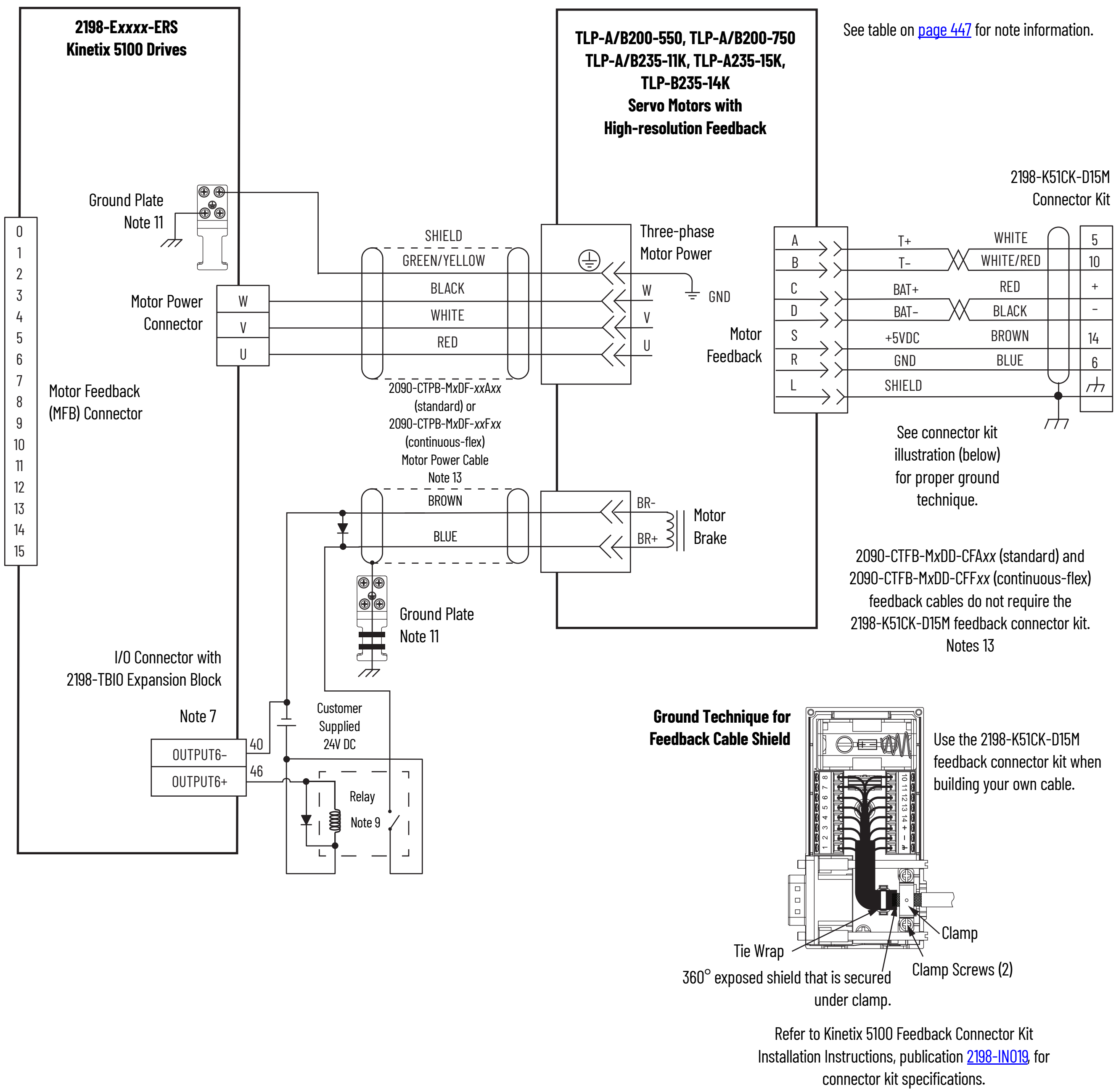



**Table 147 - Motor and Brake Cable Pinouts**

| Motor Power/Brake Cable Cat. No. | Motor Power | | | Motor Brake | | |
|---|---|---|---|---|---|---|
| | Signal | Wire Color | Pin | Signal | Wire Color | Pin |
| 2090-CTPx-MCDF-12 | U<br>V<br>W<br>PE | RED<br>WHITE<br>BLACK<br>GREEN/YELLOW | F<br>I<br>B<br>E | BR+<br>BR– | RED<br>BLACK | G<br>H |
| 2090-CTPx-MCDF-16 | | | | BR+<br>BR– | BROWN<br>BLUE | |
| 2090-CTPx-MDDF-08 | U<br>V<br>W<br>PE | RED<br>WHITE<br>BLACK<br>GREEN/YELLOW | D<br>E<br>F<br>G | BR+<br>BR– | RED<br>BLACK | A<br>B |
| 2090-CTPx-MDDF-12 | | | | | | |

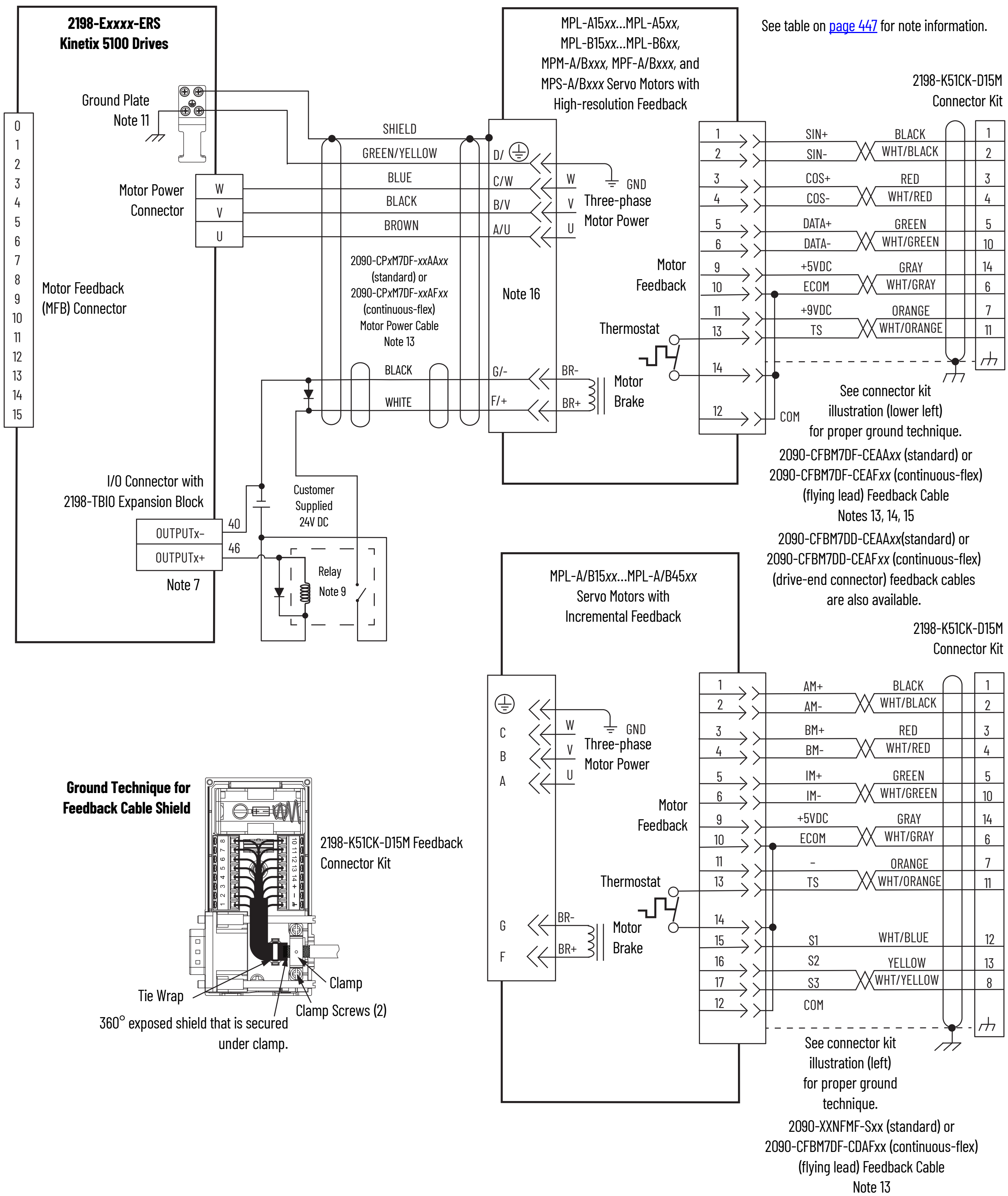
In this example, the Kinetix TLP servo motors have a separate brake (military style) connector and brake cable. The motor brake is wired to a digital output. Flying-lead feedback connections to the 2198-K51CK-D15M feedback connector kit are made by using bulk cable and building your own cables. See Build Your Own Kinetix TLP Motor Cables Installation Instructions, publication 2090-IN048, for more information.

**Figure 246 - Kinetix 5100 Drives with Kinetix TLP-A/B200-550, TLP-A/B200-750, and TLP-A/B235 Servo Motors**



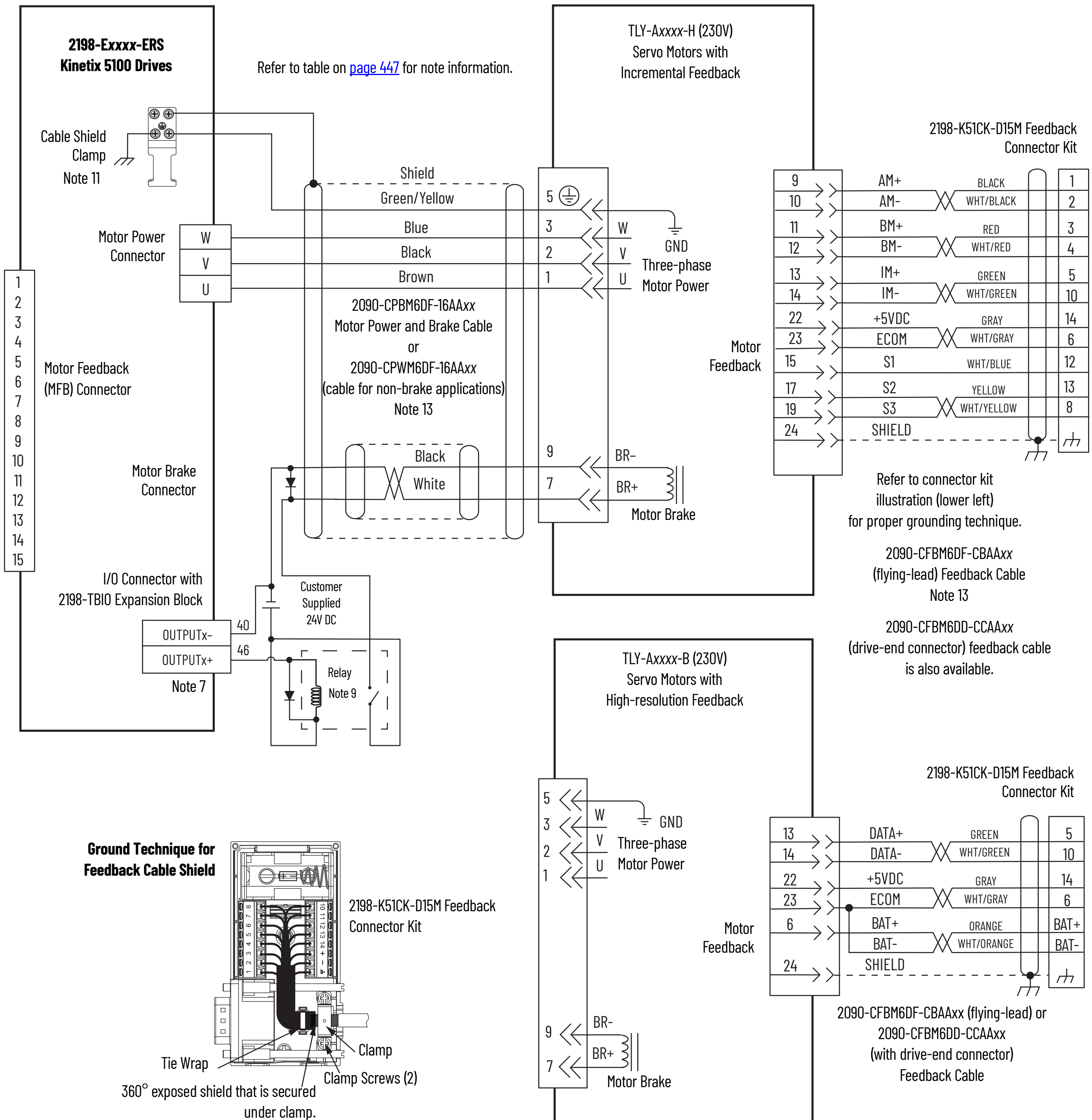
In this example, the Kinetix MP motor brake is wired to a digital output. 2090-CFBM7DD feedback cables with premolded drive-end connector are available. Flying-lead feedback connections are made with 2090-CFBM7DF cables to the 2198-K51CK-D15M feedback connector kit. See Cable Preparation for Kinetix MP Servo Motors on page 91 for more information.

**Figure 247 - Kinetix 5100 Drives with Kinetix MP Rotary Servo Motors**



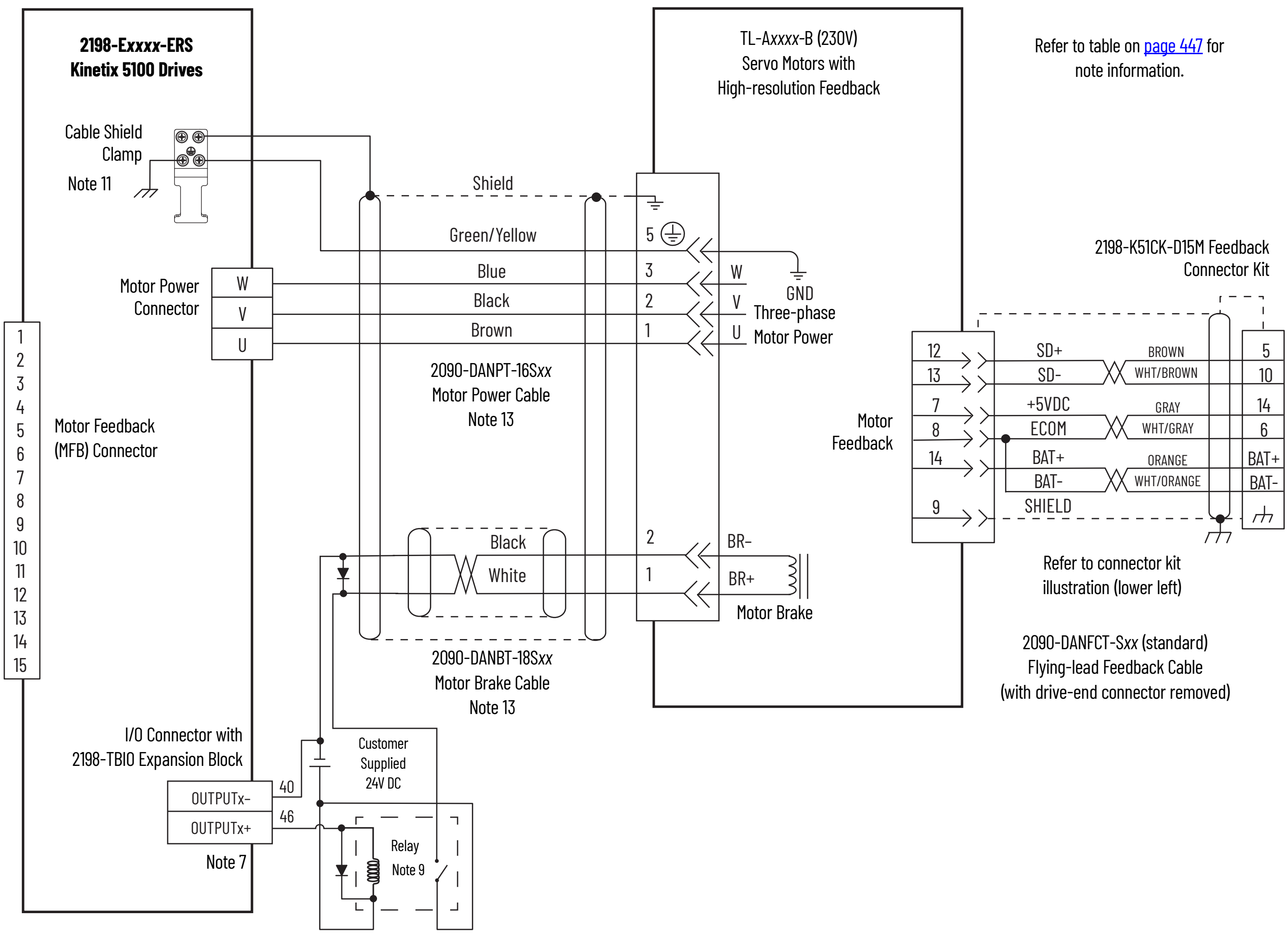
These compatible Kinetix TL and TLY rotary motors have separate connectors and cables for power/brake and feedback connections. See Cable Preparation for Kinetix TL and TLY Motor Power Cables on page 92 for more information.

**Figure 248 - Kinetix 5100 with Kinetix TLY Rotary Motors**

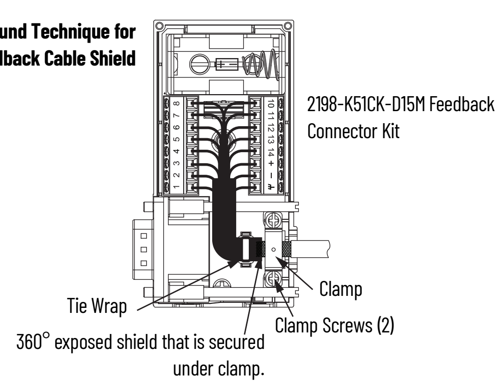


The 2090-DANFCT-S*xx* feedback cable is equipped with a drive-end connector that is not compatible with the 15-pin (MFB) feedback connector. To provide battery backup to the encoder, you can remove the drive-end connector and prepare the cable shield and conductors for wiring to the 2198-K51CK-D15M feedback connector kit. See Cable Preparation for Kinetix TL and TLY Motor Power Cables on page 92 for more information.

**Figure 249 - Kinetix 5100 with Kinetix TL Rotary Motors**



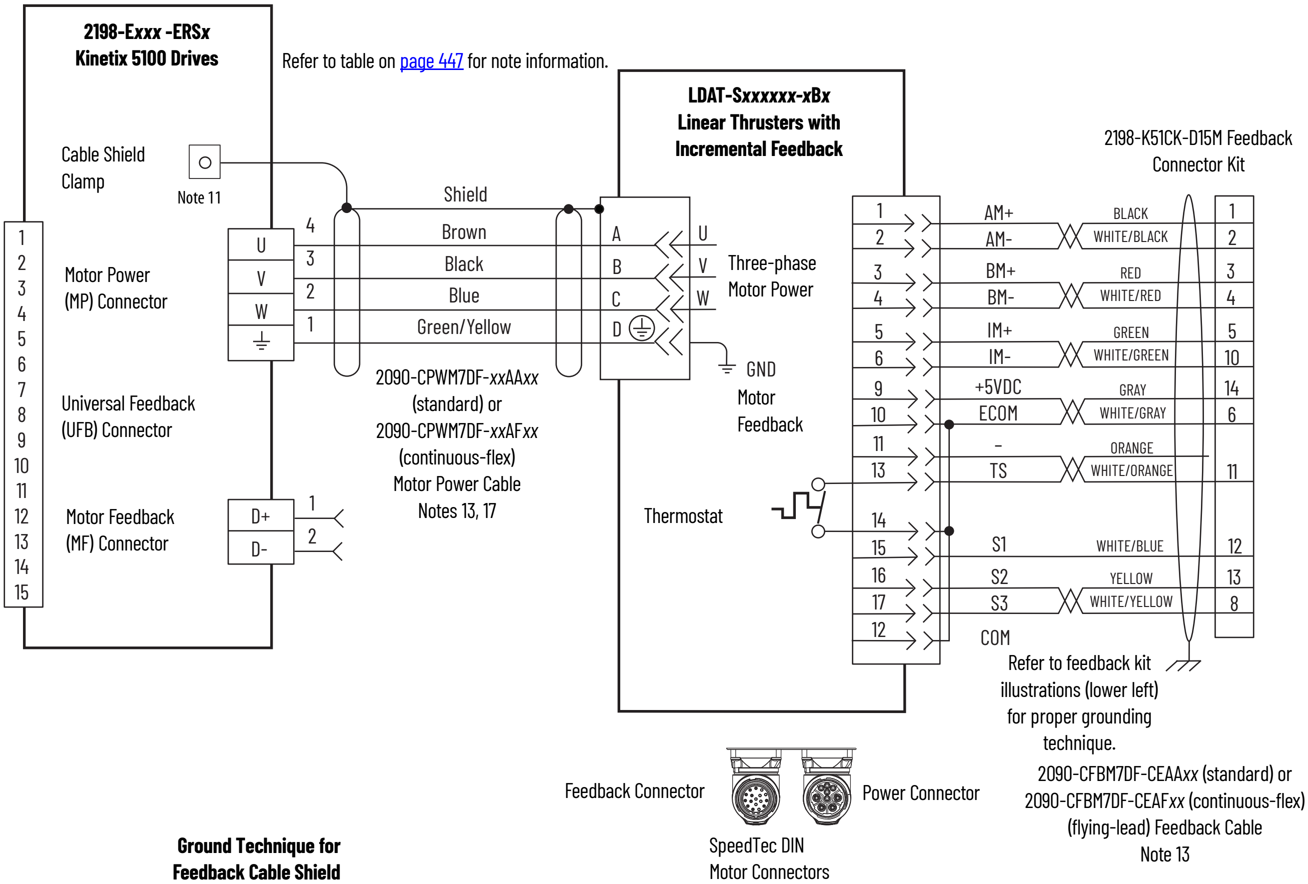

**Ground Technique for Feedback Cable Shield**



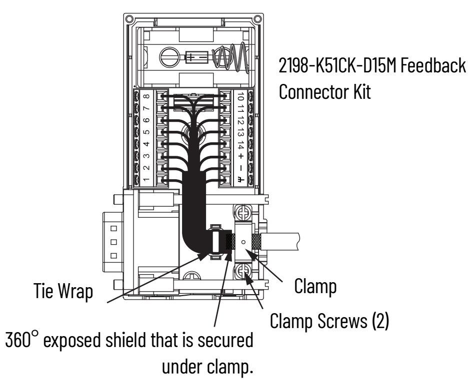
## Kinetix 5100 Servo Drive and Linear Actuator Wiring Examples

These compatible linear actuators have separate connectors and cables for power/brake and feedback connections.

**Figure 250 - Kinetix 5100 Drives with Kinetix LDAT Linear Thrusters**

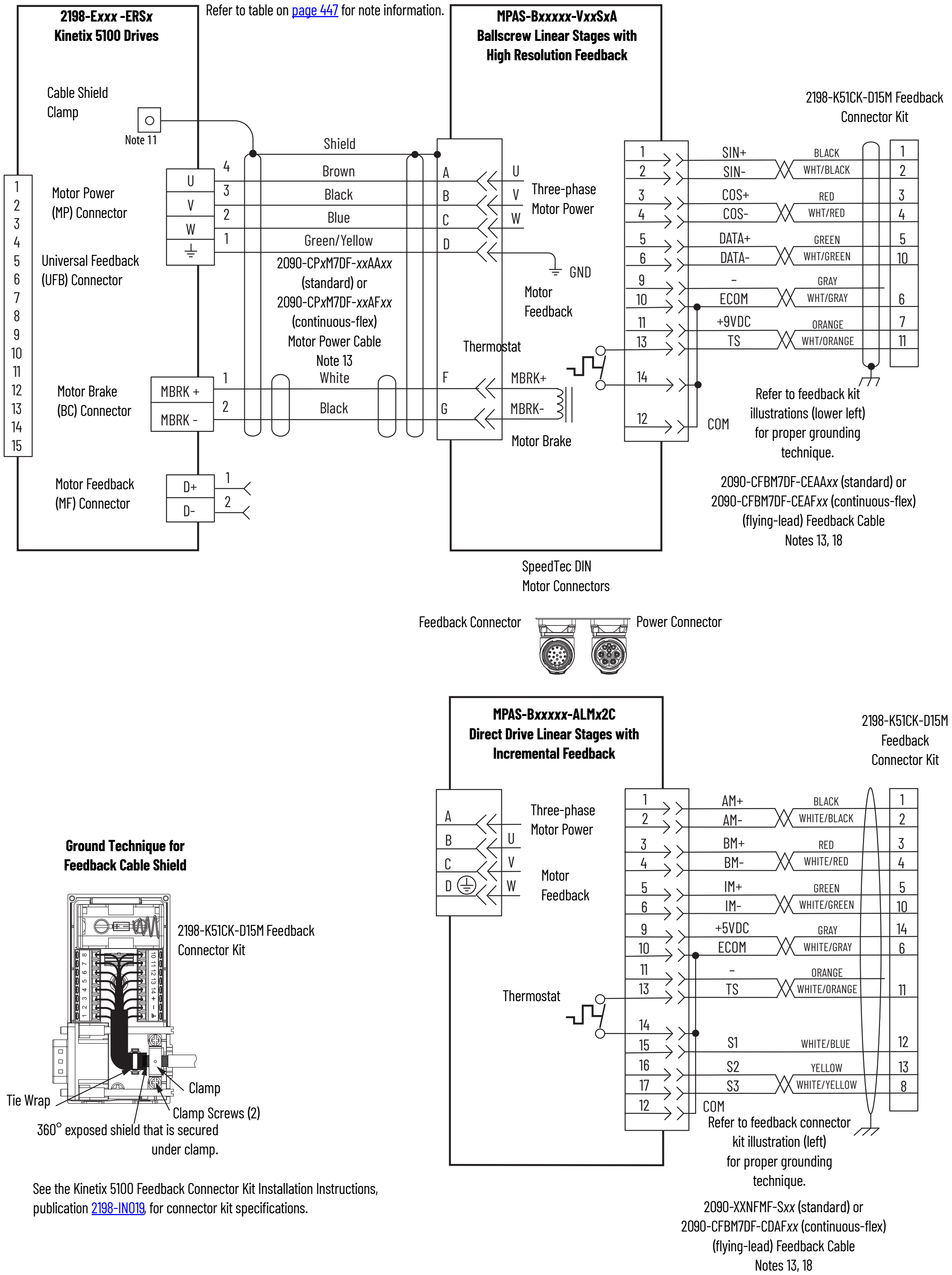



**Ground Technique for Feedback Cable Shield**




See the Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, for connector kit specifications.

**Figure 251 - Kinetix 5700 Drives with Kinetix MPAS Linear Stages**




See the Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, for connector kit specifications.

**Figure 252 - Kinetix 5700 Drives with Kinetix MPAR and MPAI Electric Cylinders**

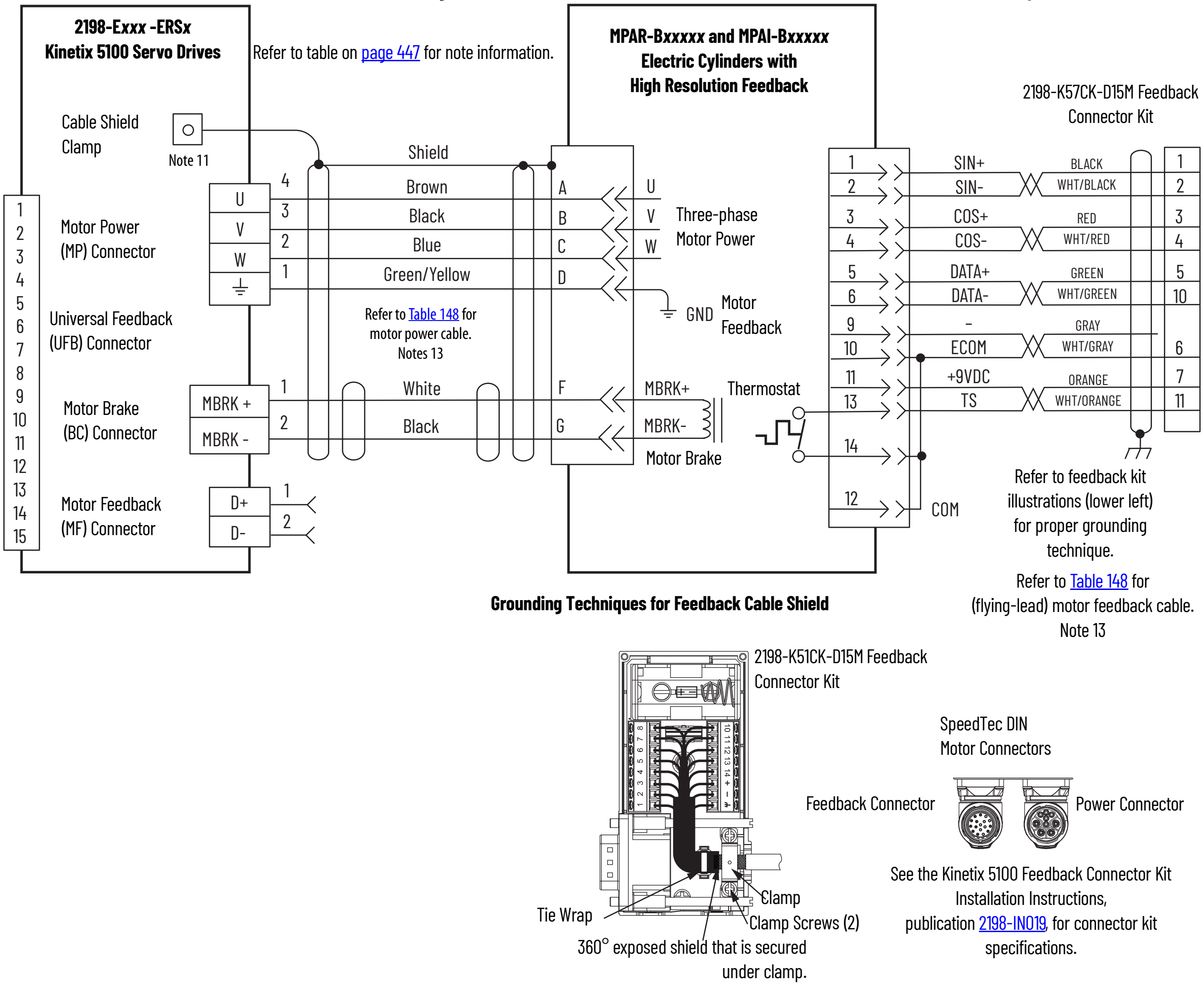
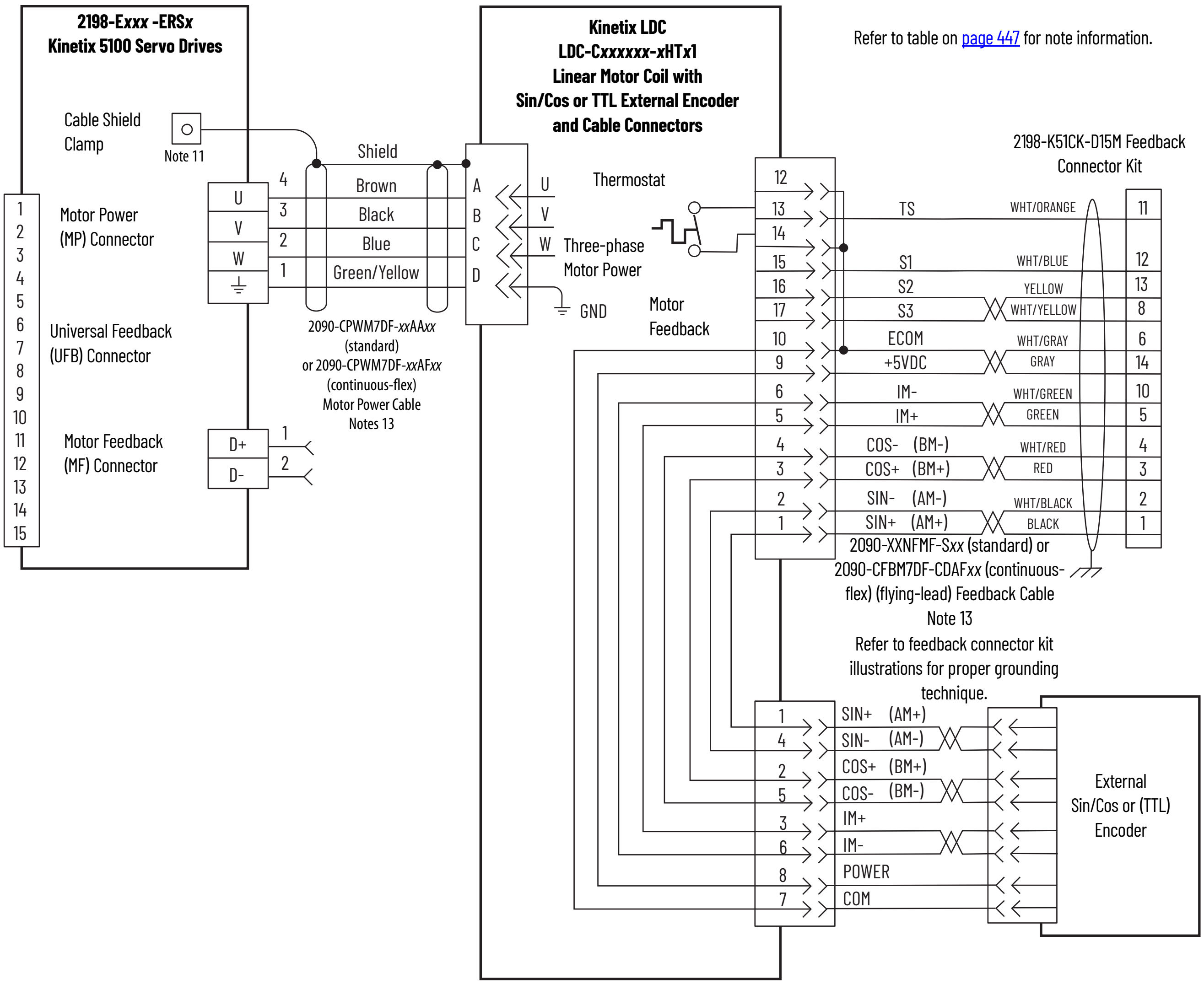
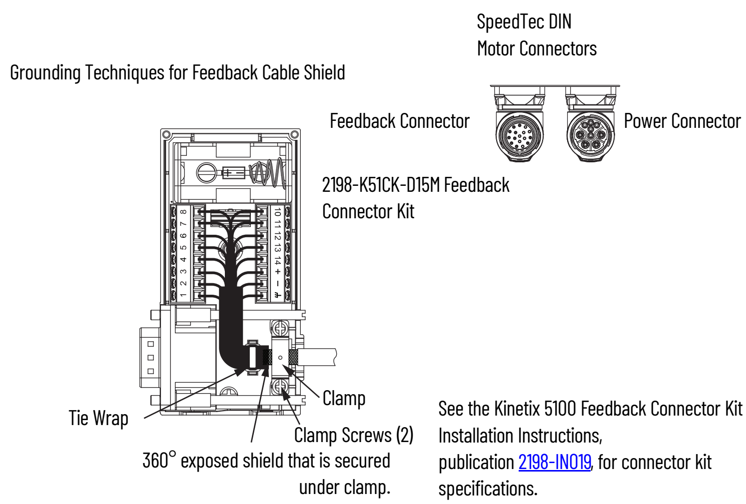



**Table 148 - Kinetix MPAR and MPAI Electric Cylinders Power and Feedback Cables**

| Kinetix MPAR and MPAI Electric Cylinders Cat. No. | Frame | Power Cable Cat. No. | Feedback Cable Cat. No. |
|---|---|---|---|
| MPAR-B1*xxx* (series A and B) | 32 | 2090-XXNPMF-16S*xx* (standard) or 2090-CPxM4DF-16AF*xx* (continuous-flex) | 2090-XXNFMF-S*xx* (standard) or 2090-CFBM4DF-CDAF*xx* (continuous-flex) |
| MPAR-B2*xxx* (series A and B) | 40 | | |
| MPAR-B1*xxx* (series B and C) | 32 | 2090-CPxM7DF-16AA*xx* (standard) or 2090-CPxM7DF-16AF*xx* (continuous-flex) | 2090-CFBM7DF-CEAA*xx* (standard) or 2090-CFBM7DF-CEAF*xx* (continuous-flex) |
| MPAR-B2*xxx* (series B and C) | 40 | | |
| MPAR-B3*xxx* | 63 | | |
| MPAI-B2*xxxx* | 64 | | |
| MPAI-B3*xxxx* | 83 | | |
| MPAI-B4*xxxx* | 110 | | |
| MPAI-B5*xxxx* | 144 | | |

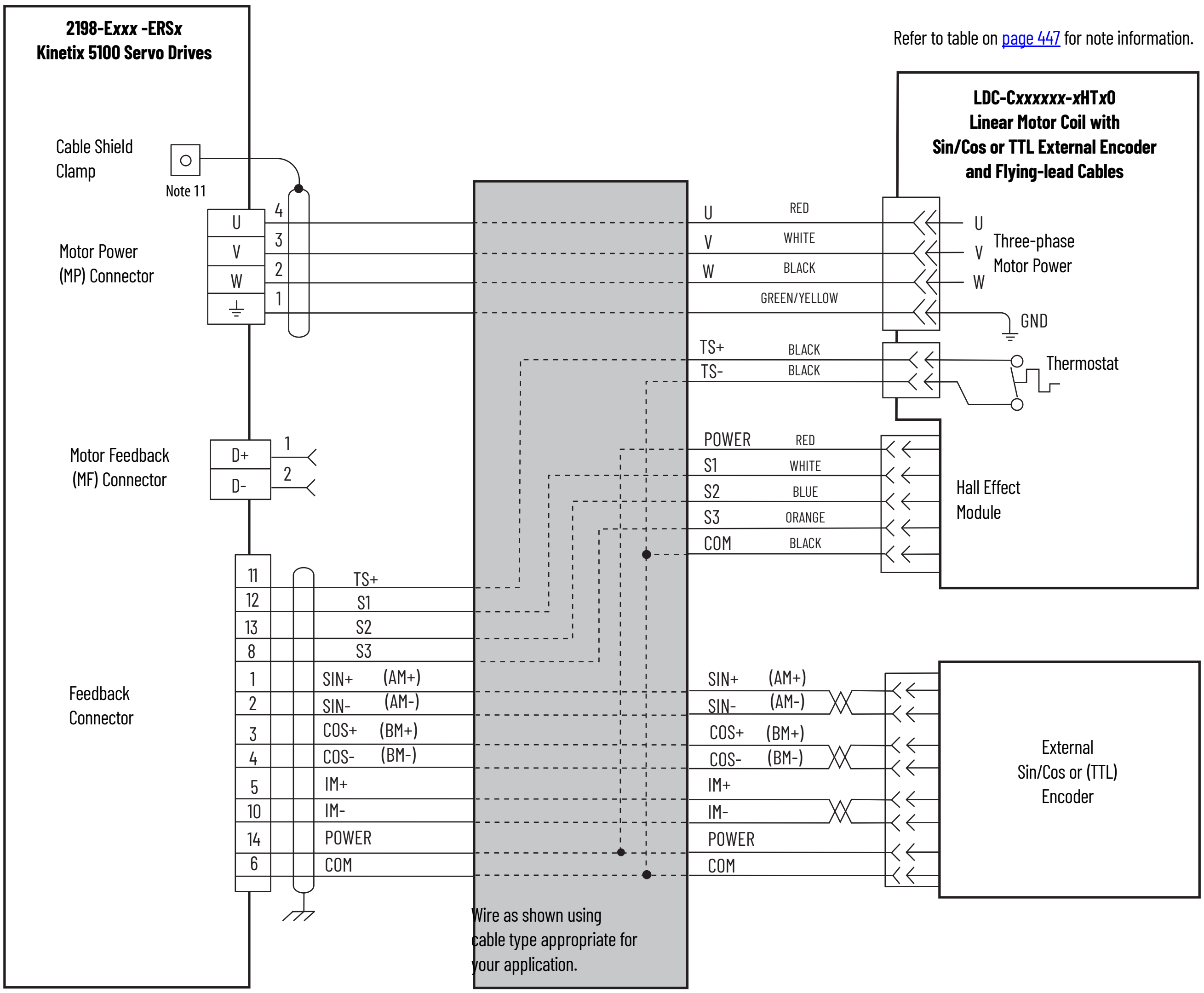
**Figure 253 - Kinetix 5100 Drives with Kinetix LDC Linear Motors (cable connectors)**



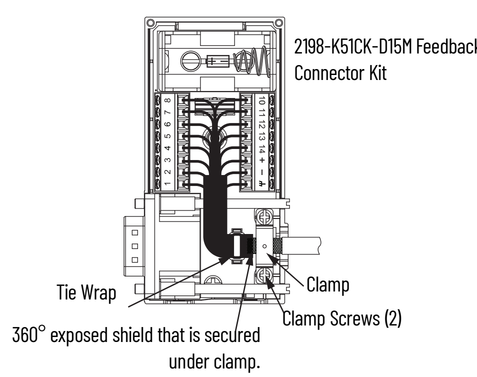




See the Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, for connector kit specifications.

**Figure 254 - Kinetix 5700 Drives with Kinetix LDC Linear Motors (flying-lead cables)**




Grounding Techniques for Feedback Cable Shield

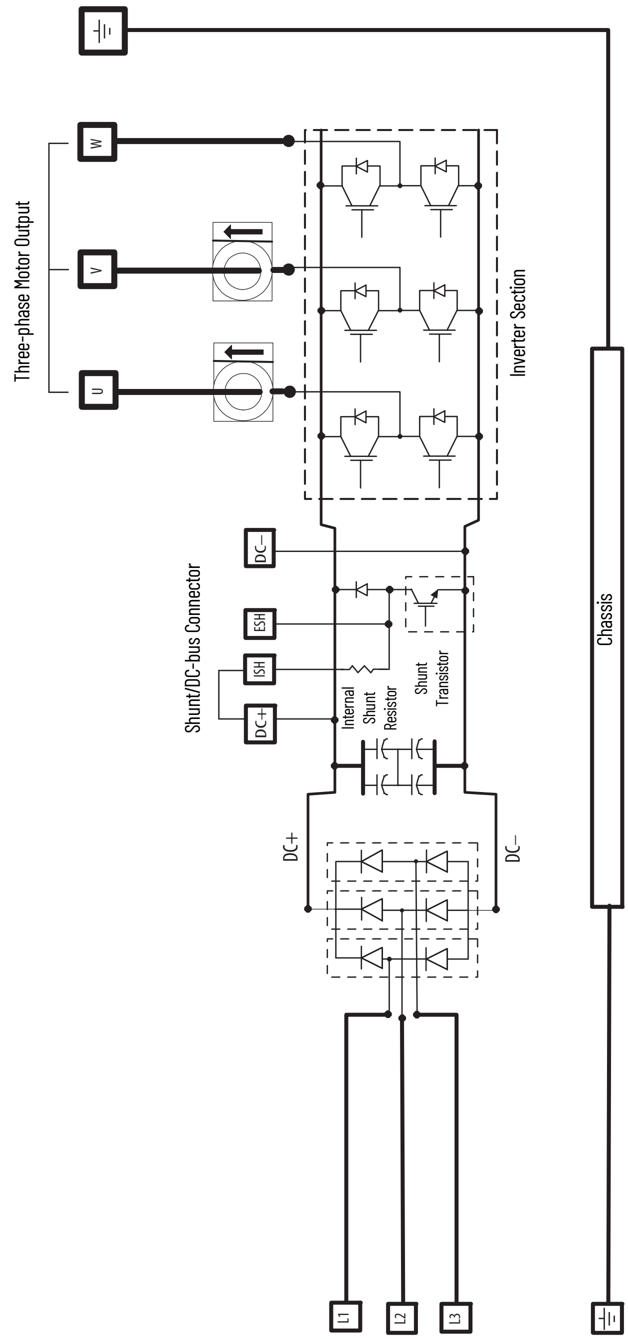



See the Kinetix 5100 Feedback Connector Kit Installation Instructions, publication 2198-IN019, for connector kit specifications.

## System Block Diagram

This power block diagram applies to all 2198-E*xxxx*-ERS servo drives.

**Figure 255 - Power Block Diagram**




| | |
|---|---|
| **IMPORTANT** | Only 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, 2198-E1020-ERS, 2198-E2030-ERS, 2198-E4004-ERS, 2198-E4007-ERS, and 2198-E4015-ERS drives have an internal shunt and ISH terminal. |

| | |
|---|---|
| **IMPORTANT** | Only 2198-E1004-ERS, 2198-E1007-ERS, 2198-E1015-ERS, and 2198-E1020-ERS drives support both single-phase and three-phase operation. |

# Notes:

# Upgrade Kinetix 5100 Drive Firmware

This appendix provides procedures for upgrading your Kinetix® 5100 firmware.



The firmware update procedure uses the Ethernet/IP port of the drive. You must have an Ethernet/IP cable connected to the drive and any active Class 1 connection must be inhibited.

You can upgrade your Kinetix 5100 drive firmware by using either of these two methods:

- ControlFLASH Plus™ software
- ControlFLASH™ software

To upgrade drive firmware, you must configure a path to your drive, select the drive module to upgrade, and complete the firmware upgrade procedure.

We recommend that you use ControlFLASH Plus software for firmware upgrades. See the ControlFLASH Plus Quick Start Guide, publication CFP-QS001, for more information.

## Before You Begin

The firmware revision for software must be as shown for EtherNet/IP™ networks.

**Table 149 - Kinetix 5100 System Requirements**

| Description | Firmware Revision |
|---|---|
| Logix Designer application | 30.00.00 or later |
| RSLinx® software (1) | 3.60.00 or later |
| FactoryTalk® Linx software (2) | 6.20.00 or later |
| ControlFLASH software kit(3) | 14.01.00 or later |
| ControlFLASH Plus software kit (3) | 3.01 or later |

(1) Only required when using ControlFLASH software.
(2) Only required when using ControlFLASH Plus software.
(3) Download the ControlFLASH software kit from the Product Compatibility and Download Center at: rok.auto/pcdc. For more ControlFLASH software information (not Kinetix 5100 specific), refer to the ControlFLASH Firmware Upgrade Kit User Manual, publication 1756-UM105.

Gather this information before you begin your firmware upgrade.

- Network path to the targeted Kinetix 5100 drives you want to upgrade.
- Catalog numbers of the targeted Kinetix 5100 drives you want to upgrade.

| | |
|---|---|
| **IMPORTANT** | Control power at L1C and L2C (200V drives) and 24V+ and 24V- (400V drives) must be present prior to upgrading your target module. |

| | |
|---|---|
| **IMPORTANT** | The state on the display must be STDBY (STANDBY) in IO Mode before upgrading your target module.<br>The state on the display must be STOP (STOPPED) in other modes before upgrading your target module. |

**ATTENTION:** To avoid personal injury or damage to equipment during the firmware upgrade due to unpredictable motor activity, do not apply the main power to the drive. Do apply the control power to the drive.

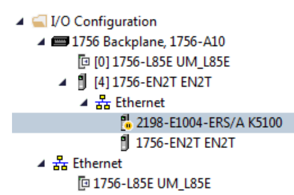
## Inhibit the Module

If the drive is configured as IO Mode, you must inhibit the connection before performing the firmware upgrade.

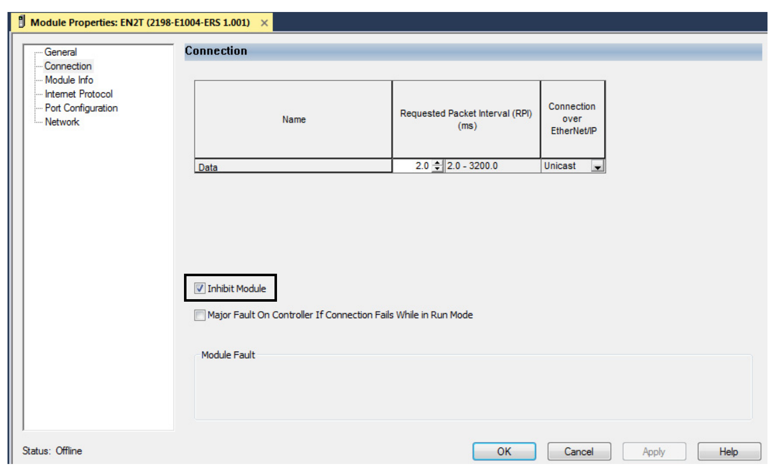
Follow these steps to inhibit the connection.

1. Open your Logix Designer application.
2. Right-click the 2198-E*xxxx*-ERS drive and choose Properties.

   The Module Properties dialog box appears.




3. Select the Connection category.




4. Check Inhibit Module.
5. Click OK.
6. Save your file and download the program to the controller.

## Upgrade Your Firmware

Use either ControlFLASH Plus software or ControlFLASH software to upgrade your firmware.

- To use ControlFLASH Plus software, see Use ControlFLASH Plus Software to Upgrade Your Drive Firmware on page 469.
- To use ControlFLASH software, see Use ControlFLASH Software to Upgrade Your Drive Firmware on page 472.

### Use ControlFLASH Plus Software to Upgrade Your Drive Firmware

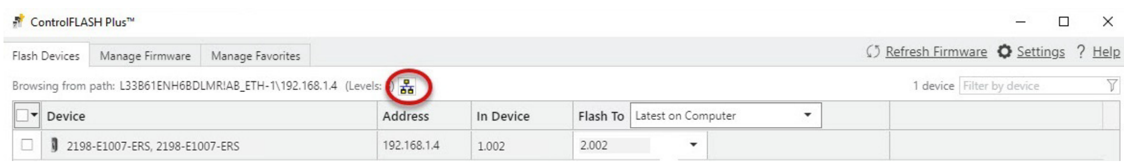
Follow these steps to select the Kinetix 5100 drive to upgrade.

1. Start ControlFLASH Plus software.

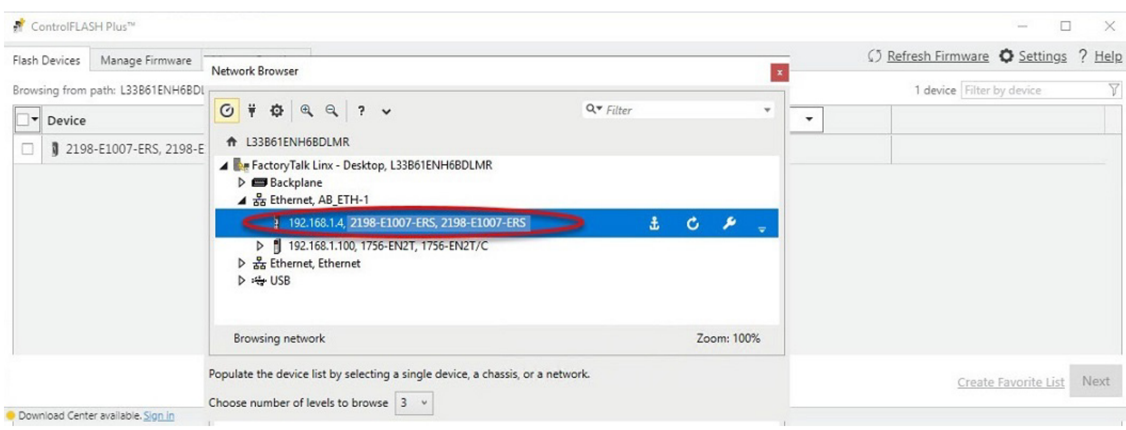
   You can choose to select and upgrade the firmware for all drive modules in your system. However, in this procedure only one drive is selected for a firmware upgrade.

2. Click the Flash Devices tab. If the device is not already present in Browsing from path:, complete these steps:

   a. Click  .

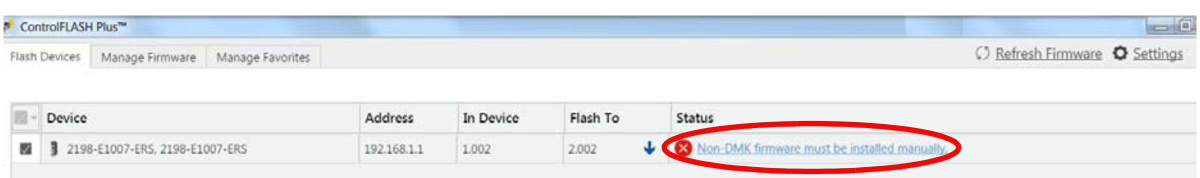



   b. In the Network Browser dialog box, locate and select the device to upgrade.

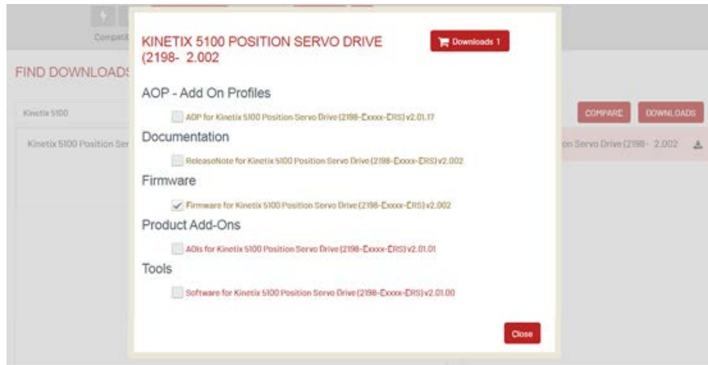



   c. Click OK.

   The Status field displays Non-DMK Firmware must be installed manually. This is accomplished with the ControlFLASH MSI file.

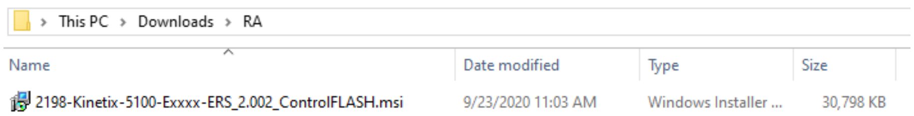


3. To download the ControlFLASH MSI file, go to the Product Compatibility and Download Center (PCDC).



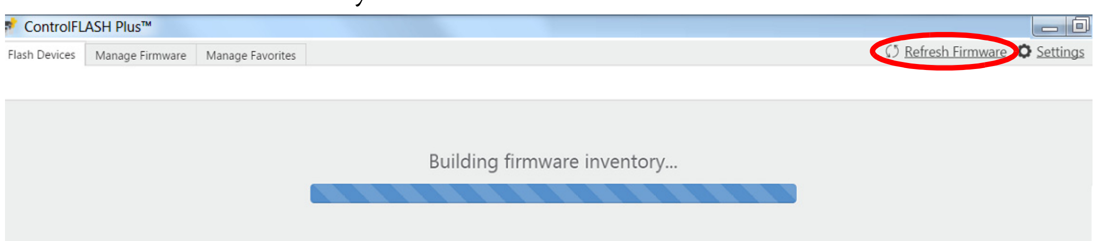

a. Check Firmware, click Downloads, and follow the prompts to download the ControlFLASH MSI file.

b. Install the Kinetix 5100 ControlFLASH MSI file.



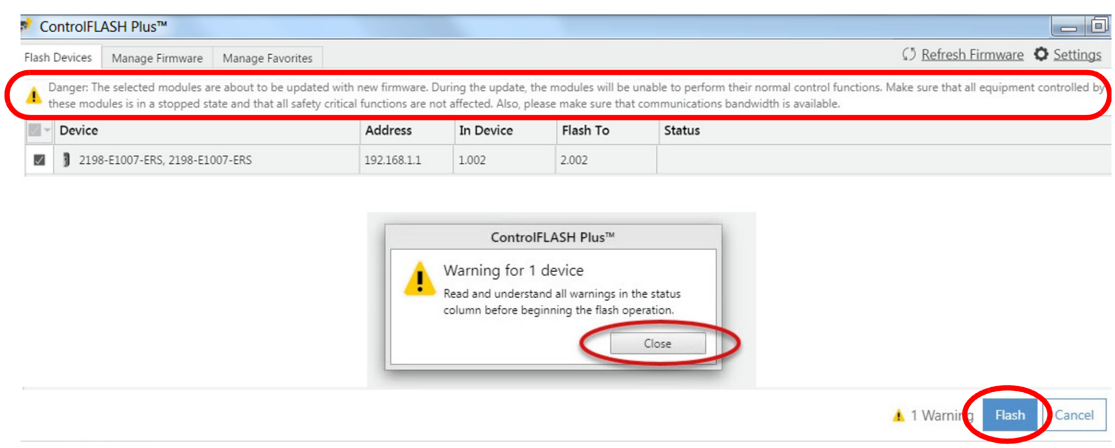

c. Click Refresh Firmware.

The Building firmware inventory dialog box opens and the firmware inventory installs.



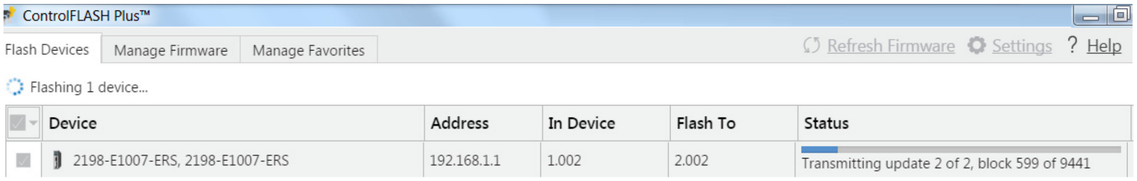

When the refresh is complete, the Status field is empty.

4. If a warning dialog box appears, read the warning, complete any recommendations, and click Close.



5. After acknowledging all warnings and confirming the desired revisions, click Flash to begin the firmware upgrade.

   The Status bar appears to show the progress of the firmware update. Also, the status display scrolls 'Updating. Do Not Turn Off', which indicates that the upgrade is in progress.

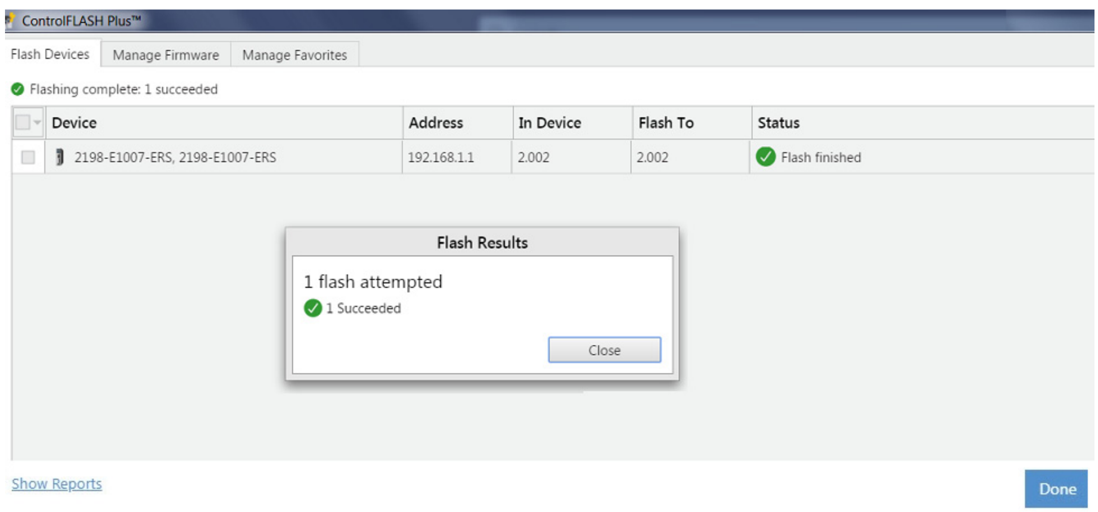



   After the upgrade information is sent to the drive, the drive resets and performs diagnostic checking.

   After the download, the drive applies the new firmware and reboots. This can take several minutes.

| | |
|---|---|
| **IMPORTANT** | Do not cycle power to the drive during this process. A power cycle results in an unsuccessful firmware upgrade and an inoperable module. |

   After the drive reboots, ControlFlash Plus software indicates success or failure of the update.




6. When the upgrade has completed, click Close.
7. To complete the process and close the application, click Done.

| | |
|---|---|
| **IMPORTANT** | You must return to the drive Module Properties>Connection category to clear the Inhibit Module checkbox before resuming normal operation. |

## Use ControlFLASH Software to Upgrade Your Drive Firmware

Before using ControlFLASH software you need to configure the communication path by using RSLinx software.

*Configure Your Communication Path with RSLinx Software*

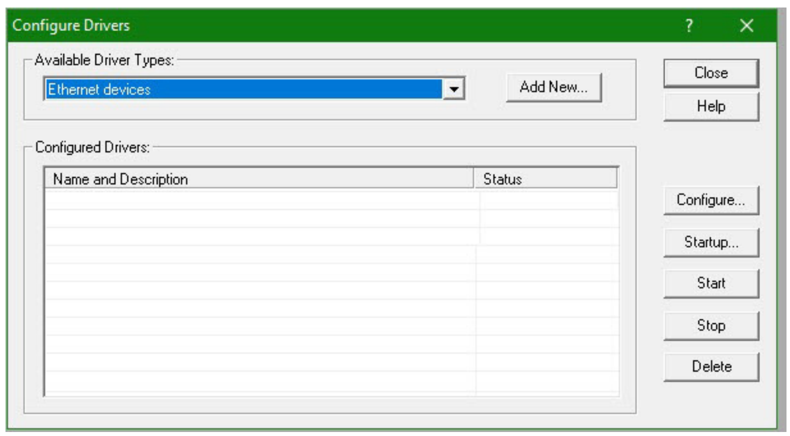
This procedure assumes that your communication method to the target device is the Ethernet network. It also assumes that any Ethernet communication module or Logix 5000™ controller in the communication path has already been configured.

For more controller information, see Additional Resources on page 8.

Follow these steps to configure the communication path to the target device.

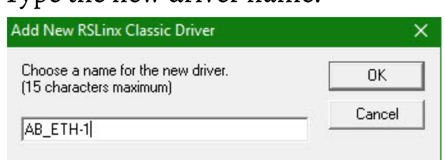
1. Open your RSLinx Classic software.
2. From the Communications menu, choose Configure Drivers.

   The Configure Drivers dialog box appears.



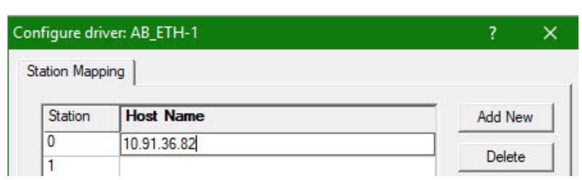

3. From the Available Driver Types pull-down menu, choose Ethernet devices.
4. Click Add New.

   The Add New RSLinx Classic Driver dialog box appears.
5. Type the new driver name.



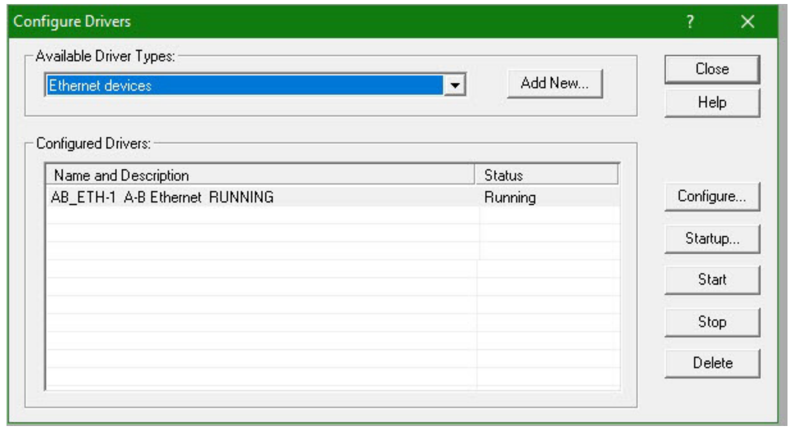

6. Click OK.

   The Configure driver dialog box appears.



7. Type the IP address of your Ethernet Module or Controller that bridges between the Ethernet network and the EtherNet/IP network.
8. Click OK.

   The new Ethernet driver appears under Configured Drivers.




9. Click Close.
10. Minimize the RSLinx application dialog box.

### *Start the ControlFLASH Software*

Follow these steps to start ControlFLASH software and begin your firmware upgrade.

1. In the Logix Designer application, from the Tools menu, choose ControlFLASH.

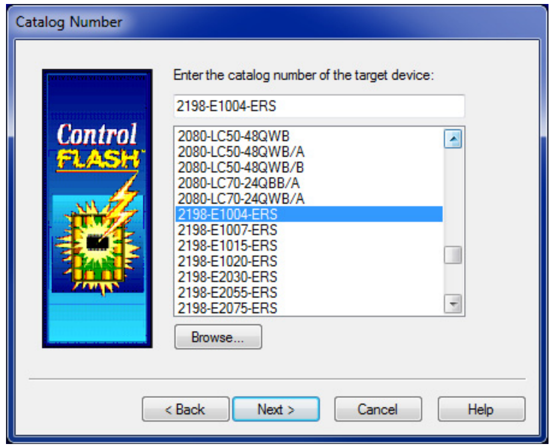
   You can also open ControlFLASH software by choosing Start>Programs>FLASH Programming Tools>ControlFLASH.

2. In the Logix Designer application, from the Tools menu, choose ControlFLASH.

   The Welcome to ControlFLASH dialog box appears.


3. Click Next.

The Catalog Number dialog box appears.



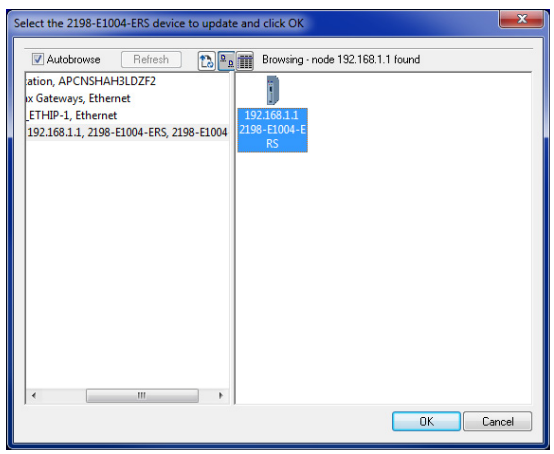

If your catalog number does not appear, click Browse, select the monitored folder where the firmware kit (DMK files) is located. Click Add and OK.

4. Select your drive module.

   In this example, the 2198-E1004-ERS drive is selected.

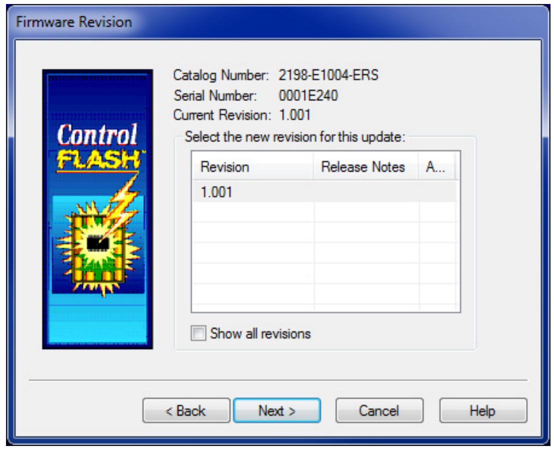
5. Click Next.

   The Select Device to Update dialog box appears.



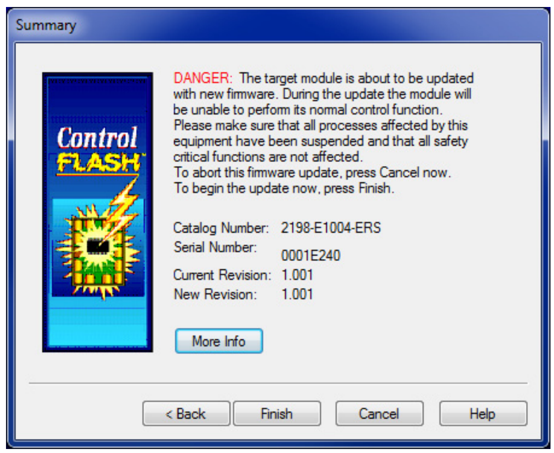

6. Expand your Ethernet node, Logix backplane, and EtherNet/IP network module.
7. Select the servo drive to upgrade.
8. Click OK.

The Firmware Revision dialog box appears.



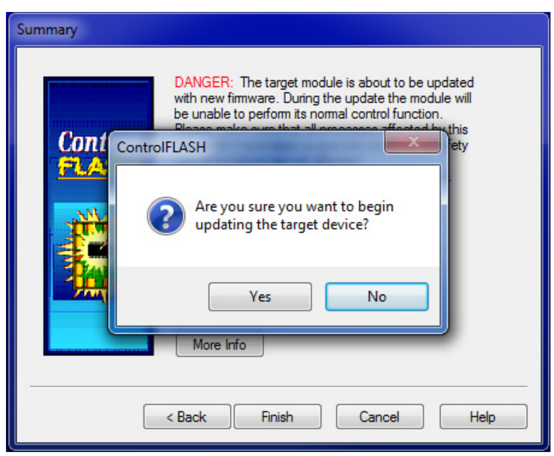

9. Select the firmware revision to upgrade.
10. Click Next.

    The Summary dialog box appears.



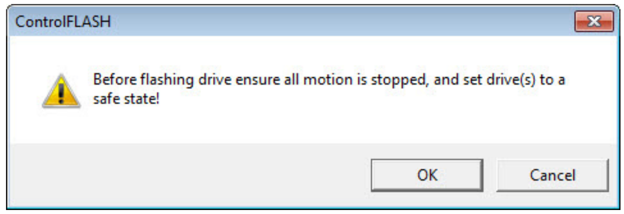

11. Confirm the drive catalog number and firmware revision.
12. Click Finish.

    This ControlFLASH warning dialog box appears.



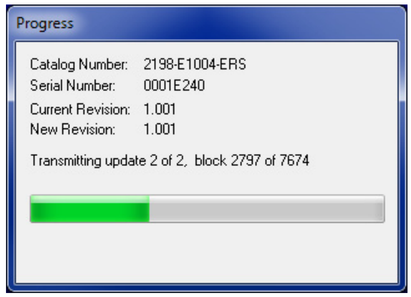

13. To complete the update now, click Yes.

This ControlFLASH warning dialog box appears.

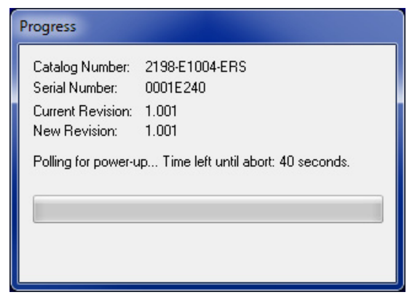



14. Acknowledge the warning and click OK.

    The Progress dialog box appears and the update begins.




    The state on the display changes from STDBY (STANDBY), or STOP (STOPPED) to F_UPD (FIRMWARE UPDATE), which indicates that the upgrade is in progress.



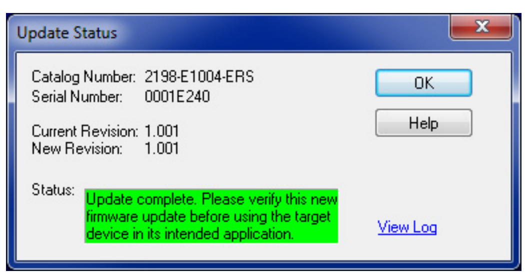

    After the upgrade information is sent to the drive, the drive resets and performs diagnostic checking.

15. Wait for the Progress dialog box to time out.

    It is normal for this process to take several minutes.

| | |
|---|---|
| **IMPORTANT** | Do not cycle power to the drive during this process. A power cycle results in an unsuccessful firmware upgrade and an inoperable module. |

16. Verify that the Update Status dialog box appears and indicates success or failure as described below.



| Upgrade Status | If |
|---|---|
| Success | Update complete appears in a GREEN Status dialog box, then go to step 17. |
| Failure | Update failure appears in a RED Status dialog box, then see the ControlFLASH Firmware Upgrade Software User Manual, publication 1756-UM105 for troubleshooting information.<br>IMPORTANT: If the power is lost during the firmware upgrade, the update fails. When the power is restored, three different situations happen depending on when the power went off.<br>• Panel display shows UPt 1: Update the firmware again.<br>• Panel display is blank:, The drive automatically finishes the last firmware update in 20 seconds, then it resets to complete the update.<br>• Panel display shows UPt 3: Update the firmware again. |

17. Click OK.

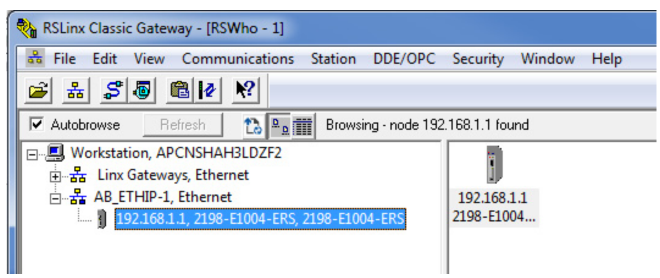
**IMPORTANT** If you checked Inhibit Module on the Connection tab in Module Properties, you must clear the Inhibit Module check box before resuming normal operation.

## Verify the Firmware Upgrade

Follow these steps to verify that your firmware upgrade was successful.

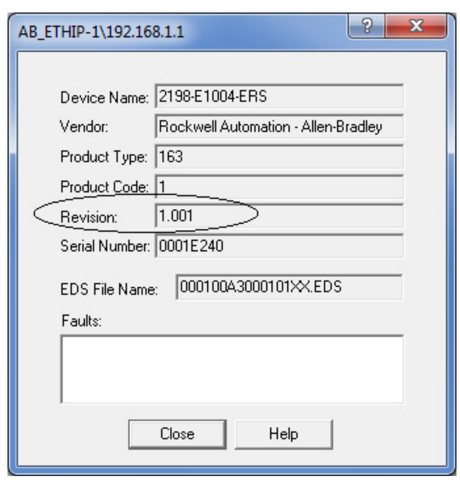
Verifying the firmware upgrade is optional.

1. Open your RSLinx software.
2. From the Communications menu, choose RSWho.




3. Expand your Ethernet node, Logix backplane, and EtherNet/IP network module.
4. Right-click the drive module and choose Device Properties.

   The Device Properties dialog box appears.




5. Verify the new firmware revision level.
6. Click Close.

# Notes:

# Use Add-On Instructions



## Use of the Add-On Instruction Library

When the Kinetix® 5100 drive is configured for IO Mode operation and is used with Studio 5000 Logix Designer®, the use of the pre-defined Add-On Profile (AOP) and Add-On Instruction library provide an easy way to program your simple motion control application.

| IMPORTANT | Induction and linear motors are not supported with the Add-On Instruction library. |
|---|---|

The Kinetix 5100 drive was designed to use the Add-On Instruction library since its launch with major revision 1.*xx*. This library has evolved to include a Device Object handler (Figure 256) designed to provide a robust method to control the read/write functions of the drive assemblies. This Device Object handler has many advantages including:

- Integration with the Power Device Library and its framework for programming
- Optional HMI faceplate
- Creation of Position Units
- Removal of user created logic (CPS) and interlocks that allow the Motion Add-On Instructions to operate effectively

Table 150 shows the differences between the Add-On Instruction libraries and the use of the device object handler.

**Table 150 - Device Object Handler Availability**

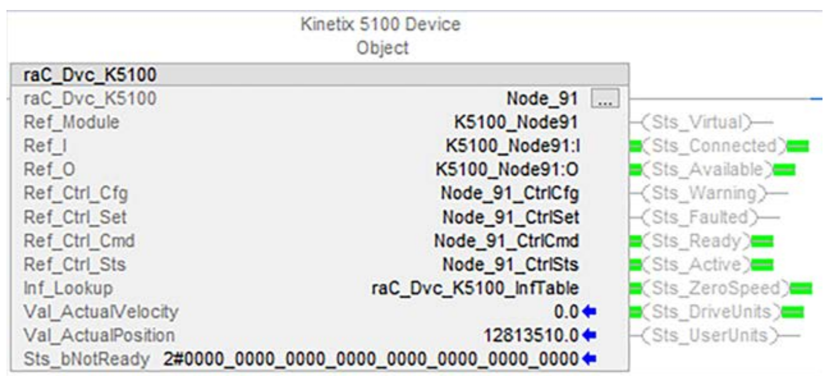
| Kinetix Firmware Major Rev | Device Handler Add-On Instruction | Add-On Instruction Library |
|---|---|---|
| 1.*xx* | NO | raC_Dvc_K5100_*xxx* |
| 2.*xx* | YES | raC_Opr_K5100_*xxx* |

| IMPORTANT | If you are using the Kinetix 5100 drive with major revision 2.*xx*, you must use the Device Handler Add-On Instruction with the Opr Add-On Instruction Library. Motion Add-On Instruction versions 1.*xx* and 2.*xx* are not interchangeable and cannot be combined to perform motion control.<br>The Add-On Instruction library containing raC_Dvc instructions is available for legacy applications. They can be downloaded from the Rockwell Automation Product Compatibility Download Center (PCDC) website; use keyword Kinetix 5100.<br>For new applications that are using the Kinetix 5100 drive with major revision 2.*xx*, use the Device Object handler Add-On Instruction. These Add-On Instructions can be downloaded from the PCDC website; use keyword Power Device Library. |
|---|---|

## Kinetix 5100 Drive Device Object Add-On Instructions

The Device Object Add-On Instruction comes with the Add-On Instruction library that is downloaded from the PCDC as part of the Power Device Library. This Add-On Instruction works together with a commonly developed faceplate created with the Studio 5000 View Designer® application. Each Kinetix 5100 drive requires a unique instance of the Device Object Add-On Instruction. This Add-On Instruction provides a single software interface that is used by each drive that commands the drive and provides the drive status you can use with your application logic.

**Figure 256 - Device Object Add-On Instruction**



The Kinetix 5100 drive Add-On Instructions are aimed to provide necessary simple motion functions. Table 151 lists the Kinetix 5100 drive Add-On Instructions.

**Table 151 - Add-On Instruction List for Kinetix 5100 Drives**

| Name(1) | Description |
|---|---|
| raC_*xxx*_K5100_MSO | Motion Servo On.<br>Use the Motion Servo On instruction to activate the drive output and to activate the drive servo loops. |
| raC_*xxx*_K5100_MSF | Motion Servo Off.<br>Use the Motion Servo Off instruction to deactivate the drive output and to deactivate the drive servo loops. |
| raC_*xxx*_K5100_MAJ | Motion Axis Jog<br>Use the Motion Axis Jog instruction to accelerate or decelerate the motor at a constant speed without termination. |
| raC_*xxx*_K5100_MAT | Motion Axis Torque<br>Use the Motion Axis Torque instruction to use torque limiting while a pre-defined speed is used to move the motor. |
| raC_*xxx*_K5100_MAM | Motion Axis Move<br>Use the Motion Axis Move instruction to move the motor to a specified position. |
| raC_*xxx*_K5100_MAH | Motion Axis Home<br>Use the Motion Axis Home instruction to home the motor. |
| raC_*xxx*_K5100_MAG | Motion Axis Gear<br>Use the Motion Axis Gear instruction to set the gear ratio between a pulse-source and follower drive.<br>IMPORTANT: This Add-On Instruction changes the drive E-Gear ratio; Slave/Follower ID151 (P1.044) and Master ID152 (P1.045) Counts. If your drive is positioning, be aware that the units are impacted because the E-Gear ratio controls the counts/motor rotation value. |
| raC_*xxx*_K5100_MAS | Motion Axis Stop<br>Use the Motion Axis Stop instruction to stop a specific motion process on the motor or to stop the motor completely. |
| raC_*xxx*_K5100_MAFR | Motion Axis Fault Reset.<br>Use the Motion Axis Fault Reset instruction to clear many motion faults for the drive. Some faults cannot be cleared until you power cycle the drive. The faults, which can be cleared by raC_*xxx*_K5100_MAFR, are listed in the fault list section. |
| raC_*xxx*_K5100_MAI | Motion Axis Index<br>Use the Motion Axis Index instruction to execute the specified PR (index) function of the drive. Use K5100C configuration software or explicit messaging to set the PR (index) parameters. The raC_*xxx*_K5100_MAI instruction specifies the PR (index) number to be executed. |

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

## Download the Add-On Instruction Files and Data Types

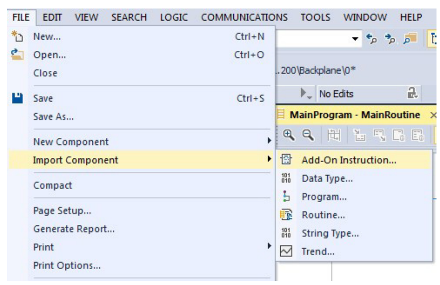
The Add-On Instructions files and Data Types for the Kinetix 5100 drive are available for download at the Rockwell Automation Product Compatibility Download Center (PCDC) website. Follow these steps to download the Add-On Instruction files and Data Types from the PCDC website, https:rok.auto/pcdc.

- For legacy applications: Enter 2198-E*xxxx*-ERS in the Search PCDC window.
- For new applications: Enter Power Device Library in the Search PCDC window.

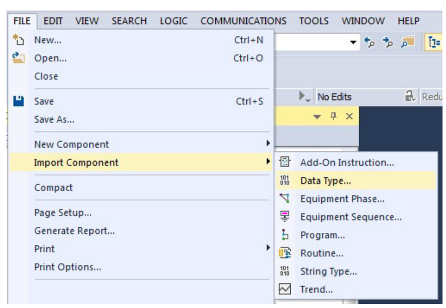
## Import the Add-On Instruction Files and Data Types (version 1.*xxx*)

In Legacy applications, (version1.*xxx*) follow these steps to import the Add-On Instruction files and Data Types to your Studio 5000 Logix Designer application. Use this method when you want to import individual Add-On Instructions. This method also contains some simple interlocking to begin your application programming.

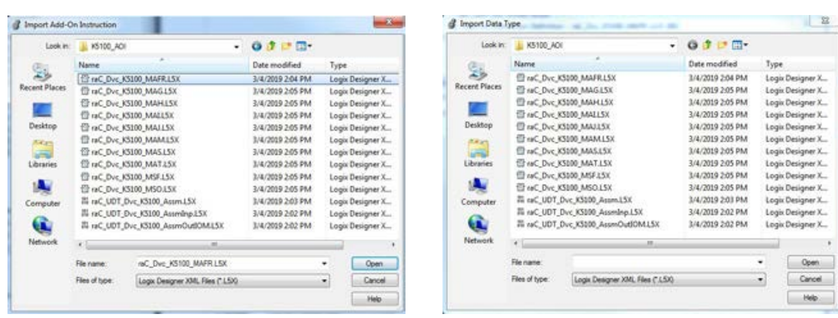
1. From the File menu, click Import Component>Add-On Instruction to import Add-On Instruction Files.




Or, click Import Component>Data Type to import Data Types.

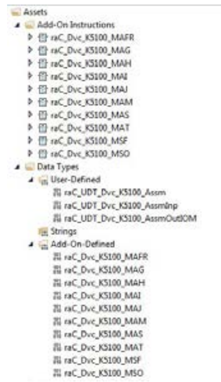



The Import Add-On Instruction/Data Types dialog box appears.




2. Browse to the Add-On Instruction files/Data Types you downloaded and select a file to add to your Logix Designer application and click Open.
3. Repeat step 1 and step 2 for the other Add-On Instruction file/Data Types.

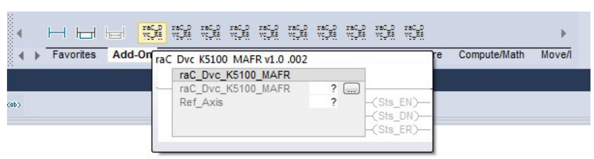
Your Add-On Instruction files appear in the Controller Organizer under the Add-On Instructions folder, along with the Add-On-Defined Data Types, which appear in the Controller Organizer under Data Types> Add-On-Defined folder. Your Data Types appear in the Controller Organizer under Data Types>User-Defined folder.




There are 11 Add-On Instruction files and five user-defined data types for the Kinetix 5100 drive firmware revision 2 or later to provide a necessary function block with assembly output instance 106 or 'Connection' is 'Data with Camming' of AOP version 2 or later. If the assembly output instance 104 is configured or 'Connection' is 'Data' of AOP version 2 or later, MAG and MAT must use the files in 'Version 1'.

To avoid incorrect data types, or incorrectly setting the data types, when using version 2.*xxx*, use the Add-On Instructions that are designed for new applications.

The Add-On Instruction files also appear in the ladder logic toolbox.



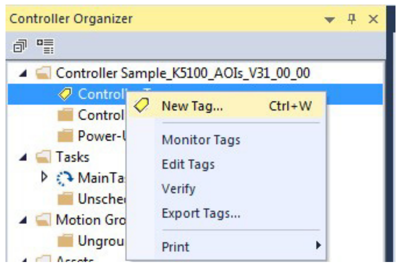
## Dvc Add-On Instruction Configuration (version 1.*xxx*)

For legacy applications (version 1.*xxx*), follow these steps to configure your Add-On Instruction.

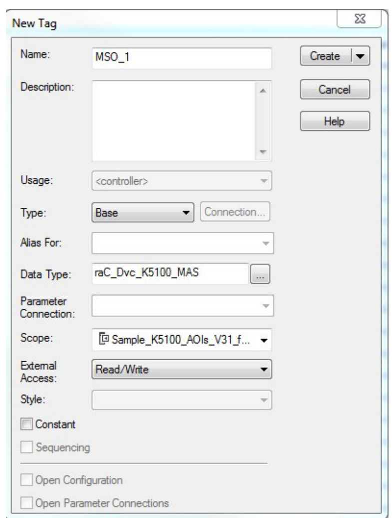
For new applications (version 2.*xxx*), use the PCDC keyword 'Power Device Library', and download the video from the PCDC website to install the Opr Add-On Instructions.

### Create the Add-On Instruction Tag

1. In the Controller Organizer, right-click Controller Tags and click New Tag.

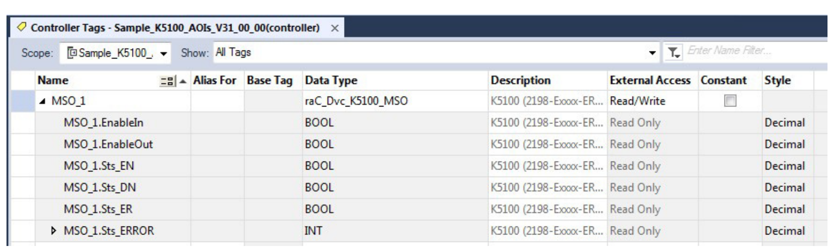



The New Tag dialog box appears.




2. Type a name (for example, MSO_1) for the Tag.
3. In the Data Type field, click Browse and choose an Add-On Instruction (for example, raC_Dvc_K5100_MSO).
4. Click OK.

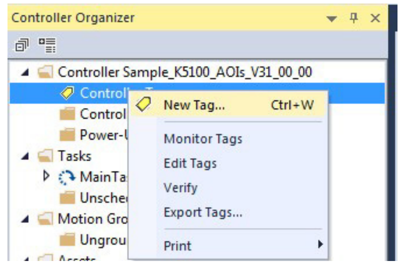
   The Add-On Instruction tag that you created, with the module-defined data types, populates in the Controller Tags group.



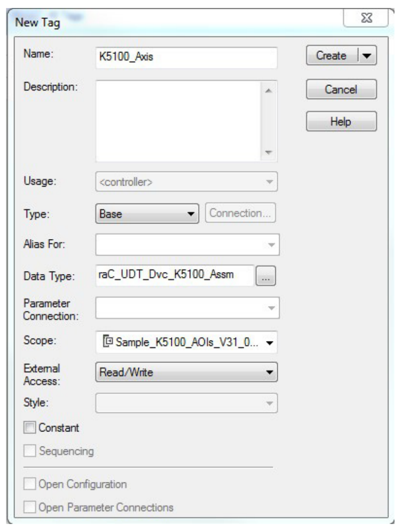
## Create the Ref_Axis Tag

To use the Kinetix 5100 drive Add-On Instructions, you must create a tag Ref_Axis whose type is raC_UDT_Dvc_K5100_Assm. Follow these steps to create a Ref_Axis tag.

1. In the Controller Organizer, right-click Controller Tags and click New Tag.

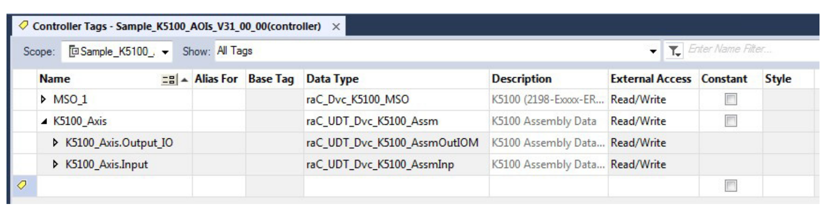



The New Tag dialog box appears.




2. Type a name (for example, K5100_Axis) for the Tag.
3. In the Data Type field, click Browse and choose an Add-On Instruction (for example, raC_UDT_Dvc_K5100_Assm).
4. Click OK.

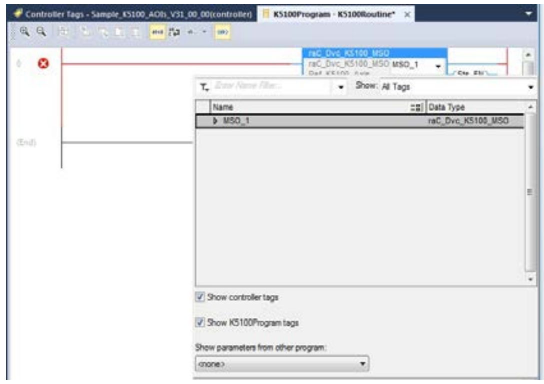
   The Add-On Instruction tag that you created, with the module-defined data types, populates in the Controller Tags group.




| IMPORTANT | All Add-On Instructions use the K5100_Axis as the operation object. |
|---|---|

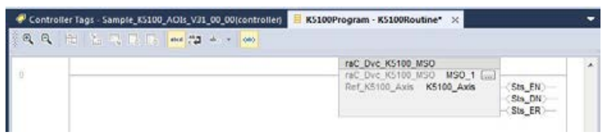
## Configure the Add-On Instruction

1. Double-click the entry of raC_Dvc_K5100_MSO argument and choose the MSO_1 Tag created earlier.




2. Double-click the entry of Ref_Axis argument and choose the K5100_Axis tag that you created earlier.

   The error disappears after you configured the Add-On Instruction arguments.

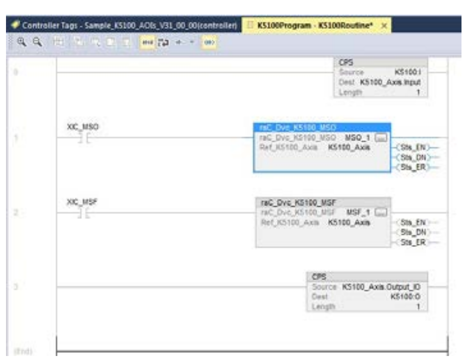



## General Execution Rules for Add-On Instructions

See IO Mode on page 265 for the input assembly data for the Kinetix 5100 drive.

To map the K5100_Axis to the Kinetix 5100 drive, before any Kinetix 5100 drive motion Add-On Instruction is used, you must use the CPS function to copy all input assembly data of the Kinetix 5100 drive to the Input element of K5100_Axis. After all Kinetix 5100 drive motion Add-On Instructions are used, you must use the CPS function to copy the Output element of K5100_Axis to the output assembly data of the Kinetix 5100 drive. This figure shows an example for mapping the K5100_Axis to the Kinetix 5100 drive.

CommandInProcess in the input assembly indicates the new motion command has been received by the Kinetix 5100 drive. It toggles between 0 and 1 after a new motion command has been received by the Kinetix 5100 drive. The CommandInProcess bit remains in the toggled state until a new command is received.

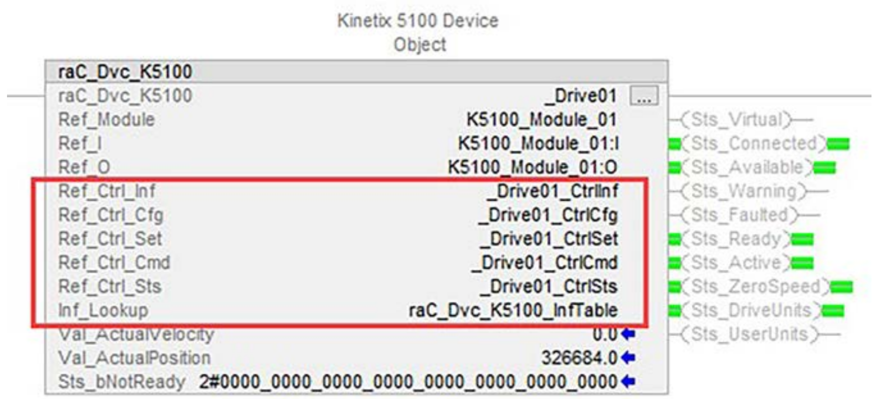


## Opr Add-On Instruction Configuration

Use the video on the PCDC to create and install the Device Object and Motion Instruction Add-On Instructions. Once the Operation Add-On Instructions are created, use the sample logic that is created as guidance for creating your application logic.

When the Device Object Add-On Instruction is created, it references Data Types that interface with the drive to exchange command and status information. You must create each Device Object Add-On Instruction as a unique instance.

**Figure 257 - Device Object**




### raC_UDT_Itf_K5100_Cfg

raC_UDT_Itf_K5100_Cfg is the Power Motion Common Control Interface User-Defined Data Type for device configuration. Its members provide selection between drive units (counts) or user units (PU).

This selection is very useful because the Kinetix 5100 drive natively supports only drive units. When the Operating Units = 1, the Motion Resolution and ConversionConstant values are used. Position Scaling originates from the KNX5100C software and is used together with the Cfg tags to derive user scaling units.

**Table 152 - raC_UDT_Itf_K5100_Cfg Data Types**

| Member | Description | DataType |
|---|---|---|
| OperatingUnits | 0 = Drive Units; 1 = UserUnits | DINT |
| MotionResolution | Motion Counts per Motor Revolution | DINT |
| ConversionConstant | Motion Counts per Position Unit | REAL |

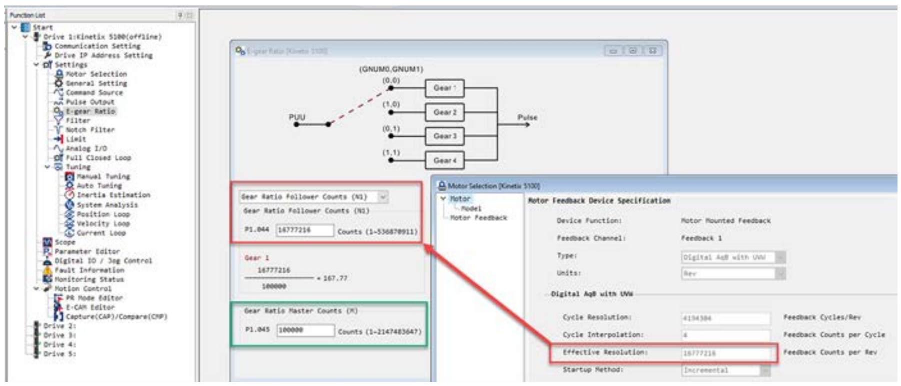
*Example Configuration with Position Units*

The E-Gear ratio (KNX5100C>Function List>E-Gear Ratio) is always used to provide a representation of positioning (units or counts) or to define a Pulse-Pulse Following relationship (MAG/PT). When the E-Gear ratio is changed, the positioning of the drive is changed. When not using the MAG Add-On Instruction or PT operation mode, the E-Gear ratio is used to define position scaling.

When Operating Units =1, Position Units are used, and we can define application units instead of using drive counts. In KNX5100C software, the E-Gear ratio is defined to provide Position Scaling. This is encoder counts (or pulses)/motor rotation.

By using KNX5100C software, navigate to Settings>E-Gear Ratio.

**Figure 258 - Position Units Configuration**



All Position Unit configurations must:

- Configure GearRatioFollowerCounts ID151 (P1.044) to be the same as the motor feedback effective resolution.
- Configure GearRatioMasterCounts ID152 (P1.045) to provide motor feedback counts/motor rotation.
- You define this value and can be any count value, default values with high-resolution encoders are 100,000 counts/motor rotation. The E-Gear configuration is used with the Device Object Cfg tags.

**Figure 259 - Position Unit Configuration Tag**

| | | | |
|---|---|---|---|
| ◢ K5100_NodeXXX_CtrlCfg | {...} | {...} | Automation Device Interface |
| ▸ K5100_NodeXXX_CtrlCfg.OperatingUnits | 1 | | Automation Device Interface 0 = Drive Units; 1 = UserUnits |
| ▸ K5100_NodeXXX_CtrlCfg.MotionResolution | 100000 | | Automation Device Interface Motion Counts per Motor Revolution |
| K5100_NodeXXX_CtrlCfg.ConversionConstant | 100000.0 | | Automation Device Interface Motion Counts per Position Unit |

The Device Object Cfg values must:

- Set Cfg.MotionResolution = GearRatioMasterCounts ID152 (P1.045) -> Motion Counts/Motor Revolution
- Set Cfg.ConversionConstant based on the Counts/Position Unit -> Motion Counts/Position Unit that is required for your application.

The example in Figure 259 results in Position Units = motor rotations. Now, entry values that originally used drive counts can be entered as motor rotations.

## raC_UDT_Itf_K5100_Set

raC_UDT_Itf_K5100_Set is the Power Motion Common Control Interface User-Defined Data Type for device settings. Its members provide application program access to allow or inhibit commands and settings from the device faceplate or other external sources. The table below shows member names, descriptions, and tag data types.

For example, to inhibit write commands from the device faceplate or other external sources write a 1 to the ModuleName_AOI_CtlrSet.InhibitCmd program tag from your application program. This write prevents a jog command from the device faceplate.

**Table 153 - raC_UDT_Itf_K5100_Set Data Types**

| Member | Description | DataType |
|---|---|---|
| bInhibit | Bit overlay for external access restriction | DINT |
| InhibitCmd | 1 = Inhibit user Commands from external sources; 0 = Allow Control. This is only used with the optional device faceplate. | BOOL |
| InhibitSet | 1 = Inhibit user Settings from external sources; 0 = Allow This member is only used with the optional device faceplate. | BOOL |
| OperatingMode | Determines the drive operating mode when 'Start Motion' has a zero-to-one transition.<br>1 - Position mode<br>2 - Speed mode<br>3 - Home mode<br>4 - Torque mode<br>5 - Gear mode (Fixed Ratio, based on present E-Gear ratio)<br>6 - Index mode<br>7 - Reserved<br>8 - Gear Mode (Variable Ratio, based on Master/Slave tag values)<br>9 - Enhanced MAT mode | DINT |
| MoveType | Specify the type of move.<br>0 = Absolute<br>1 = Incremental<br>2 = Rotary Shortest Path<br>3 = Rotary Positive<br>4 = Rotary Negative<br>7 = Relative<br>8 = Capture | DINT |
| PositionCommandOverlap | Allows overlapping of successive movements. | BOOL |
| PositionCommandOverride | Allows interruption of current movement, replacing it with a new movement. | BOOL |
| CapturedPositionSelect | Capture position selection (First capture or second capture). | BOOL |
| Position | Determines the command position. | REAL |
| Velocity | Determines the command speed. | REAL |
| Accel | Determines the command acceleration. | REAL |
| Decel | Determines the command deceleration. | REAL |
| Torque | Determines the command torque. | DINT |
| TorqueRampTime | Determines the command torque ramp time. | DINT |
| StartingIndex | This entry is the PR (Position Register) the drive should execute. | DINT |
| HomingMethod | Homing Method. | DINT |
| HomeReturnSpeed | Determines the command home return speed. | REAL |
| CamMasterReference | Future: Determines the master position reference of CAM. | DINT |
| CamExecutionSchedule | Future: Determines the method used to execute the CAM profile. | DINT |
| CamExecutionMode | Future: Determines if the cam profile is executed only one time or repeatedly. | DINT |
| CamStopMode | Future: Determines the stop mode of CAM. | BOOL |
| CamSlaveScaling | Future: Scales the total distance covered by the slave axis through the cam profile. | DINT |
| CamLockPosition | Future: Determines the starting location in the cam profile | DINT |
| CamMasterLockPosition | Future: Determines the master location where the slave axis locks to the mater axis. | DINT |
| CamMasterLeadingCounts | Future: Determines the leading counts (master axis) before the cam profile is executed. | DINT |

**Table 153 - raC_UDT_Itf_K5100_Set Data Types (Continued)**

| Member | Description | DataType |
|---|---|---|
| CamMasterUnlockCounts | Future: Determines the unlock counts (master axis) when the cam profile is executed. | DINT |
| CamMasterCyclicLeadingCounts | Future: Determines the cyclic leading counts (master axis) during the cam profile is executed. | DINT |
| GearRatioSlaveCounts | Integer value representing slave counts. This value is P1.044 Gear Ratio Follower Counts from the E-Gear ratio in KNX5100C software. | DINT |
| GearRatioMasterCounts | Integer value representing master counts. This value is P1.045 Gear Ratio Master Counts from the E-Gear ratio in KNX5100C software. | DINT |

## raC_UDT_Itf_K5100_Cmd

raC_UDT_Itf_K5100_Cmd is the Power Motion Common Control Interface User-Defined Data Type for device commands. Its members provide application program access to common basic device commands.

Table 154 shows member names, descriptions, and tag data types.

All the commands are available whether operating the device physically or virtually.

While it is possible, it is not typical to modify any of these UDT values directly. The Motion Operation Add-On Instructions manipulate these values as a result of their operation.

**Table 154 - raC_UDT_Itf_K5100_Cmd Data Types**

| Member | Description | DataType |
|---|---|---|
| bCmd | Commands (Bit Overlay) | DINT |
| Physical | 1 = Operate as a physical device | BOOL |
| Virtual | 1 = Operate as a virtual device | BOOL |
| ResetWarn | 1 = Reset device warning | BOOL |
| ResetFault | 1 = Reset device trip or fault | BOOL |
| Activate | 1 = Activate Output Power Structure | BOOL |
| Deactivate | 1 = DeActivate Output Power Structure | BOOL |
| StartMotion | A zero-to-one transition means the motion command is issued from the external controller. | BOOL |
| StopMotion | A zero-to-one transition will stop any active motion command in the drive. | BOOL |

## raC_UDT_Itf_K5100_Sts

raC_UDT_Itf_K5100_Sts is the Power Motion Common Control Interface User-Defined Data Type for device status. Its members provide application program access to device states, status, and diagnostic data. The table below shows member names, descriptions, and tag data types.

**Table 155 - raC_UDT_Itf_K5100_Sts Data Types**

| Input | Description | DataType |
|---|---|---|
| eState | Enumerated state value:<br>0 = Unused<br>1 = Initializing<br>2 = Disconnected<br>3 = Disconnecting<br>4 = Connecting<br>5 = Idle<br>6 = Configuring<br>7 = Available | DINT |
| FirstWarning | Capture the First Alarm Bit to trigger. Display the respective Description and Time Stamp on Faceplate. Log the same in Event Queue. | raC_UDT_Event |
| FirstFault | Capture the Fault Code of the device. Display the respective code, description, and timestamp on faceplate. Log the same in Event Queue. | raC_UDT_Event |
| eCmdFail | Enumerated command failure code | DINT |
| bSts | Status (Bit Overlays) | DINT |
| Physical | 1 = Operating as a physical device | BOOL |
| Virtual | 1 = Operating as a virtual device | BOOL |
| Connected | 1 = PAC to device connection has been established. | BOOL |
| Available | 1 = The automation device is available for interaction with the user program | BOOL |
| Warning | 1 = A warning is active on the automation device | BOOL |
| Faulted | 1 = A fault is active on the automation device | BOOL |
| Ready | 1 = Device is ready to be Activated | BOOL |
| Active | 1 = Device power structure is active | BOOL |
| ZeroSpeed | 1 = Motor is within zero speed tolerance (this tolerance is defined in KNX5100C software) | BOOL |
| Homed | Indicates whether the drive completed the home operation. | BOOL |
| AtReference | Depending on the motion command (position, speed, torque), AtReference is 1 when the actual reference = command reference. | BOOL |
| CommandInProgress | Toggles state when a motion command is active in the drive. This bit changes state (toggles between 0 and 1) when a new command is executed from the drive.<br>**IMPORTANT**: Once this bit changes state, it remains in that state for the duration of the command; it toggles to the opposite state (and remains in that state) once a new command is received. | BOOL |
| FaultCode | Active Fault Code in the drive | DINT |
| WarningCode | Active Warning Code in the drive | DINT |
| OperatingMode | Indicate which operating mode is currently used. | DINT |
| MotorType | Indicate which type of motor is connected to the drive.<br>Rotary Motor = 1<br>Linear Motor =2 (Future) | DINT |
| ActualPosition | Actual position of the motor. Units depend on the Cfg settings. These can be drive counts or Position Units. | REAL |
| ActualVelocity | Actual speed of the motor. Units depend on the Cfg settings. These can be 0.1 RPM/sec or Position Units. | REAL |
| ActualTorque | When the operating mode is 4, Torque Mode, this represents the % motor torque. | REAL |
| ActiveIndex | Indicates the currently executing Position Register PR (index). | DINT |

**Table 155 - raC_UDT_Itf_K5100_Sts Data Types (Continued)**

| Input | Description | DataType |
|---|---|---|
| ParameterMonitor1Value | Parameter Monitor 1 Value<br>You can use ID60 (P0.035) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID60 (P0.035) is shown in ID55 (P0.025). | DINT |
| ParameterMonitor2Value | Parameter Monitor 2 Value<br>You can use ID61 (P0.036) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID61 (P0.036) is shown in ID56 (P0.026). | DINT |
| ParameterMonitor3Value | Parameter Monitor 3 Value<br>You can use ID62 (P0.037) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID62 (P0.037) is shown in ID56 (P0.027). | DINT |
| ParameterMonitor4Value | Parameter Monitor 4 Value<br>You can use ID63 (P0.038) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID63 (P0.038) is shown in ID57 (P0.028). | DINT |
| ParameterMonitor5Value | Parameter Monitor 5 Value<br>You can use ID64 (P0.039) to specify the mapping parameter instance ID number. The content of the parameter that is specified by ID64 (P0.039) is shown in ID57 (P0.028). | DINT |

## raC_UDT_LookupMember_STR0082

**Table 156 - raC_UDT_LookupMember_STR0082 Data Types**

| Member | Description | DataType |
|---|---|---|
| Code | Stores the value of device fault code. | DINT |
| Desc | Stores the Messages related to fault code. | STRING |

Use these Ctrl*xxx* tags where possible instead of the Operation Add-On Instruction status bits. For example, instead of evaluating the raC_Opr_K5100_MSO.Sts_DN =1 to indicate an Active state, use _Drive01_CtrlSts.Active = 1. This bit is inclusive of interlocks that check for connection status as well as the drive being Ready and not faulted.

**Figure 260 - Ctrl*xxx* Tag Example**


When using the Device Object Add-On Instructions, using the Input/Output Assemblies is not required because the Device Object Add-On Instruction is now the interface between the drive and controller.

## raC_UDT_Event

raC_UDT_Event is an array of size 4 and is used to log the FirstWarning and FirstFault capture. The data is captured in FIFO order. The faceplate displays the same data. This UDT is created as part of the Device Object, however, is only used with the optional faceplate. You assign this Device Object to record events in Logix. When using Machine Builder Libraries, a suite of instructions is available to customize event handling.

**Table 157 - raC_UDT_Event Data Types**

| Member | Description | Data Type |
|---|---|---|
| Type | 1 = Status<br>2 = Warning<br>3 = Fault<br>4….n = User | DINT |
| ID | User definable event ID | DINT |
| Category | User definable category (Electrical, Mechanical, Materials, Utility) | DINT |
| Action | User definable event action code | DINT |
| Value | User definable event value or fault code | DINT |
| Message | Event message text | STRING |
| EventTime_L | Timestamp | LINT |
| EventTime_D | Timestamp (Y,M,D,h,m,s,us) | DINT[7] |

## Add-On Instruction Details

When the Device Object is used with the current version of the Add-On Instruction library, using the Device Object states to represent the axis is preferred, as these states incorporate the instruction and drive information in one location, which results in accurate drive state representation.

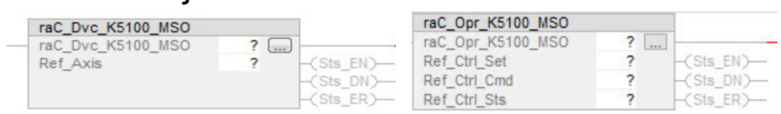
This section provides details for each instruction.

| | |
|---|---|
| **IMPORTANT** | Although the Dvc instructions function similarly to the Opr instructions, the Opr are described in this section. The Opr instructions are used for new applications. |

### raC_*xxx*_K5100_MSO[1]

Use the Motion Servo On (raC_*xxx*_K5100_MSO) instruction to activate the drive amplifier for the specified axis and to activate the servo control loops.

**Figure 261 - MSO Ladder Diagram**




*Operands*

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MSO | Tag | Unique instance of the MSO Add-On Instruction |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and remains set as the message transaction to activate the drive is initiated and in process. It remains set while the rung-in condition is true and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the cmd to activate the drive has been acknowledged. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

*Description*

Use the raC_*xxx*_K5100_MSO instruction to activate the motor. This instruction must be used while there are no active faults on the drive and the drive is in a Ready State. The resulting state of the drive is reflected when Ref_CtrlSts.Active is one.

**IMPORTANT** The instruction execution can take multiple scans to execute because it requires multiple RPI updates to complete the request. The Done (Sts_DN) bit is not set immediately, but only after the request is completed.

*Error Codes*

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 102 - Another raC_*xxx*_K5100_MSO message is executing
- 103 - raC_Dvc_K5100_MSF is executing
- 127 - Previous command has not completed
- 129 - Motor not connected

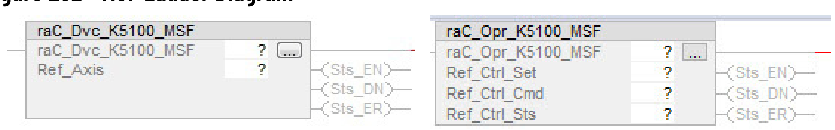
See Error Codes on page 513 for details.

You can use the F1 key to view fault error codes.

## raC_*xxx*_K5100_MSF[1]

Use the Motion Servo Off (raC_*xxx*_K5100_MSF) instruction to deactivate the drive output for the specified axis and to deactivate the motor.

**Figure 262 - MSF Ladder Diagram**




*Operands*

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MSF | Tag | Unique instance of the MSF Add-On Instruction |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and remains set as the message transaction to deactivate the drive is initiated and in process. It remains set while the rung-in condition is true and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to deactivate the drive (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

### Description

The raC_*xxx*_K5100_MSF instruction deactivates the motor. This instruction must be used when there are no active faults on the drive and the drive is in the Ready state. The resulting state of the drive is reflected when RefCtrlSts.Active is zero.

| | |
|---|---|
| **IMPORTANT** | The instruction execution can take multiple scans to execute because it requires multiple RPI updates to complete the request. The Done (Sts_DN) bit is not set immediately, but only after the request is completed. |

### Error Codes

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 104 - Another raC_Dvc_K5100_MSF message is executing
- 129 - Motor not connected

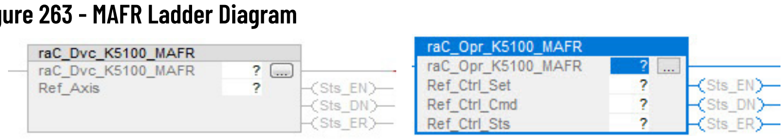
See Error Codes on page 513 for details.

You can use the F1 key to view fault error codes.

## raC_*xxx*_K5100_MAFR(1)

Use the Motion Axis Fault Reset (raC_*xxx*_K5100_MAFR) instruction to clear some drive faults. When the fault is no longer active in the drive, this instruction clears the fault. This instruction does not clear any faults that are still active in the drive.

**Figure 263 - MAFR Ladder Diagram**




### Operands

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MAFR | Tag | Unique instance of the MAFR Add-On Instruction |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and the message transaction to Reset is initiated and in process. It remains high until the rung-in condition is false and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to Reset the drive (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

*Description*

The raC_*xxx*_K5100_MAFR instruction attempts to clear any active fault on the specified axis. If the active fault condition is still present, the drive remains faulted.

| | |
|---|---|
| **IMPORTANT** | The instruction execution can take multiple scans to execute because it requires multiple RPI updates to complete the request. The Done (Sts_DN) bit is not set immediately, but only after the request is completed. |

*Error Codes*

- 100 - Kinetix 5100 drive is not ready
- 101- Drive is faulted
- 106 - Another raC_Dvc_K5100_MAFR message is executing
- 129 - Motor is not connected

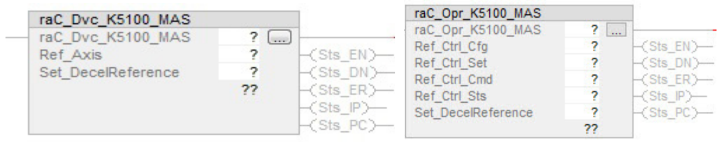
See Error Codes on page 513 for details.

You can use the F1 key to view fault error codes.

## raC_*xxx*_K5100_MAS[1]

Use the Motion Axis Stop (raC_*xxx*_K5100_MAS) instruction to stop motion on an axis. The drive remains active when the stop instruction is complete.

**Figure 264 - MAS Ladder Diagram**




### *Operands*

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MAS | Tag | Unique instance of the MAS Add-On Instruction |
| Ref_Ctrl_Cfg | raC_UDT_Itf_PowerMotionSA_Cfg | Tag | Interface for Ctrl_Cfg of the Device Object |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |
| Set_DecelReference | REAL | Tag | The Deceleration Rate in 0.1 RPM/s for rotary motor. Range: 458…30,000,000 |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and the message transaction to Stop is initiated and in process. It remains high until the rung-in condition is false and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to Stop the drive (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |
| Sts_IP (In Progress) | This bit is set when the rung makes a false-to-true transition, the Stop message transaction is successful, and the motor begins to decelerate. This bit remains set as the motor is executing the stop. |
| Sts_PC (Process Completed) | This bit is set when the rung makes a false-to-true transition, the Sts_IP is set, and Zero Speed is reached.  Zero Speed is defined using KNX5100C software>General Setting. |

### *Description*

Use the raC_*xxx*_K5100_MAS instruction when you want a controlled stop for any controlled motion. The instruction stops the motion without disabling the motor. This Add-On Instruction stops any motion that is generated by motion Add-On Instruction including the MAJ, MAM, or MAG.

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

### *Error Codes*

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - MSF is executing
- 105 - Drive is disabled
- 107 - Another raC_*xxx*_K5100_MAS message is executing
- 113 - Decel_Rate is out of range
- 127 - Previous command has not completed
- 129 - Motor is not connected

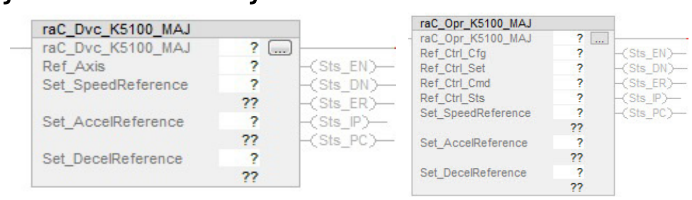
See Error Codes on page 513 for details.

You can use the F1 key to view fault error codes.

## raC_*xxx*_K5100_MAJ(1)

Use the Motion Axis Jog (MAJ) instruction to move an axis at a constant speed until the command is terminated.

**Figure 265 - MAJ Ladder Diagram**




### *Operands*

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MAJ | Tag | Unique instance of the MAJ Add-On Instruction |
| Ref_Ctrl_Cfg | raC_UDT_Itf_PowerMotionSA_Cfg | Tag | Interface for Ctrl_Cfg of the Device Object |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |
| Set_SpeedReference | REAL | Immediate or Tag | Units are 0.1 rpm for rotary motors.<br>Range: -80,000…+80,000 |
| Set_AccelReference | REAL | Immediate or Tag | Units are 0.1 rpm/s for rotary motors.<br>Range: 458…30,000,000 |
| Set_DecelReference | REAL | Immediate or Tag | Units are 0.1 rpm/s for rotary motors.<br>Range: 458…30,000,000 |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and the message transaction to Jog is initiated and in process. It remains set while the rung-in condition is true and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to Jog the drive (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |
| Sts_IP (In Process) | This bit is set when the rung makes a false-to-true transition, the Jog message transaction is successful, and the motor begins to move. This bit remains set as the motor is moving towards the target speed (Accel or Decel). It remains set while the Jog is active, regardless of the rung-in condition. |
| Sts_AtSpeed (Process Complete)/Sts_AtSpeed | This bit is set when the rung makes a false-to-true transition, the Sts_IP is set, and the Target Speed is reached. This bit remains set while the Jog is active and AtSpeed condition is true. |

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

*Description*

Use the MAJ instruction to move an axis at a constant speed until the command is terminated.

*Error Codes*

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - raC_*xxx*_K5100_MSF is running
- 105 - Drive is disabled
- 107 - raC_*xxx*_K5100_MAS is executing
- 108 - Other motion Add-On Instruction is sending the command
- 111 - Input speed is out of range
- 112 - Accel_rate is out of range
- 113 - Decel_rate is out of range
- 127-Previous command has not completed
- 129 - Motor is not connected

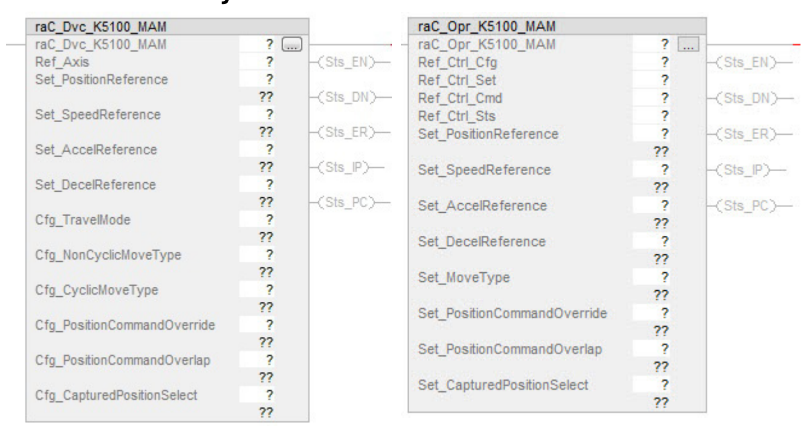
See Error Codes on page 513 for details.

You can use the F1 key to view fault error codes.

## raC_xxx_K5100_MAM[1]

Use the Motion Axis Move (raC_*xxx*_K5100_MAM) instruction to move (index) an axis to a specified position.

**Figure 266 - MAM Ladder Diagram**




(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

*Operands*

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MAM | Tag | Unique instance of the MAM Add-On Instruction |
| Ref_Ctrl_Cfg | raC_UDT_Itf_PowerMotionSA_Cfg | Tag | Interface for Ctrl_Cfg of the Device Object |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |
| Set_PositionReference | REAL | Immediate or Tag | Set the Target Distance/Position Reference (PUU)<br>Range: -2,147,483,648…+2,147,483,647 |
| Set_SpeedReference | REAL | Immediate or Tag | Units are 0.1 rpm for rotary motors<br>Range: -80,000…+80,000 |
| Set_AccelReference | REAL | Immediate or Tag | Units are 0.1 rpm/s for rotary motors<br>Range: 458…30,000,000 |
| Set_DecelReference | REAL | Immediate or Tag | Units are 0.1 rpm/s for rotary motors<br>Range: 458 …30,000,000 |
| Set_MoveType | INT | Tag | Specify the type of move:<br>0 = Absolute<br>1 = Incremental<br>2 = Rotary Shortest Path<br>3 = Rotary Positive<br>4 = Rotary Negative<br>7 = Relative<br>8 = Capture (see page 330, and page 503 for details) |
| Set_PositionCommandOverride | BOOL | Tag | 0 = Do not interrupt previous movement<br>1 = Interrupt previous movement (see page 503 for details) |
| Set_PositionCommandOverlap | BOOL | Tag | 0 = Current movement is not overlapped with next<br>1 = Current movement is overlapped with next movement (see page 503 for details) |
| Set_CapturedPositionSelect | BOOL | Tag | 0 = First High Speed Capture (triggered by DI9)<br>1 = Second High Speed Capture (triggered by DI10) |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and the message transaction to Index is initiated and in process. It remains high until the rung-in condition is false and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to Index the drive (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be as a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |
| Sts_IP (In Progress) | This bit is set when the rung makes a false-to-true transition, the Index message transaction is successful, and the motor begins to move. This bit remains set as the motor is executing the index. |
| Sts_PC (Process Completed) | This bit is set when the rung makes a false-to-true transition, the Index message transaction is successful, and the motor reaches the Target position. |

*Description*

The raC_*xxx*_K5100_MAM instruction moves an axis to using a target position specified and uses the Move Type to perform the move (index).

*Error Codes*

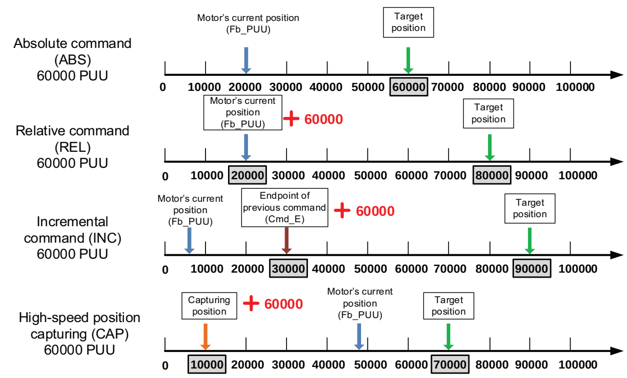
- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - MSF is executing
- 105 - Drive is disabled
- 107 - raC_*xxx*_K5100_MAS is executing
- 108 - Other motion Add-On Instruction is sending the command
- 111 - SpeedReference is out of range
- 112 - AccelReference is out of range
- 113 - DecelReference is out of range
- 117 - NonCyclicMoveType is out of range
- 118 - CyclicMoveType is out of range
- 119 - TravelMode is out of range
- 126 - Homing not completed
- 127 - Previous command has not completed
- 129 - Motor is not connected to drive

See Error Codes on page 513 for details.

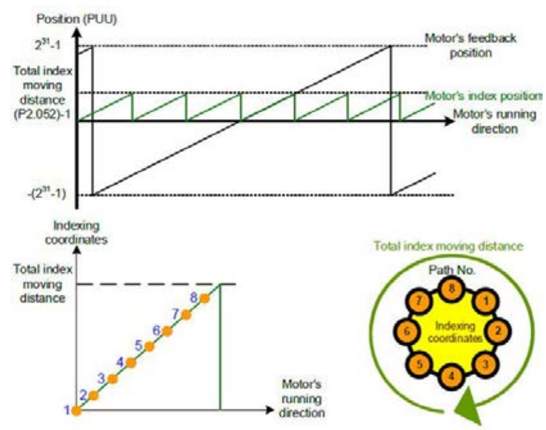
You can use the F1 key to view fault error codes.

### *Set_MoveType*

- Positioning Operation (Cfg_Selection is set to 2 (0b0010)): Four types of move operations (Set_MoveType) are executed as shown.

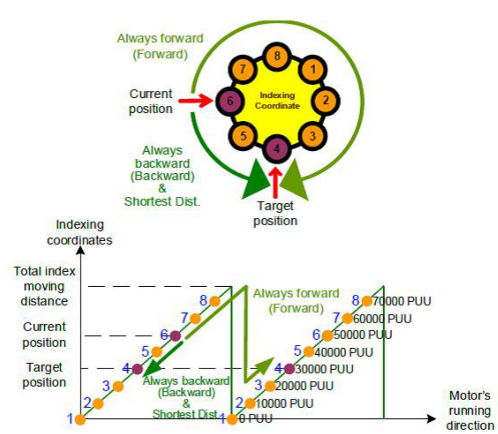



- Positioning Operation (Cfg_Selection is set to 10 (0b1010)): Three types of move operations (Set_MoveMethod) are executed as shown.
  - Define 'Indexing Coordinate':

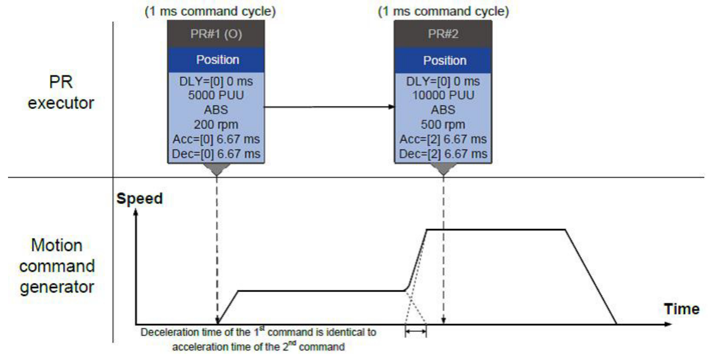



  - Rotate Positive or Rotate Negative or Rotate Shortest Path.
    The Rotary move types are used to provide a way to index while observing the natural rollover of the feedback device. For example, if the motor could only index positive, the Rotary Positive is used. When the feedback device transitions through its natural unwind (typically 2.1 billion counts), the movements always index positive.

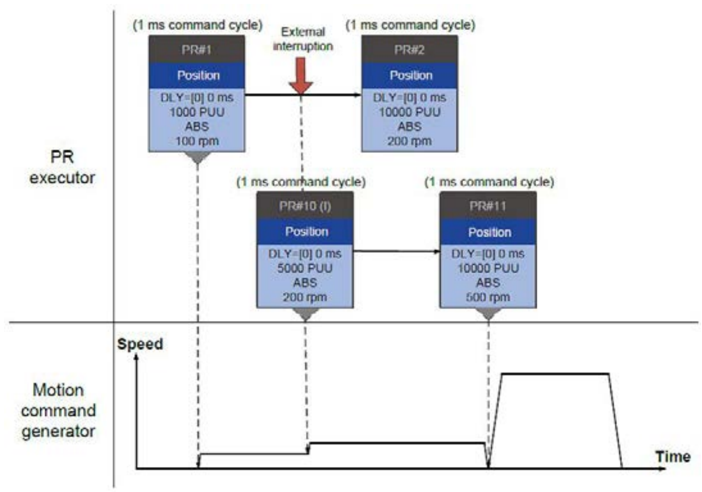
| | |
|---|---|
| **IMPORTANT** | At this time, the Kinetix 5100 drive does not have a user defined Unwind function. The rotary selections in this Add-On Instruction do not refer to user defined rotary axis types. |



- Position Command with Overlap option.
  The executing index is interrupted during its deceleration. The new index is started before the deceleration is complete




- Position Command with Interrupt option.
  The executing index (Index 1) is terminated. The new index (Index 2) is executed using its dynamics. This is shown in the graphic below. The red arrow is the point where the command for Index 2 is received by the drive

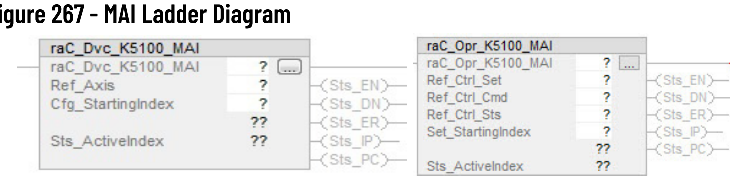



(a) External interruption – Position command

## raC_xxx_K5100_MAI(1)

It may be useful to execute a motion control internal register (PR) while in the IO operation mode. This can be for performing an action that is not able to be performed by one of the Add-On Instructions in the motion library. Using this means that the PR has to be pre-configured in the drive by using KNX5100C software, which is done before the IO Mode connection is established.

**Figure 267 - MAI Ladder Diagram**




(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

### Operands

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MAI | Tag | Unique instance of the MAI Add-On Instruction |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |
| Set_StartingIndex | INT | Tag | Enter the pre-configured PR# to execute |
| Sts_ActiveIndex | INT | Tag | Reads the current PR# that is executing in the drive |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and the message transaction to MAI is initiated and in process.  It remains high until the rung-in condition is false and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to MAI the drive (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |
| Sts_IP (In Progress) | This bit is set when the rung makes a false-to-true transition, the MAI message transaction is successful, and the PR command has been sent to the drive. This bit remains set until the AtReference bit is set. |
| Sts_PC (Process Completed) | This bit is set when the rung makes a false-to-true transition, the Sts_IP is set, and the MAI has sent the PR execution and the AtReference bit is set. |

### Description

Use the Motion Axis Index (raC_*xxx*_K5100_MAI) instruction to execute motion control by internal register (PR) in Kinetix 5100 drives. The 99 built-in command registers selects the PR command source. See Chapter 11, Motion Control in PR Mode on page 279 for details.

### Error Codes

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - MSF is executing
- 105 - Drive is disabled
- 107 - raC_*xxx*_K5100_MAS is executing
- 108 - Other motion Add-On Instruction is sending the command
- 115 - StartingIndex is out of range
- 127 - Previous command is not completed
- 129 - Motor is not connected

See Error Codes on page 513 for details.

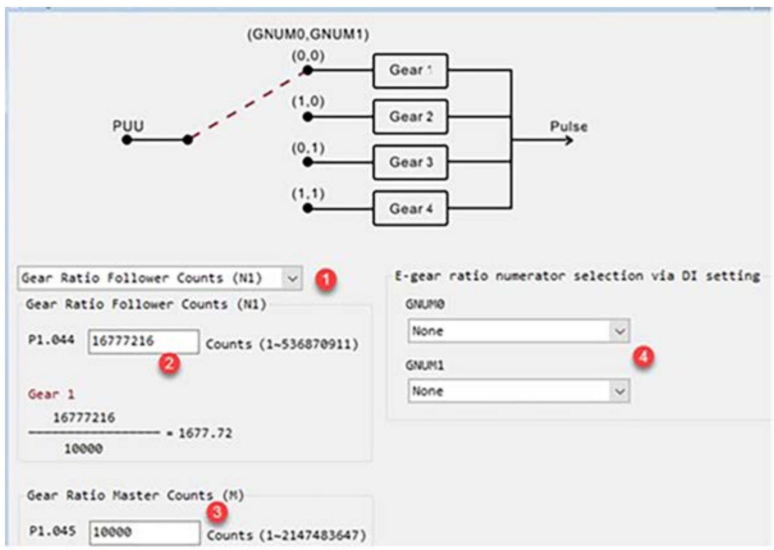
You can use the F1 key to view fault error codes.

## raC_xxx_K5100_MAG(1)

Use the Motion Axis Gear (MAG) Add-On Instruction to execute a pulse-pulse relationship with the drive. The MAG Add-On Instruction uses the E-Gear ratio configured in the KNX5100C software. The E-Gear ratio dialog box is shown in Figure 268. When the MAG Add-On Instruction is used, the drive behaves like it is in PT (Position Terminal - or Pulse Train) mode and the drive uses the E-Gear ratio to respond to master pulses.

Figure 268 describes the values in the E-Gear ratio dialog box. Not all values shown here are used with the Motion Operation Add-On Instruction.

**Figure 268 - E-Gear Ratio Dialog Box**




| Item | Description |
|---|---|
| 1 | Gear Ratio Selection pull-down menu - You can choose from four different ratios (N1...N4) (Not used with Add-on Instructions) |
| 2 | Gear Ratio Follower Counts (N1) - Set this value as the motor feedback resolution. |
| 3 | Gear Ratio Master Counts (M) - Set this value as the counts/motor resolution. This value is set for whatever your application requires. Typical values are 100,000 counts for a high-resolution encoder. |
| 4 | GNUM0/1 - These values are mapped to the Digital Inputs that represent binary weighted values to select the Gear Ratio value. (Not used with Add-on Instructions) |

The PT Mode is a pulse-pulse follower relationship. When the variable ratio is used and the ratio is changed, there is no positioning ability. Therefore, when you are finished using the MAG Add-On Instruction, your position scaling (which also uses the E-Gear ratio) might have changed if you used variable GearingMode and changed the Master ratio because of your application requirements.

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

The MAG Set_SlaveCounts is sometimes called the Gear Ratio Follower Counts or numerator (shown as 2 in Figure 268) because it is used to determine the internal 'ratio' of the drive (shown as 1677.72 in Figure 268). For our purposes, the E-Gear ratio Follower = MAG Set_SlaveCounts = motor feedback resolution (from the KNX5100C>Function List>Motor Selection>Feedback dialog box).

**Figure 269 - Set the Follower Counts**


The MAG Set_MasterCounts is sometimes called the Gear ratio Master counts or denominator (shown as 3 in Figure 268). Any gearing relationship must consider the actual motor mechanics, like a gearbox, or actuator pitch, and use those mechanics to relate back to a motor rotation. Gear Ratio Master counts is desired counts/motor rotation. Desired counts are not used for positioning; but defines how many counts your motor moves in one rotation based on the number of feedback pulses you expect to receive from the source input, which is used to determine your gearing relationship. So, this Master counts value is used to define the pulse-pulse relationship.

**IMPORTANT** The MAG Add-On Instruction can affect your positioning. The issuing Kinetix 5100 drive (slave) uses the E-Gear ratio to define how it follows pulses from a source (a master). While the result is that the issuing Kinetix 5100 drive (slave) follows pulses from another source (master), the way the function operates can affect positioning of the drive. Regardless of Operation Mode, the E-Gear ratio is always used to provide a representation of positioning (units or counts) or to define a Pulse-Pulse Following relationship (MAG/PT). When the E-Gear ratio is changed, the positioning of the axis is changed.

**EXAMPLE** Gearing example:

The master in our system is a 4000 ppr encoder. When the encoder makes one revolution, we expect the Slave1 drive to see: 4000 pulses.

Our application requirement is that we want to follow this encoder at a 1:2 relationship. So, when the master encoder moves one encoder revolution, the motor rotates two times.

The Master PPR is not entered anywhere, but is required that we know this value. We calculate the MAG Set_MasterCounts value knowing the Master PPR counts and the relationship we want in the Slave1 motor.

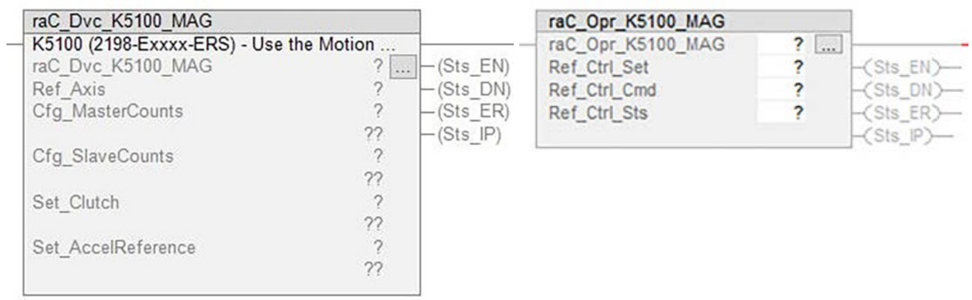
We set the MAG Set_SlaveCounts = Motor Feedback Resolution = 16,777,216.

We set MAG Set_MasterCounts = 2000, so when the Slave1 drive sees 2000 master pulses, the Slave1 motor moves one rotation, and thus, as the Master encoder moves 4000 pulses, Slave1 would have moved two rotations.

There are two modes of the MAG function that can be used. These modes are defined by the Cfg_GearingMode entry. This entry is not visible and is set for Fixed initially. You must intentionally change this setting. Fixed mode does not impact positioning because it uses the existing E-Gear ratio in the Kinetix 5100 drive. Therefore, we can follow a master source at this fixed ratio and when gearing is disabled, we can continue positioning without losing the position scaling for the drive.

Variable mode lets you change the E-Gear ratio by manipulating the master/slave counts values. The variable mode lets you change the ratio. When the ratio is changed, the motor positioning is affected because the E-Gear ratio is also used to define Position Scaling. If you require positioning after using the variable gearing, issue a Homing Sequence to re-establish an origin.

**Figure 270 - MAG Ladder Diagram**




*Operands*

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MAG | Tag | Unique instance of the MAG Add-On Instruction |
| Ref_Ctrl_Cfg | raC_UDT_Itf_PowerMotionSA_Cfg | Tag | Interface for Ctrl_Cfg of the Device Object |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |
| Set_MasterCounts | DINT (not visible) | Immediate or Tag | Sets the value of E-Gear Ratio; Denominator ID152 (P1.045)<br>Set this value to represent the desired counts/motor rotation. This value defines the number of pulses/motor rotation and when used with the feedback pulses you expect to see from the source input (also pulses/ revolution) provides a gearing relationship. |
| Set_SlaveCounts | DINT (not visible) | Immediate or Tag | Sets the value of E-Gear Ratio; Numerator ID151 (P1.044)<br>Set this value the same as the Motor Feedback Resolution. |
| Cfg_GearingMode | BOOL (not visible) | Tag | 0 = Fixed<br>1 = Variable |
| Set_AccelReference (future) | REAL (not visible) | Immediate or Tag | Units are 0.1 rpm/s for rotary motor<br>Range: 458…30,000,000 |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and the message transaction to MAG is initiated and in process. It remains high until the rung-in condition is false and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to MAG (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |
| Sts_IP (In Progress) | This bit is set when the rung makes a false-to-true transition, the MAG message transaction is successful, and the drive begins following. This bit remains set as the motor is executing the gearing. It remains set while the MAG is active, regardless of the rung-in condition. |

*Error Codes*

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - MSF is executing
- 105 - Drive is disabled
- 107 - raC_*xxx*_K5100_MAS is executing
- 108 - Other motion Add-On Instruction is sending the command
- 112 - AccelReference is out of range
- 127 - Previous command is not completed
- 129 - Motor is not connected
- 131 - Slave count is out of range 1 to ($2^{29}$…1)
- 132 - Master counts is out of range 1 to ($2^{31}$…1)
- 133 - Gear ratio is out of range (262144…1)

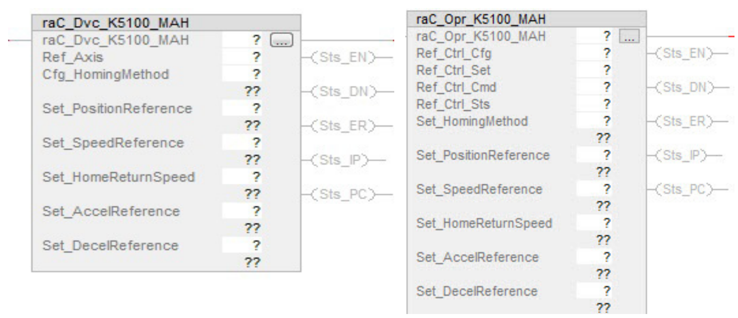
See Error Codes on page 513 for details.

You can use the F1 key to view fault error codes.

## raC_*xxx*_K5100_MAH(1)

Use the Motion Axis Home (raC_*xxx*_K5100_MAH) instruction to command a homing procedure in the drive. Homing is used to define an origin for your motor and to establish an absolute positioning reference for the motor. The description of the different homing configurations is shown on page 292.

**Figure 271 - MAH Ladder Diagram**




(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

*Operands*

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MAH | Tag | Unique instance of the MAH Add-On Instruction |
| Ref_Ctrl_Cfg | raC_UDT_Itf_PowerMotionSA_Cfg | Tag | Interface for Ctrl_Cfg of the Device Object |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |
| Set_HomingMethod | SINT | Tag | 0…38 - See Table 112 on page 295 for Homing methods.<br>**TIP**: You can press F1 to see the Homing Methods from the Add-On Instructions help. |
| Set_PositionReference | REAL | Tag | The feedback position when a homing procedure is completed. Range: -2,147,483,648…+2,147,483,647 |
| Set_SpeedReference | REAL | Tag | The first (high) speed reference. Units are 0.1 rpm for rotary motors. Range: 1…20,000 |
| Set_HomeReturnSpeed | REAL | Tag | The second (low) speed reference. Units are 0.1 rpm for rotary motors. Range: 1…5000 |
| Set_AccelReference | REAL | Tag | Units are 0.1 rpm/s for rotary motors. Range: 458…30,000,000 |
| Set_DecelReference | REAL | Tag | Units are 0.1 rpm/s for rotary motor. Range: 458…30,000,000 |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and the message transaction to Home is initiated and in process. It remains high until the rung-in condition is false and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to Home the drive (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |
| Sts_IP (In Process) | This bit is set when the rung makes a false-to-true transition, the Home message transaction is successful, and the homing begins. This bit remains set if the homing is executing. |
| Sts_PC(Process Complete) | This bit is set when the rung makes a false-to-true transition and the Homing Sequence is completed. Once homing is successfully completed, the CtrlSts.Homed bit = 1. |

*Error Codes*

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - raC_*xxx*_K5100_MSF is running
- 105 - Drive is disabled
- 107 - raC_*xxx*_K5100_MAS is executing
- 108 - Other motion Add-On Instruction is sending the command
- 111 - SpeedReference is out of range
- 112 - AccelReference is out of range
- 113 - DecelReference is out of range
- 122 - HomingMethod is out of range
- 127 - Previous command has not completed
- 129 - Motor is not connected

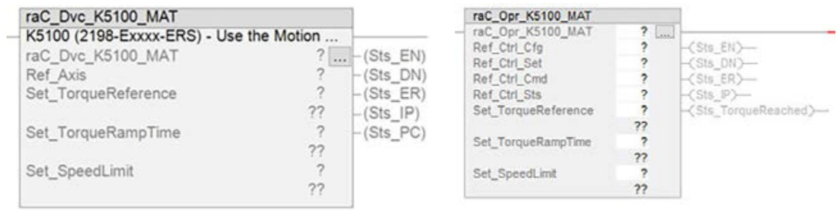
See Error Codes on page 513 for details.

You can use the F1 key to view fault error codes.

## raC_*xxx*_K5100_MAT[1]

The Motion Axis Torque (raC_*xxx*_K5100_MAT) instruction lets you use torque limiting while a pre-defined speed is used to move the motor. The first time the pre-defined torque limit is reached, the Sts_TorqueReached bit is set. While the Sts_TorqueReached bit is set, the MAT operation remains active until it is terminated by an raC_*xxx*_K5100_MAS (Motion Axis Stop)/MSF (Motion Servo Off), or a drive fault. The torque and speed entries are bi-directional.

**Figure 272 - MAT Ladder Diagram**




*Operands*

| Operand | Type | Format | Description |
|---|---|---|---|
| Instance | raC_*xxx*_K5100_MAT | Tag | Unique instance of the MAT Add-On Instruction |
| Ref_Ctrl_Cfg | raC_UDT_Itf_PowerMotionSA_Cfg | Tag | Interface for Ctrl_Cfg of the Device Object |
| Ref_Ctrl_Set | raC_UDT_Itf_PowerMotionSA_Set | Tag | Interface for Ctrl_Set of the Device Object |
| Ref_Ctrl_Cmd | raC_UDT_Itf_PowerMotionSA_Cmd | Tag | Interface for Ctrl_Cmd of the Device Object |
| Ref_Ctrl_Sts | raC_UDT_Itf_PowerMotionSA_Sts | Tag | Interface for Ctrl_Sts of the Device Object |
| Set_TorqueReference | DINT | Immediate or Tag | The limited value of motor torque, in the unit of 0.1% of the motor rated torque. Range: -4000…+4000 |
| Set_TorqueRampTime | DINT | Immediate or Tag | Torque Ramp Time, the time (ms) it takes to ramp up from 0 to the TorqueReference. Range: 1…65500 |
| Set_Speedlimit | REAL | Immediate or Tag | Speed limit that is used during the constant torque operation: unit is 0.1 rpm for rotary motor. Range: -80,000…+80,000 |

| Mnemonic | Description |
|---|---|
| Sts_EN (Enable) | This bit is set when the rung makes a false-to-true transition and remains set as the message transaction to execute the MAT is initiated and in process. It remains high until the rung-in condition is false and no faults are active. |
| Sts_DN (Done) | This bit is set when the rung makes a false-to-true transition and the message transaction to the drive (Sts_EN) is complete. |
| Sts_ER (Error) | This bit is set when the rung makes a false-to-true transition and there is an error that has occurred with the instruction. (This instruction error can be a result of a fault on the drive itself). See Sts_ERR for details on the cause of the error. |
| Sts_IP (In Progress) | This bit is set when the rung makes a false-to-true transition, the MAT message transaction is successful, and the motor begins to move. This bit remains set while the MAT operation is active. |
| Sts_PC (Process Completed)/ Sts.TorqueReached | This bit is set when the rung makes a false-to-true transition, the Sts_IP is set, and the Set_TorqueReference value is reached. This bit is set (and remains set) on the first occurrence of this condition. |

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

*Error Codes*

- 100 - Kinetix 5100 drive is not ready
- 101 - Kinetix 5100 drive is faulted
- 103 - raC_*xxx*_K5100_MSF is executing
- 105 - Drive is disabled
- 107 - raC_*xxx*_K5100_MAS is executing
- 108 - Other motion Add-On Instruction is sending the command
- 111 - Speed limit is > 80000 or < -80000
- 116 - TorqueReference is out of range
- 125 - TorqueRampTime is out of range
- 127 - Previous command has not completed
- 129 - Motor is not connected

See Error Codes on page 513 for details.

You can use the F1 key to view fault error codes.

# Error Codes

Motion Error Codes (Sts_ERR) describes the error for Logix Designer. Table 158 lists the error codes for Logix Designer application motion instructions for the Kinetix 5100 drive.

You can use the F1 key to view fault error codes.

**Table 158 - Kinetix 5100 Drive Add-On Instruction Error Codes**

| Error Code | Description | Instruction Name[1] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MSO | MSF | MAFR | MAS | MAJ | MAT | MAI | MAM | MAH | MAG |
| 100 | Drive is not ready | X | X | X | X | X | X | X | X | X | X |
| 101 | Drive is faulted | X | X | X | X | X | X | X | X | X | X |
| 102 | raC_*xxx*_K5100_MSO is executing | X | | | | | | | | | |
| 103 | raC_*xxx*_K5100_MSF is executing | X | | | X | X | X | X | X | X | X |
| 104 | Another raC_*xxx*_K5100_MSF is executing | | X | | | | | | | | |
| 105 | Drive is disabled | | | | X | X | X | X | X | X | X |
| 106 | Another raC_*xxx*_K5100_MAFR message is executing | | | X | | | | | | | |
| 107 | raC_*xxx*_K5100_MAS is executing | | | | X | X | X | X | X | X | X |
| 108 | Another RA motion Add-On Instructions is sending the command | | | | | X | X | X | X | X | X |
| 111 | SpeedReference is out of range | | | | | X | | | X | X | |
| 112 | AccelReference is out of range | | | | | X | | | X | X | X |
| 113 | DecelReference is out of range | | | | X | X | | | X | X | |
| 115 | StartingIndex is higher than 99 | | | | | | | X | | | |
| 116 | Torque is out of range | | | | | | X | | | | |
| 117 | NonCyclicMoveType is higher than 3 | | | | | | | | X | | |
| 118 | CyclicMoveType is higher than 2 | | | | | | | | X | | |
| 119 | TravelMode is not either 2 or 10 | | | | | | | | X | | |
| 122 | HomingMethod is out of range | | | | | | | | | X | |
| 125 | TorqueRampTime is out of range | | | | | | X | | | | |
| 126 | Homing is not completed | | | | | | | | X | | |
| 127 | Previous command has not completed | | | | X | X | X | X | X | X | X |
| 129 | Motor is not connected | X | X | X | X | X | X | X | X | X | X |
| 131 | Gear slave counts is out of range | | | | | | | | | | X |
| 132 | Gear master count is out of range | | | | | | | | | | X |
| 133 | Gear ratio is out of range | | | | | | | | | | X |
| 140 | Operation is not supported when device is virtual | | | | X | X | X | X | X | X | X |
| 141 | Motor type not supported (Linear) | | | | X | X | X | X | X | X | X |

(1) The *xxx* in the name can be Dvc (legacy applications) or Opr (new applications).

# Notes:

# Full Closed Loop Control

| Topic | Page |
|---|---|
| Full Closed-loop Control | 516 |

The full closed (dual)-loop control can be useful when compliance or slip exists between the motor and the load. A second encoder is used to close the position loop. This encoder is located at the load side where accurate positioning is required.

The full closed-loop control function is used to reduce the position error/offset and improve the positioning accuracy at the load, since the load feedback device is typically located on the load side of the mechanism.

**IMPORTANT** This function applies to PT, PR, and IO operation modes.

**Figure 273 - Wiring Diagram**

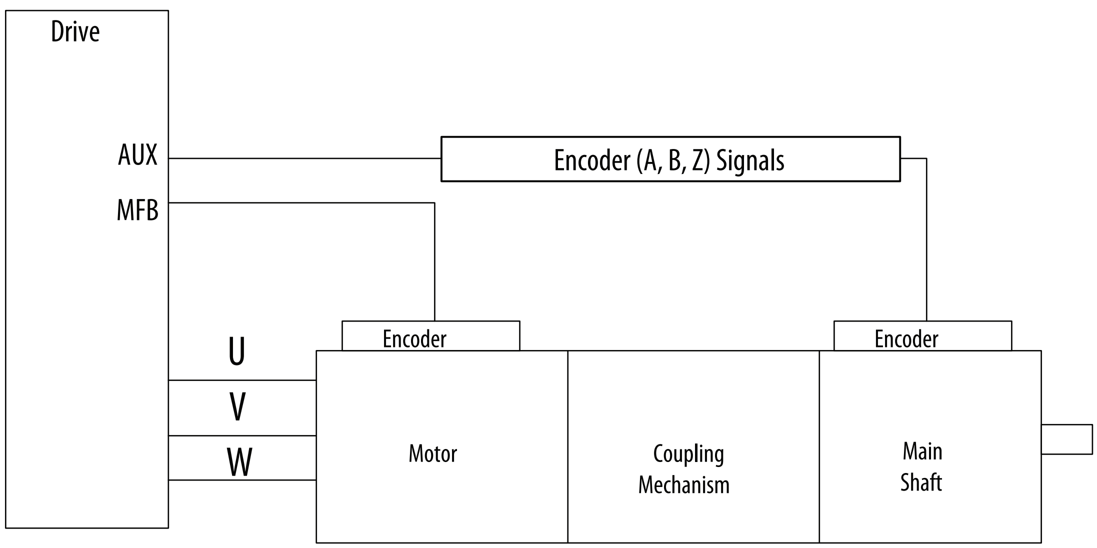
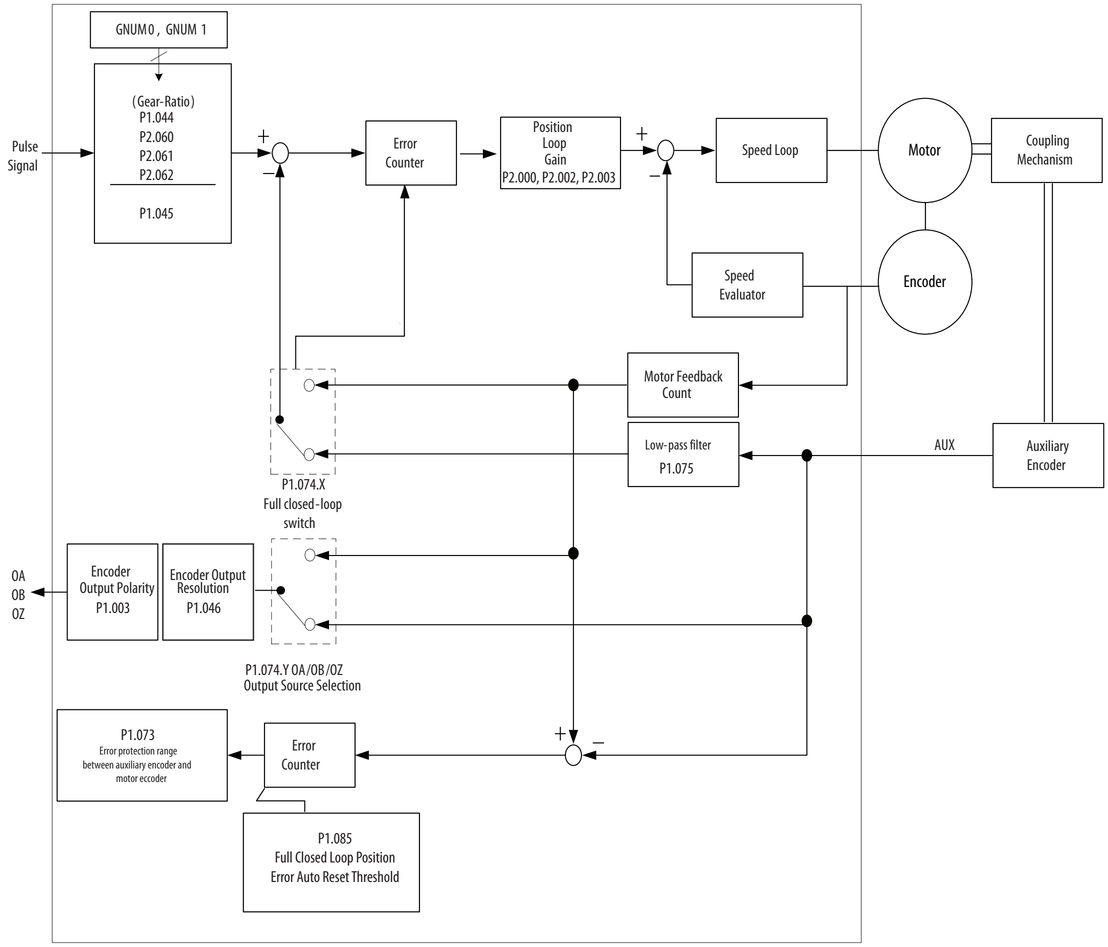


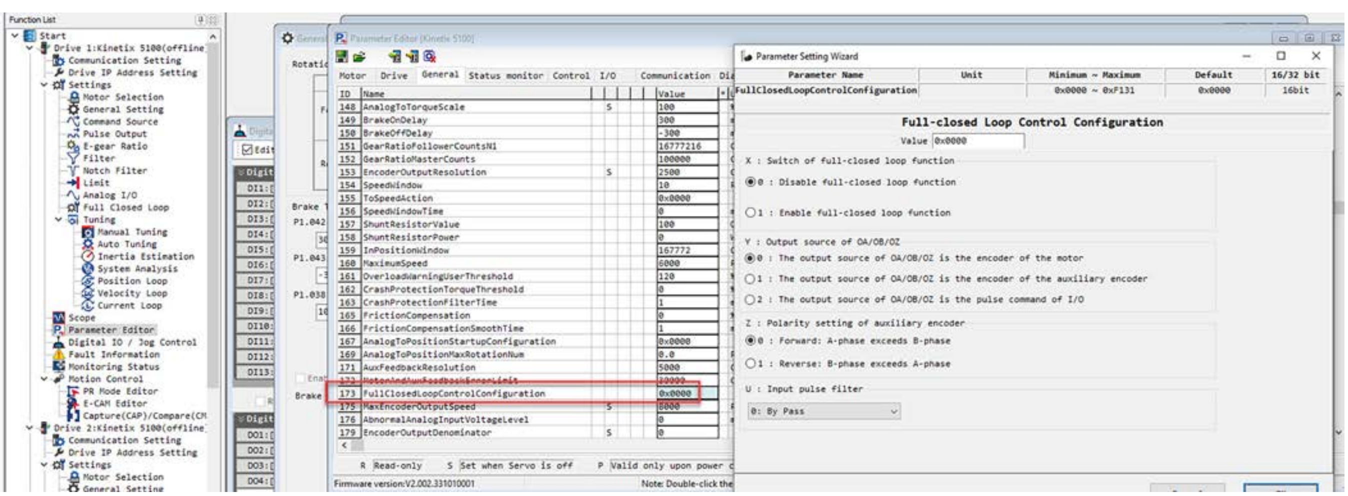
Figure 274 - Control Structure




## Full Closed-loop Control

To execute the full closed-loop control, follow these steps.

1. Connect auxiliary encoder (OA, OB, OZ) to the AUX port.




2. Use KNX5100C software Function List>Parameter Editor>General to Enable full-closed loop function (x=1).
3. Choose the source of the encoder output.
4. Configure the auxiliary encoder resolution ID171 (P1.072) AuxFeedbackResolution.

5. Set the appropriate gear ratio ID151 (P1.044), ID152 (P1.045).
6. Configure the error protection range between auxiliary encoder and motor encoder ID172 (P1.073) MotorAndAuxFeedbackErrorLimit.

   When commissioning, set (ID172 (P1.073)) with a smaller value to avoid the motor runaway due to auxiliary encoder disconnection or polarity configuration issue.
7. Configure Low-pass filter time constant ID174 (P1.075) FullHalfClosedLoopLowPassFilterTime.
8. Configure the error auto-reset condition ID677 (P1.085) FullClosedLoopPositionErrorAutoResetThreshold.
9. Configure encoder output parameters, if necessary ID119 (P1.003.Y), ID173 (P1.074.Y), ID153 (P1.046), ID175 (P1.076), ID179 (P1.097)).
10. Start full closed-loop control function ID173 (P1.074.X) FullClosedLoopControlConfiguration.

# Notes:

# Appendix E

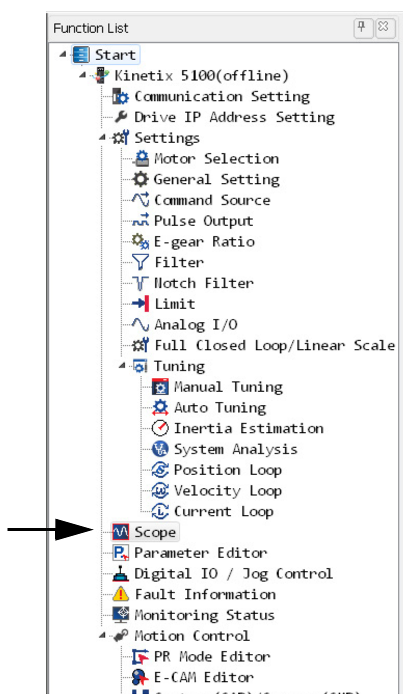
# Use the Scope Function in KNX5100C Software



The Scope option provides you with a personal computer-based digital oscilloscope function for real-time drive data monitoring. You can use two scope modes (8K and 16K) to measure and monitor many signals quickly without oscilloscope equipment.

## Get Started

To open the Scope dialog box, select Scope from the Function list.



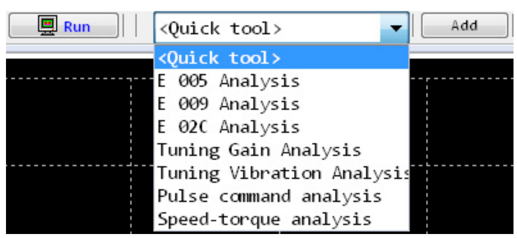
## Scope Functions

To execute Scope functions, click icons on the toolbar.


- Save File (*.scp): Save the waveform displays on the screen as a scope file (*.scp) or other files in several kinds of format.
- Open File (*.scp): Open and read the scope file (*.scp) and display the waveform displays on the screen.
- Show all channels with same scaling: Display the channel data with the same scaling/axis on the screen.
- Show all channels with different scaling: Display the channel data with different scaling/axis on the screen.
- Zoom in (F5). Zoom in to the waveform displays on the current screen.
- Zoom out (F6). Zoom out of the waveform displays on the current screen.
- Previous screen (F7). Display the previous screen.
- Optimize the current view: Optimize the display in the current screen.
- Clear Screen. Clear the waveform displays on the current screen.
- Screen second switch (20 <-> 120). It is used to select the data buffer (X-axis) that the screen can display one time. When selecting 20, it indicates that the screen can display 20 seconds of data buffer for one time.
- Run: start to execute the data logging against time.
- Quick tool: select the Quick Setup from the Quick tool template.
- Add: add the current channel setting to Quick tool template.
- Update: update the current channel setting to Quick tool template.
- Delete: delete the selected Quick Setup from Quick tool template.

## Quick Setup of Communication Channels

Use the pull-down menu to select monitor option from Quick tool template and do the quick setup of Communication Channels.




- E005 Analysis - Quick setup for E005 (Regeneration Error) Analysis.
- E009 Analysis - Quick setup for E009 (Excessive deviation of Position Command) Analysis.
- E02C Analysis - Quick setup for E02C (Drive Overload) Analysis.
- Tuning Gain Analysis - Quick setup for Gain Analysis.
- Tuning Vibration Analysis - Quick setup for Vibration Analysis.
- Pulse command analysis - Quick setup for Pulse command analysis.
- Speed-torque Analysis - Quick setup for Speed-torque Analysis.

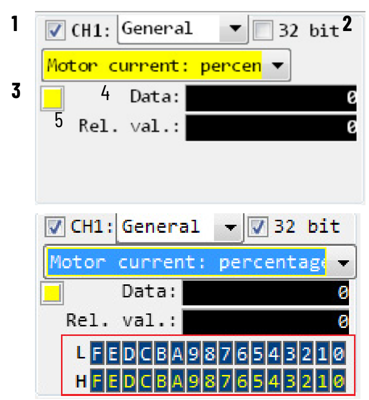
## Select Communication Channels

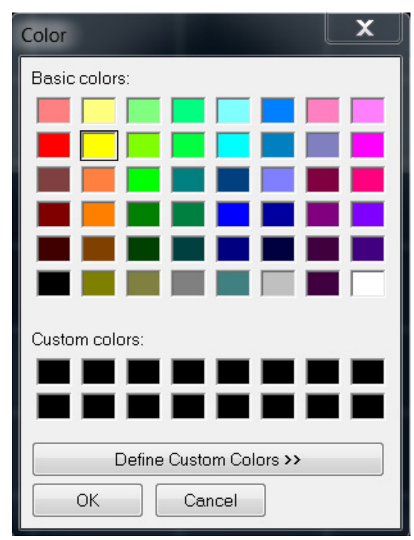
The scope speed determines the available channels. After you choose the communication speed, the system disables the unavailable channels automatically.

- CH (Channel) (1) - To display data on the screen, check the channel that you want to view.
- 32 bit (2) - This option is used to select the data length of the channel.
  - When the checkbox is checked, it indicates that it is a 32-bit data. At this time, two 16-bit data (the data of CH1 and CH3) is combined into a 32-bit data and CH3 is disabled. By the same logic, the data of CH2 and CH4 is combined into a 32-bit data channel and CH4 is disabled.
  - When the checkbox is not checked, it indicates it is 16-bit data. You can enable each channel.
- Color Selection (3) - You can choose the channel display color by preference. When you click, a color selection dialog box appears and you can choose your favorite color.
- Data (4) - If there is data on the screen, when you move your mouse over the data, the current data value of the point where the mouse is located is shown.

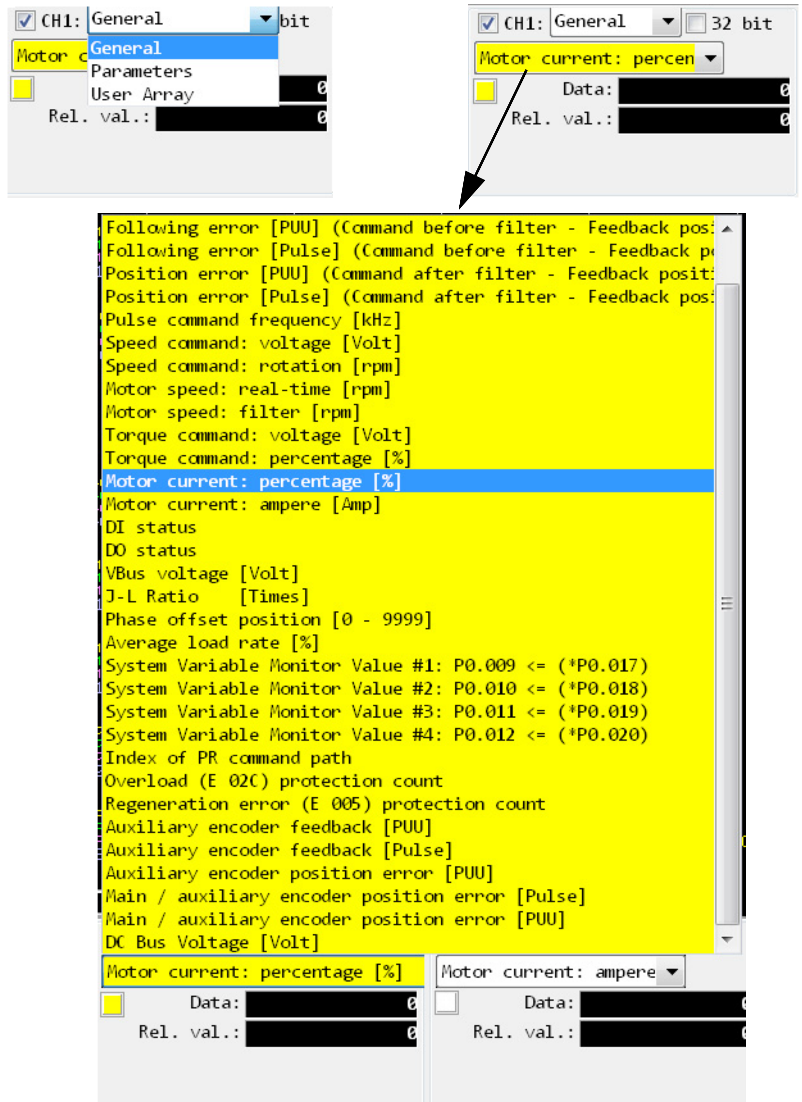
Double click the Data field to display the data with BIT or HEX format.

- Relative Value (Rel. val.) (5) - If there is data on the screen, when you move your mouse over the data, the data value relative to the value of the starting point is shown.

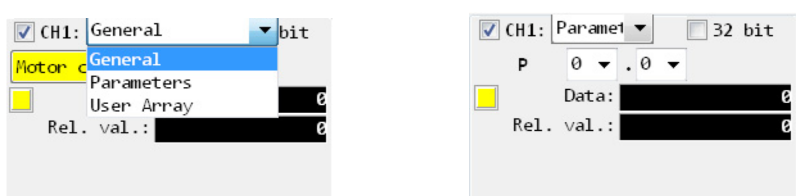


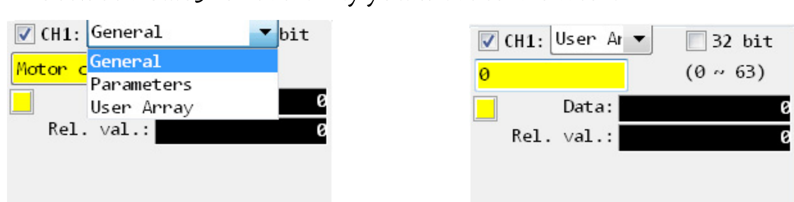
- General - From the pull-down menu, choose General. The General setting lets you choose what to monitor.



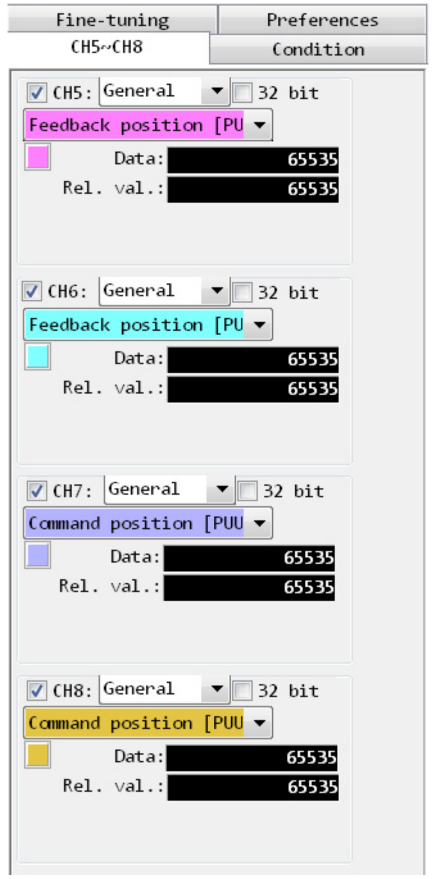

- Parameters - From the pull-down menu, choose Parameters.




- User Array - From the pull-down menu, choose User Array. Set the array between 0…63 for the array you want to monitor.

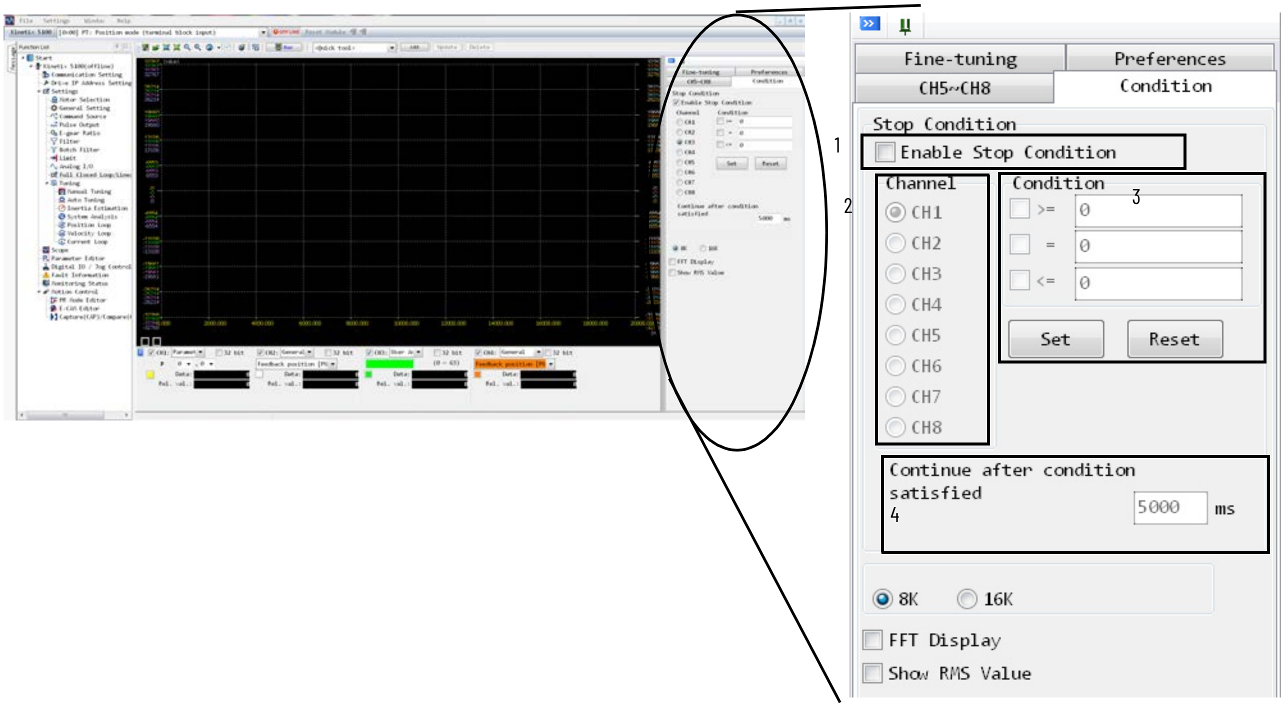


- CH 5…8: This function is only available for 8K baud-rate enabled. You can observe all eight channels of data. Channels 5…8 function the same as Channels 1…4.



## Enable Stop Condition

When Enable Stop Condition option is selected, after Run is pressed, you can select one channel and stop its monitoring operation after a period.



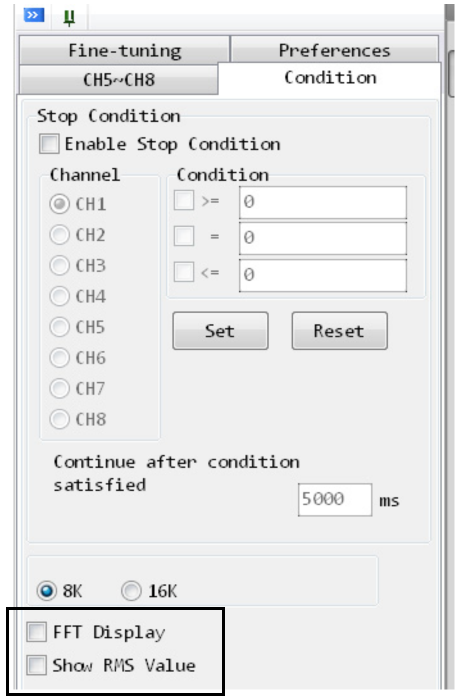

1. Check Enable Stop Condition.
2. Select the channel.
3. Select the logical condition (>=, =, and <=), add a value that determines the threshold for when the monitoring operation is to stop, and click Set.
4. Add a value for 'Continue after condition satisfied'.

   This option is used to set the time (lasting time) for which the digital scope collects data after the stop conditions are met.

   For example, select CH2, select '=' and set the value to 1000, then set the continue time to 2000 ms. Once the value reaches 1000, data is collected for another 2000 ms.

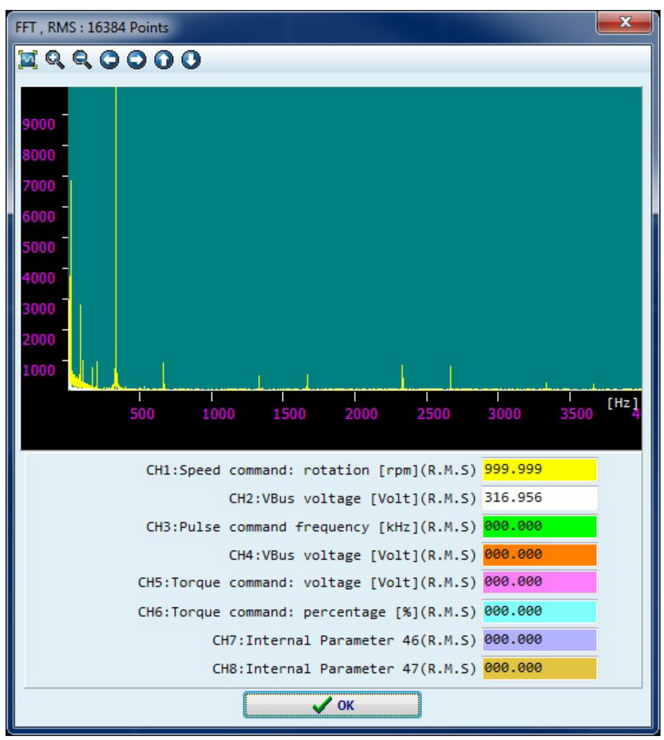
## FFT Display and Show RMS Value

This option is used to display the frequency spectrum of the waveforms. From the Condition tab, you can select FFT Display and Show RMS Value.




When you check FFT Display, use the zoom in/zoom out tools or use the mouse to drag a rectangle area and drop it on the screen to display the frequency spectrum of the waveforms.

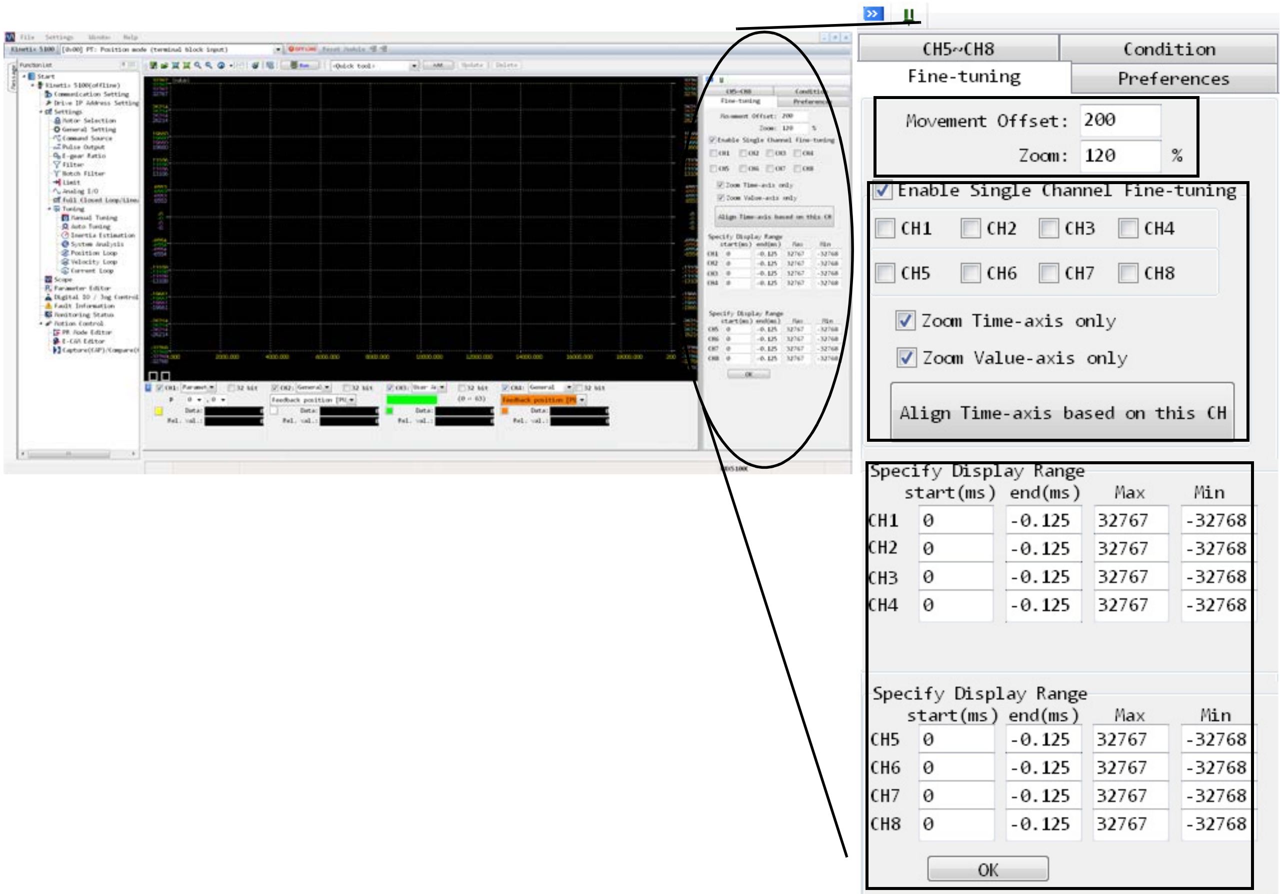
When you check Show RMS Value, the RMS value of each channel is also displayed.



- The X-axis represents the frequency and the unit is Hz.
- The Y-axis represents the strength of the signal, which has no absolute unit but is a relative value.
- The icons on the FFT Display toolbar function the same as the icons on the Scope toolbar.
- Double-click any point of the FFT Display screen and all points display.
- You can also use the mouse to drag a rectangle and drop it on the screen to display the frequency spectrum of the waveforms.
- The title bar of FFT Display window, such as FFT: 32768 Pts, indicates the data number of the selected area. The larger the number, the better the resolution (DPI™). We recommended a value of at least 512 or higher.
- The image of the FFT Display screen can also be saved as a picture (*.bmp file). Place the cursor on the FFT Display screen, right-click the mouse, and choose 'Save as picture (*.bmp)'.

## Fine-Tune the Scope

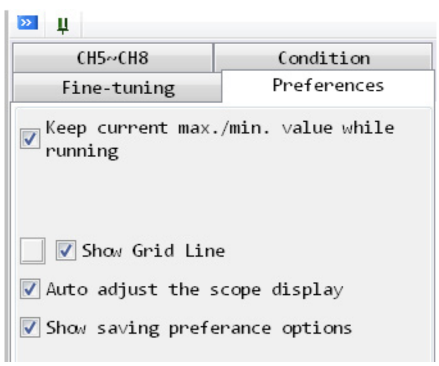
When the other functions cannot meet your requirements, you can enable the Fine-Tuning function.



- When the Enable Single Channel checkbox is checked, it indicates that Fine-Tuning function is enabled.
- When the Channel checkboxes are checked, only the waveform displays of the selected channels can be zoomed in/out and moved.
- When all Channel checkboxes are checked, the waveform displays of all channels can be zoomed in/out and moved.
- Zoom Time-axis only - If this option is not selected, the values of Time axis do not change when you zoom in/out and move the waveform displays.
- Zoom Value-axis only - If this option is not selected, the values of Value axis do not change when you zoom in/out and move the waveform displays.
- Align Time axis based on this CH - When this button is clicked, the system changes the time of other channels and make it the same as the time of the selected channel.
- Specify Display Range - The start and end values are the start and end points of the data. To convert these values into time, multiply by the time unit. For example:
  - Time unit is 0.125 ms
  - Start point is 100, therefore, 100 * 0.125 = 12.5 ms
  - Endpoint is 2000, therefore 2000 * 0.125 = 250 ms

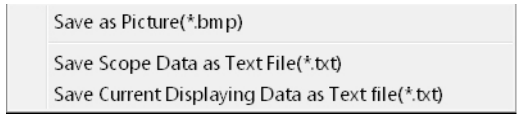
## Set Preferences

- Keep current Max/Min while running - The scope remains the current Max/Min value after the user pressing RUN if this setting is checked. The system uses the default Max/Min value if this option is not checked.
- Show Grid Line - The scope screen shows the grid line when selecting this option. The square button on left is to select the color of the grid line.
- Auto adjust the scope display - The system adjusts the size of scope automatically according to screen resolution and selected condition.
- Show saving preference options - The options that appear when you right-click on the screen.



## Use Popup Menu for Save Options

When you right-click the mouse on the screen, the following popup menu appears.




- Save as a picture(*.bmp) Save the signal data as a picture (*.bmp file).
- Save Scope Data as Text File (*.txt) Save all signal data as a text file (*.txt file).
- Save Data of Current Display as Text (*.txt) Save the signal data on the current display as a text file (*.txt file).

# History of Changes

This appendix contains the new or updated information for each revision of this publication. These lists include substantive updates only and are not intended to reflect all changes. Translated versions are not always available for each revision.

## 2198-UM004B-EN-P, November 2020

| Change |
|---|
| Added 400V-class drive information. |
| Added drive compatibility with Kinetix TL/TLY (200V-class) servo motors. |
| Added Table 96 Kinetix 5100 Output Assembly Data (Instance 106). |
| Added Table 98 CAM Parameters. |
| Added Figure 86 CAM Execution. |
| Added I/O Mode - CAM section. |
| Added Message Service - Get/Set Chunk data to the Data Array section. |
| Added power wiring examples. |
| Added Add-On Instruction information for raC_Dvc_K5100_MAPC. |
| Added Automatic Device Configuration appendix. |

# Notes:

## Numerics



## A



## B



## C

## S



## T



## U



## W

# Notes:

## Rockwell Automation Support

Use these resources to access support information.

| | | |
|---|---|---|
| **Technical Support Center** | Find help with how-to videos, FAQs, chat, user forums, and product notification updates. | rok.auto/support |
| **Knowledgebase** | Access Knowledgebase articles. | rok.auto/knowledgebase |
| **Local Technical Support Phone Numbers** | Locate the telephone number for your country. | rok.auto/phonesupport |
| **Literature Library** | Find installation instructions, manuals, brochures, and technical data publications. | rok.auto/literature |
| **Product Compatibility and Download Center (PCDC)** | Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes. | rok.auto/pcdc |

## Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

## Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental information on its website at rok.auto/pec.



Publication 2198-UM004C-EN-P - August 2021
Supersedes Publication 2198-UM004B-EN-P - November 2020