SMART Motor™

EtherNet/IP Guide

Class 6 SmartMotor Technology

MOOG ANIMATICS

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Moog Animatics Class 6 SmartMotor™ EtherNet/IP Guide, Rev. C, SC80100010-001.

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Introduction

This chapter provides information on the purpose and scope of this manual. It also provides information on safety notation, related documents and additional resources.

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Purpose

This manual explains the Moog Animatics Class 6 SmartMotor™ support for the EtherNet/IP™ protocol. It describes the major concepts that must be understood to integrate a SmartMotor slave with a PLC or other EtherNet/IP master. However, it does not cover all the low-level details of the EtherNet/IP protocol.

> **NOTE:** The feature set described in this manual requires a specific motor firmware version. Please consult Moog Animatics for the proper software version.

This manual is intended for programmers or system developers who have read and understand *THE CIP NETWORKS LIBRARY Volume 1 - Common Industrial Protocol (CIP™)* and *THE CIP NETWORKS LIBRARY Volume 2 - EtherNet/IP Adaptation of CIP*, which are published and maintained by ODVA.org (http://www.odva.org). Therefore, this manual is not a tutorial on those specifications or the EtherNet/IP protocol. Instead, it should be used to understand the specific implementation details for the Moog Animatics SmartMotor. For a general overview of EtherNet/IP, see EtherNet/IP Overview on page 17.

The reference chapters of this manual include details about the specific commands available in the SmartMotor through the EtherNet/IP protocol. The commands include those required by the specifications and those added by Moog Animatics.

Combitronic Technology

The most unique feature of the SmartMotor is its ability to communicate with other SmartMotors and share resources using Moog Animatics' Combitronic™ technology. On the Class 6 SmartMotor, Combitronic is a protocol that operates over Ethernet and coexists with the EtherNet/IP protocol. It requires no single dedicated master to operate. Each SmartMotor connected to the same network communicates on an equal footing, sharing all information, and therefore, sharing all processing resources.

For details on Combitronic addressing over Ethernet, see Combitronic Addressing over Ethernet (UDP) on page 41. For more information on Combitronic communications, see the *SmartMotor Developer's Guide*.

Abbreviations and Definitions

The following table provides a list of abbreviations and definitions of terms that may be used in this manual or related documents.

Abbreviation/ Term	Description
API	Actual Packet Interval
ASCII	American Standard Code for Information Interchange
AT	Acceleration Target
BOI	Buss-Off Interrupt
Client	A device that sends a request to, and expects a response from, a server.
Consumer	Network device that reads messages from a producer device.
CoS	Change of State I/O trigger
DC	Direct Current
DLR	Device Level Ring. A ring topology that allows the Ethernet devices to keep communicating if there is a break in the ring.
DT	Deceleration Target
EDS	Electronic Data Sheet. A text file that contains configuration information for the device.
EPR	Expected Packet Rate
EtherNet/IP	Ethernet Industrial Protocol
Explicit messaging	(Non-cyclic) Not time-sensitive, typically used for network and device configuration, and setup of cyclic connections.
FOC	Field Oriented Current
FTP	File Transfer Protocol
IE	Industrial Ethernet
Implicit messaging	(Cyclic) Timely, repetitive transfer of data, typically used for I/O control (e.g., PID loop closure).
IN	Input
LAN	Local Area Network
MACID	Media Access Control Identifier
NASM	Network Access State Machine
ODVA	Open DeviceNet Vendors Association, Inc, which is the standards organization that maintains the specifications for the CIP industrial network protocols.
OUT	Output
PDU	Protocol Data Unit
PLC	Programmable Logic Controller

Abbreviation/ Term	Description
Producer	A device that puts messages on the network for "consumer" devices (other network devices that will read the messages).
PU	Position Units
PV	Profile Velocity (mode)
PT	Position Target
RTE	Real-Time Ethernet
Rx	Receive
Server	A device that receives requests from clients and sends responses to them.
Slave device	Device consuming data transfers from a Network Master. A PLC (Programmable Logic Controller) is a good example of a Master.
SMI	SmartMotor Interface (software)
STD	State Transition Diagram
TCP	Transmission Control Protocol
TQ	Torque (mode)
Tx	Transmit
UDP	User Datagram Protocol
UCMM	Unconnected Message Manager
VU	Velocity Units
VT	Velocity Target

Safety Information

This section describes the safety symbols and other safety information.

Safety Symbols

The manual may use one or more of the following safety symbols:

⚠	**WARNING:** This symbol indicates a potentially nonlethal mechanical hazard, where failure to follow the instructions could result in serious injury to the operator or major damage to the equipment.

⚠	**CAUTION:** This symbol indicates a potentially minor hazard, where failure to follow the instructions could result in slight injury to the operator or minor damage to the equipment.

NOTE: Notes are used to emphasize non-safety concepts or related information.

Other Safety Considerations

The Moog Animatics SmartMotors are supplied as components that are intended for use in an automated machine or system. As such, it is beyond the scope of this manual to attempt to cover all the safety standards and considerations that are part of the overall machine/system design and manufacturing safety. Therefore, the following information is intended to be used only as a general guideline for the machine/system designer.

It is the responsibility of the machine/system designer to perform a thorough "Risk Assessment" and to ensure that the machine/system and its safeguards comply with the safety standards specified by the governing authority (for example, ISO, OSHA, UL, etc.) for the locale where the machine is being installed and operated. For more details, see Machine Safety on page 13.

Motor Sizing

It is the responsibility of the machine/system designer to select SmartMotors that are properly sized for the specific application. Undersized motors may: perform poorly, cause excessive downtime or cause unsafe operating conditions by not being able to handle the loads placed on them. The *System Best Practices* document, which is available on the Moog Animatics website, contains information and equations that can be used for selecting the appropriate motor for the application.

Replacement motors must have the same specifications and firmware version used in the approved and validated system. Specification changes or firmware upgrades require the approval of the system designer and may require another Risk Assessment.

Environmental Considerations

It is the responsibility of the machine/system designer to evaluate the intended operating environment for dust, high-humidity or presence of water (for example, a food-processing environment that requires water or steam wash down of equipment), corrosives or chemicals that may come in contact with the machine, etc. Moog Animatics manufactures specialized

IP-rated motors for operating in extreme conditions. For details, see the *Moog Animatics Product Catalog*, which is available on the Moog Animatics website.

Machine Safety

In order to protect personnel from any safety hazards in the machine or system, the machine/system builder must perform a "Risk Assessment", which is often based on the ISO 13849 standard. The design/implementation of barriers, emergency stop (E-stop) mechanisms and other safeguards will be driven by the Risk Assessment and the safety standards specified by the governing authority (for example, ISO, OSHA, UL, etc.) for the locale where the machine is being installed and operated. The methodology and details of such an assessment are beyond the scope of this manual. However, there are various sources of Risk Assessment information available in print and on the internet.

> **NOTE:** The following list is an example of items that would be evaluated when performing the Risk Assessment. Additional items may be required. The safeguards must ensure the safety of all personnel who may come in contact with or be in the vicinity of the machine.

In general, the machine/system safeguards must:

- Provide a barrier to prevent unauthorized entry or access to the machine or system. The barrier must be designed so that personnel cannot reach into any identified danger zones.
- Position the control panel so that it is outside the barrier area but located for an unrestricted view of the moving mechanism. The control panel must include an E-stop mechanism. Buttons that start the machine must be protected from accidental activation.
- Provide E-stop mechanisms located at the control panel and at other points around the perimeter of the barrier that will stop all machine movement when tripped.
- Provide appropriate sensors and interlocks on gates or other points of entry into the protected zone that will stop all machine movement when tripped.
- Ensure that if a portable control/programming device is supplied (for example, a hand-held operator/programmer pendant), the device is equipped with an E-stop mechanism.

  > **NOTE:** A portable operation/programming device requires *many* additional system design considerations and safeguards beyond those listed in this section. For details, see the safety standards specified by the governing authority (for example, ISO, OSHA, UL, etc.) for the locale where the machine is being installed and operated.

- Prevent contact with moving mechanisms (for example, arms, gears, belts, pulleys, tooling, etc.).
- Prevent contact with a part that is thrown from the machine tooling or other part-handling equipment.
- Prevent contact with any electrical, hydraulic, pneumatic, thermal, chemical or other hazards that may be present at the machine.
- Prevent unauthorized access to wiring and power-supply cabinets, electrical boxes, etc.

- Provide a proper control system, program logic and error checking to ensure the safety of all personnel and equipment (for example, to prevent a run-away condition). The control system must be designed so that it does not automatically restart the machine/system after a power failure.
- Prevent unauthorized access or changes to the control system or software.

Documentation and Training

It is the responsibility of the machine/system designer to provide documentation on safety, operation, maintenance and programming, along with training for all machine operators, maintenance technicians, programmers, and other personnel who may have access to the machine. This documentation must include proper lockout/tagout procedures for maintenance and programming operations.

It is the responsibility of the operating company to ensure that:

- All operators, maintenance technicians, programmers and other personnel are tested and qualified before acquiring access to the machine or system.
- The above personnel perform their assigned functions in a responsible and safe manner to comply with the procedures in the supplied documentation and the company safety practices.
- The equipment is maintained as described in the documentation and training supplied by the machine/system designer.

Additional Equipment and Considerations

The Risk Assessment and the operating company's standard safety policies will dictate the need for additional equipment. In general, it is the responsibility of the operating company to ensure that:

- Unauthorized access to the machine is prevented at all times.
- The personnel are supplied with the proper equipment for the environment and their job functions, which may include: safety glasses, hearing protection, safety footwear, smocks or aprons, gloves, hard hats and other protective gear.
- The work area is equipped with proper safety equipment such as first aid equipment, fire suppression equipment, emergency eye wash and full-body wash stations, etc.
- There are no modifications made to the machine or system without proper engineering evaluation for design, safety, reliability, etc., and a Risk Assessment.

Safety Information Resources

Additional SmartMotor safety information can be found on the Moog Animatics website; open the file "109_Controls, Warnings and Cautions.pdf" located at:

http://www.animatics.com/support/moog-animatics-catalog.html

OSHA standards information can be found at:

https://www.osha.gov/law-regs.html

ANSI-RIA robotic safety information can be found at:

http://www.robotics.org/robotic-content.cfm/Robotics/Safety-Compliance/id/23

UL standards information can be found at:

http://ulstandards.ul.com/standards-catalog/

ISO standards information can be found at:

http://www.iso.org/iso/home/standards.htm

EU standards information can be found at:

http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/index_en.htm

Additional Documents

The Moog Animatics website contains additional documents that are related to the information in this manual. Please refer to the following list.

Related Guides

- *Class 6 SmartMotor™ Installation & Startup Guide*

  http://www.animatics.com/cl-6-install-startup-guide

- *SmartMotor™ Developer's Guide*

  http://www.animatics.com/smartmotor-developers-guide

- *SmartMotor™ System Best Practices*

  http://www.animatics.com/system-best-practices-application-note

Other Documents

- *SmartMotor™ Product Certificate of Conformance*

  http://www.animatics.com/download/Declaration of Conformity.pdf

- *SmartMotor™ UL Certification*

  http://www.animatics.com/download/MA_UL_online_listing.pdf

- *SmartMotor Developer's Worksheet*
  (interactive tools to assist developer: Scale Factor Calculator, Status Words, CAN Port Status, Serial Port Status, RMODE Decoder and Syntax Error Codes)

  http://www.animatics.com/tools

- *Moog Animatics Product Catalog*, which is available on the Moog Animatics website

  http://www.animatics.com/support/moog-animatics-catalog.html

Additional Resources

The Moog Animatics website contains useful resources such as product information, documentation, product support and more. Please refer to the following addresses:

- General company information:

  http://www.animatics.com

- Product information:

  http://www.animatics.com/products.html

- Product support (Downloads, How To videos, Forums, Knowledge Base, and FAQs):

  http://www.animatics.com/support.html

- Sales and distributor information:

  http://www.animatics.com/sales-offices.html

- Application ideas (including videos and sample programs):

  http://www.animatics.com/applications.html

ODVA Resources

EtherNet/IP is a common standard maintained by ODVA.org:

- ODVA.org website:

  http://www.odva.org/

- An EtherNet/IP Quick Start for Vendors Handbook is available at:

  http://www.odva.org/Portals/0/Library/Publications_Numbered/PUB00213R0_EtherNetIP_Developers_Guide.pdf

EtherNet/IP Overview

This chapter provides an overview of EtherNet/IP features. These sections briefly summarize the technical information provided on the ODVA.org website. To view the fully detailed information or to obtain the specifications, see the ODVA.org website at: http://www.odva.org.

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EtherNet/IP Introduction

Ethernet/Industrial Protocol (EtherNet/IP) is a fieldbus communications protocol that was initially developed in the 1990s. It is now a CIP-based technology that is managed by the Open DeviceNet Vendors Association (ODVA), which is a standards organization that manages all CIP network technologies.

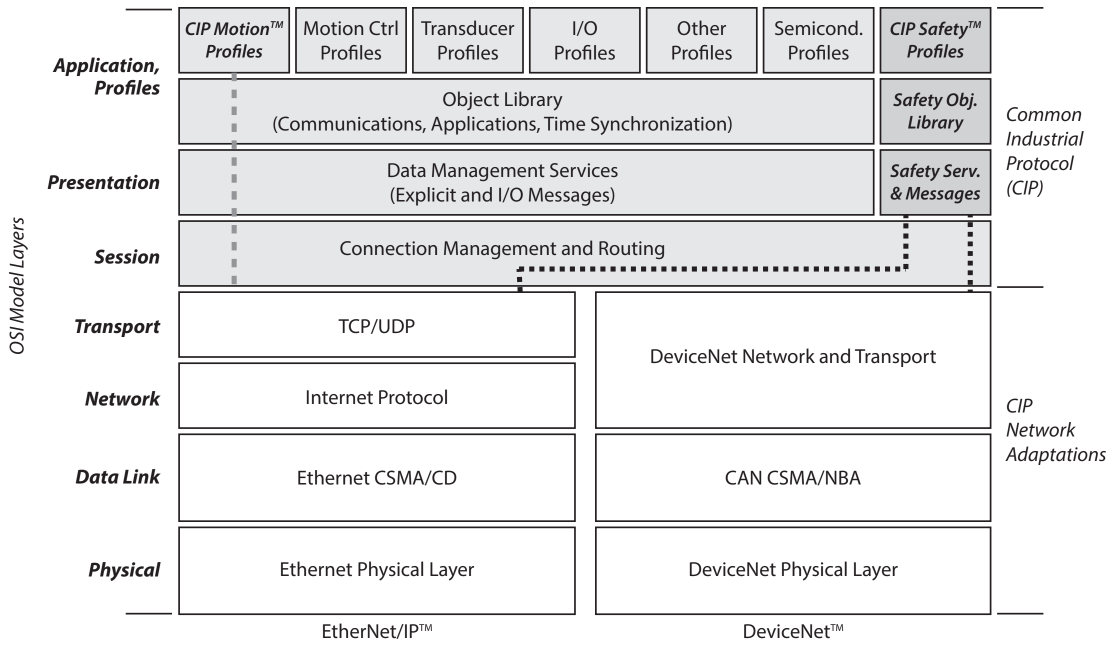
EtherNet/IP and DeviceNet are two CIP network technologies that are supported by Moog Animatics (see OSI Model for EtherNet/IP and DeviceNet on page 18). These networks share the same CIP layers and use objects to describe the network devices (this collection of objects specific to a device is the device profile). Because of this, they are able to communicate with each other. For example, a device on an EtherNet/IP network can communicate with one on a DeviceNet network. For more information on CIP objects, see Objects on page 21.

The Class 6 EtherNet/IP SmartMotor is designed to operate as a device on an EtherNet/IP network. This allows the system designer to take advantage of SmartMotor technology through its device profile (for example, start a user program stored in the SmartMotor). For details on the SmartMotor device profile using the Position Controller device, see SmartMotor Device Profile Overview on page 31.

The full specification for EtherNet/IP is available from the ODVA.org website. For details, see *THE CIP NETWORKS LIBRARY Volume 1 - Common Industrial Protocol (CIP™)* and *THE CIP NETWORKS LIBRARY Volume 2 - EtherNet/IP Adaptation of CIP*.

The OSI Model

The OSI model describes the architecture for the CIP-based industrial network protocols. Moog Animatics supports EtherNet/IP and DeviceNet using the Position Controller Supervisor and Position Controller profiles. The other profiles shown are not currently supported.



OSI Model for EtherNet/IP and DeviceNet

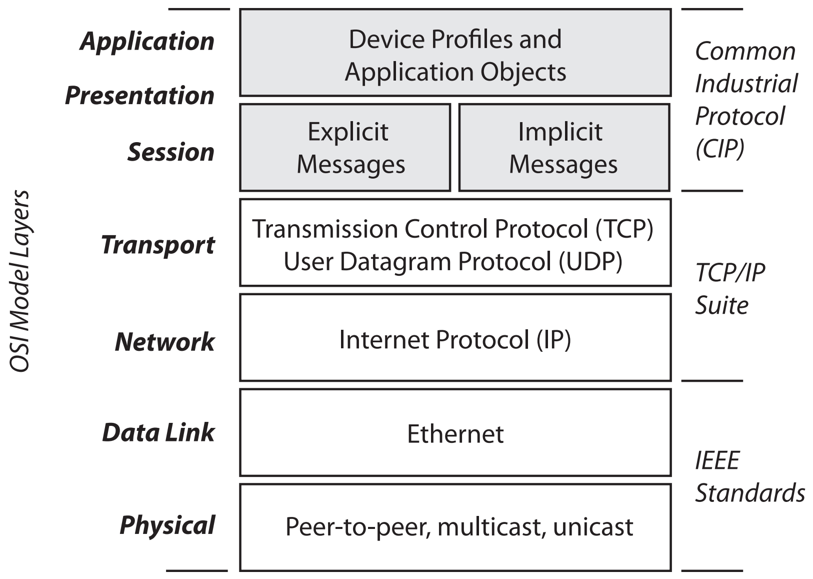
The following table provides a brief description of each of the seven OSI model layer.

Layer	Description
Physical	The physical properties—electrical and mechanical—of the network (e.g., cables, connectors, pin-outs, voltages, flow control, etc.). For EtherNet/IP, it is based on IEEE 802.3 technology.
Data Link	How packets of data will be transmitted between devices (MAC, CRC, etc.). For EtherNet/IP, it is based on IEEE 802.3 technology.
Network	The switching and routing layer, i.e, anything related to the device IP address, DNS, datagrams, cyclic and non-cyclic. For EtherNet/IP, uses the TCP/IP Suite.
Transport	Controls how much data (size of block) that will be sent and received, manages the delay time between messages, maintains the quality of service (QoS). For EtherNet/IP, uses the TCP/IP Suite, uses both TCP and UDP.
Session	Opens/closes and manages the connection between devices and applications, explicit and implicit messages are used. This layer is part of CIP.
Presentation	Delivers and formats information to/from the application layer (translates data from the network to the application or from the application to the network). This layer is part of CIP.
Application	Handles the application that provides the user interaction. This layer is part of CIP.

For more details, see the ODVA.org website.

EtherNet/IP Adaptation of CIP

EtherNet/IP is an implementation of Ethernet technology with the addition of CIP layers. Like other ODVA industrial network protocols, it is based on the OSI model. Therefore, it is specifically tailored for industrial environments and applications. Refer to the following figure.



OSI Model: EtherNet/IP Implementation

As shown in the previous figure, EtherNet/IP uses two communication protocols for message transport:

- Transmission Control Protocol (TCP) is used for Explicit messages—these are non-cyclic messages for device configuration and setup of cyclic connection content.
- User Datagram Protocol (UDP) is used for Implicit (I/O) messages—these are cyclic messages that handle time-critical control data.

  For more details on messages, see Messaging on page 23. Also, see Position Controller Implicit I/O Messages on page 46.

EtherNet/IP is designed to be reliable, easily expanded for future growth, and can theoretically handle an unlimited number of devices. Note, however, that there may be other factors that impose limitations on the size of the network.

For more details, see the ODVA.org website.

Objects

This section briefly describes the features of CIP device objects. For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

Objects

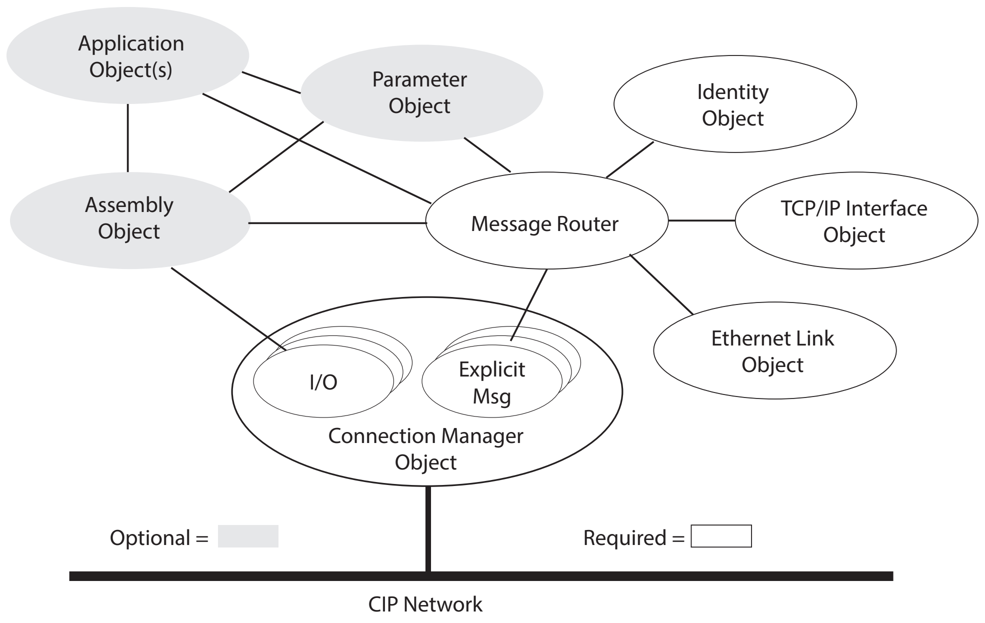
Because EtherNet/IP is a CIP-based network, the network devices are described through sets of objects. Each set of objects is organized in a specific manner with specific attributes so that each network device operates in a certain way—that organization is the object model (or device model). Every device with the same object model will operate in the same manner.

> **NOTE:** All device features must be described through objects in order to be accessible through CIP.

The following types of objects are used in a device profile:

- Required objects: these must be present in every CIP device.
- Application objects: these are specific to the type of device and its function.
- Manufacturer-Specific objects: these are optional objects that are specific to each device manufacturer.

The following figure shows a version of the EtherNet/IP object model with required and optional objects.



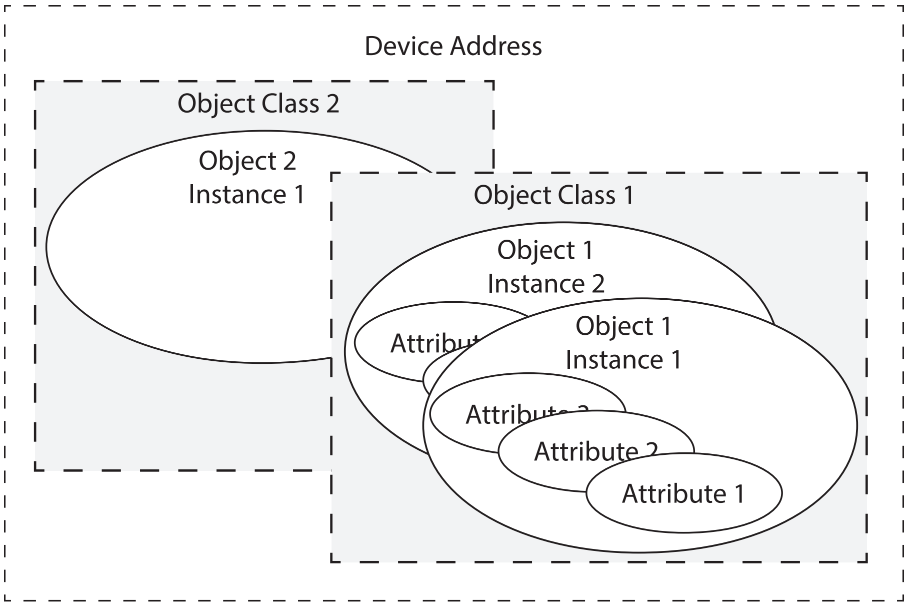
EtherNet/IP Object Model

For the SmartMotor-specific model, see the object model for your SmartMotor application, which is described later in this guide.

Classes, Instances and Attributes

The CIP object model uses classes, instances and attributes to describe each device. Refer to the following figure.

- Class: a fixed collection of objects with each object having a fixed set of attributes. The CIP object library contains three primary object classes: general use, application specific, and network specific.
- Instance: an occurrence of a particular object (in other words, there can be more than one occurrence of the same object but with different attribute values).
- Attributes: a set of data values that describe an object instance (instance attributes). They can also describe an object class (class attributes).



Classes, Instances, Attributes

The device description (class, instance, attributes) information is also contained in the Electronic Data Sheet (EDS) file, which is supplied by the equipment vendor (see EDS File on page 34).

For more details, see the ODVA.org website.

Messaging

There are two types of messages used by EtherNet/IP: explicit messages and implicit messages. Each is described in the following sections.

Explicit (Non-cyclic) Messages

Explicit messages are non-cyclic, i.e., they are typically sent once instead of at regular intervals. Further, explicit messages are not time sensitive. They are used for communicating information such as configuration, diagnostic, data logs, and other information that is not time critical. They can also be used to set up implicit (cyclic) connection content (see the next section).

Explicit messages are point-to-point messages. In other words, a device sends out a message directed to a specific recipient device. The recipient device will return a response to that message. As a result, the explicit messages are much larger than implicit messages (refer to the next section) and can generate a lot of network traffic; therefore, they are not used for transmitting cyclic data.

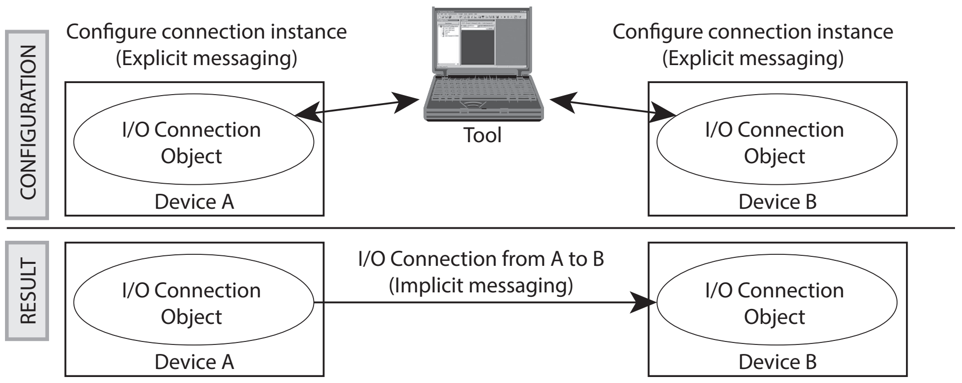
Implicit (Cyclic) Messages

Implicit messages (also referred to as I/O messages) are cyclic, i.e., they are sent at regular intervals. Implicit messages are used to communicate critical, time-sensitive information. They are typically used for I/O control, PID loop closure, and Motion or Application control.

The implicit message connection between the two devices is established up front and connection ID assignment is made. Therefore, the actual implicit messages contain just the connection ID and the data. As a result, implicit messages are very small, they can travel quickly, and they do not use much network bandwidth.

Explicit/Implicit Messaging Example

In the following figure, a tool uses explicit messaging to configure the connections between two network devices. Once that I/O connection is established, the devices can communicate using implicit messaging. For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.


CONFIGURATION
Configure connection instance (Explicit messaging)
Configure connection instance (Explicit messaging)
Tool
I/O Connection Object
Device A
I/O Connection Object
Device B
RESULT
I/O Connection Object
Device A
I/O Connection from A to B (Implicit messaging)
I/O Connection Object
Device B

Explicit/Implicit Messaging Example

Connections, Wiring and Status LEDs

This chapter provides information on the SmartMotor connectors, a multidrop cable diagram, and a description of the SmartMotor status LEDs.

Connectors and Pinouts **25**

M-Style Motor Connectors and Pinouts 25

Moog Animatics Industrial Ethernet Cables 26

M-style to M-style Ethernet Cable 26

M-style to RJ45 Ethernet Cable 26

EtherNet/IP Custom Cable 26

Cable Diagram **27**

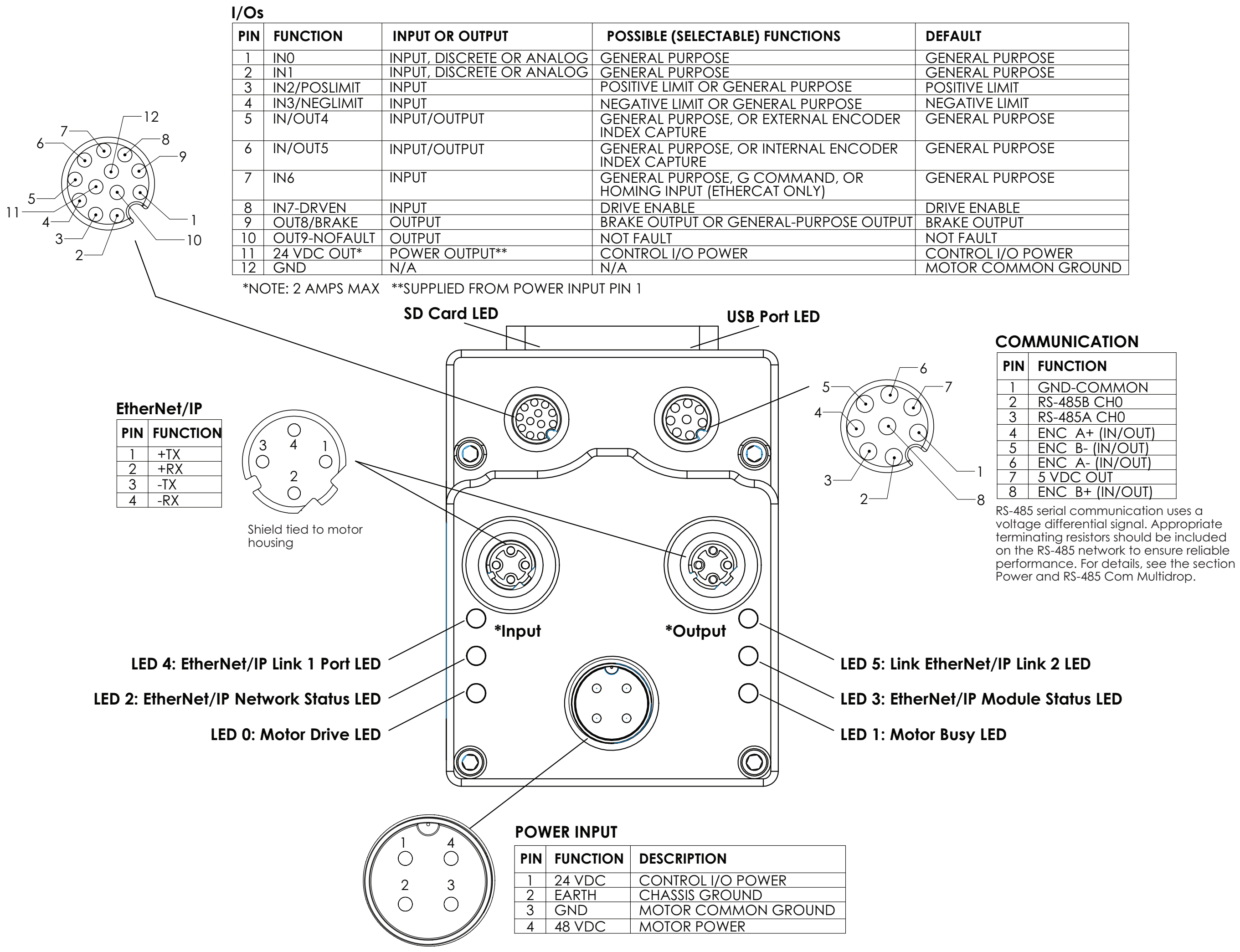
EtherNet/IP Cable Diagram 27

Status LEDs **28**

Connectors and Pinouts

M-Style Motor Connectors and Pinouts

The following figure provides a brief overview of the connectors and pinouts available on the M-style SmartMotors.



SD Card LED
USB Port LED
Shield tied to motor housing
*Input
*Output
LED 4: EtherNet/IP Link 1 Port LED
LED 2: EtherNet/IP Network Status LED
LED 0: Motor Drive LED
LED 5: Link EtherNet/IP Link 2 LED
LED 3: EtherNet/IP Module Status LED
LED 1: Motor Busy LED

I/Os

PIN	FUNCTION	INPUT OR OUTPUT	POSSIBLE (SELECTABLE) FUNCTIONS	DEFAULT
1	IN0	INPUT, DISCRETE OR ANALOG	GENERAL PURPOSE	GENERAL PURPOSE
2	IN1	INPUT, DISCRETE OR ANALOG	GENERAL PURPOSE	GENERAL PURPOSE
3	IN2/POSLIMIT	INPUT	POSITIVE LIMIT OR GENERAL PURPOSE	POSITIVE LIMIT
4	IN3/NEGLIMIT	INPUT	NEGATIVE LIMIT OR GENERAL PURPOSE	NEGATIVE LIMIT
5	IN/OUT4	INPUT/OUTPUT	GENERAL PURPOSE, OR EXTERNAL ENCODER INDEX CAPTURE	GENERAL PURPOSE
6	IN/OUT5	INPUT/OUTPUT	GENERAL PURPOSE, OR INTERNAL ENCODER INDEX CAPTURE	GENERAL PURPOSE
7	IN6	INPUT	GENERAL PURPOSE, G COMMAND, OR HOMING INPUT (ETHERCAT ONLY)	GENERAL PURPOSE
8	IN7-DRVEN	INPUT	DRIVE ENABLE	DRIVE ENABLE
9	OUT8/BRAKE	OUTPUT	BRAKE OUTPUT OR GENERAL-PURPOSE OUTPUT	BRAKE OUTPUT
10	OUT9-NOFAULT	OUTPUT	NOT FAULT	NOT FAULT
11	24 VDC OUT*	POWER OUTPUT**	CONTROL I/O POWER	CONTROL I/O POWER
12	GND	N/A	N/A	MOTOR COMMON GROUND

*NOTE: 2 AMPS MAX **SUPPLIED FROM POWER INPUT PIN 1

EtherNet/IP

PIN	FUNCTION
1	+TX
2	+RX
3	-TX
4	-RX

COMMUNICATION

PIN	FUNCTION
1	GND-COMMON
2	RS-485B CH0
3	RS-485A CH0
4	ENC A+ (IN/OUT)
5	ENC B- (IN/OUT)
6	ENC A- (IN/OUT)
7	5 VDC OUT
8	ENC B+ (IN/OUT)

RS-485 serial communication uses a voltage differential signal. Appropriate terminating resistors should be included on the RS-485 network to ensure reliable performance. For details, see the section Power and RS-485 Com Multidrop.

POWER INPUT

PIN	FUNCTION	DESCRIPTION
1	24 VDC	CONTROL I/O POWER
2	EARTH	CHASSIS GROUND
3	GND	MOTOR COMMON GROUND
4	48 VDC	MOTOR POWER

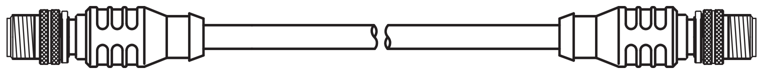
NOTE: When daisy-chaining SmartMotors for an EtherNet/IP network, there is no specific IN or OUT Ethernet port. In other words, either Ethernet port can be used for the input or the output.

Moog Animatics Industrial Ethernet Cables

The following Industrial Ethernet cables are available from Moog Animatics.

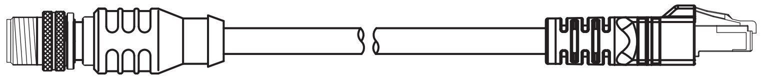
M-style to M-style Ethernet Cable

This cable has M12 male threaded connectors at both ends. It is available in 1, 3, 5 and 10 meter lengths. For the standard cable, use part number CBLIP-ETH-MM-xM, where "x" denotes the cable length. A right-angle version is also available; use part number CBLIP-ETH-MM-xMRA.



M-style to RJ45 Ethernet Cable

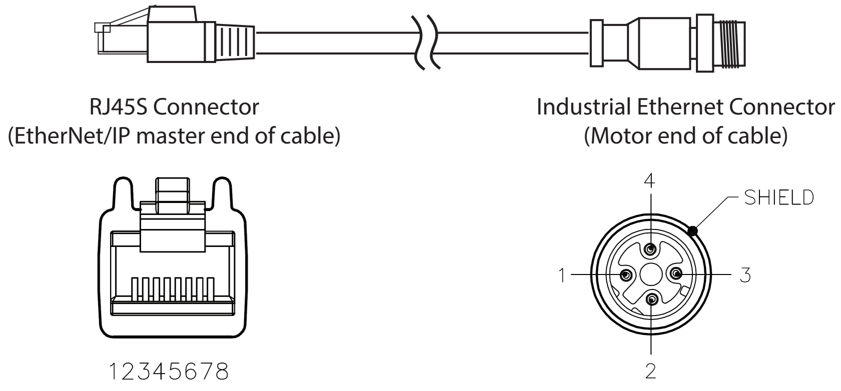
This cable has an M12 male threaded connector at one end, and an RJ45 male connector at the opposite end. It is available in 1, 3, 5 and 10 meter lengths. For the standard cable, use part number CBLIP-ETH-MRJ-xM, where "x" denotes the cable length. A right-angle version is also available; use part number CBLIP-ETH-MRJ-xMRA.



EtherNet/IP Custom Cable

The following figure provides details for creating a custom shielded EtherNet/IP cable.

NOTE: The motor end of the cable requires an industrial Ethernet connector.


RJ45S Connector
(EtherNet/IP master end of cable)
Industrial Ethernet Connector
(Motor end of cable)
12345678
4
SHIELD
1
3
2

PIN	DESCRIPTION
1	+TX
2	-TX
3	+RX
4	No Connection
5	No Connection
6	-RX
7	No Connection
8	No Connection
Shield tied to RJ45S connector	

PIN	DESCRIPTION
1	+TX
2	+RX
3	-TX
4	-RX
Shield tied to motor housing	

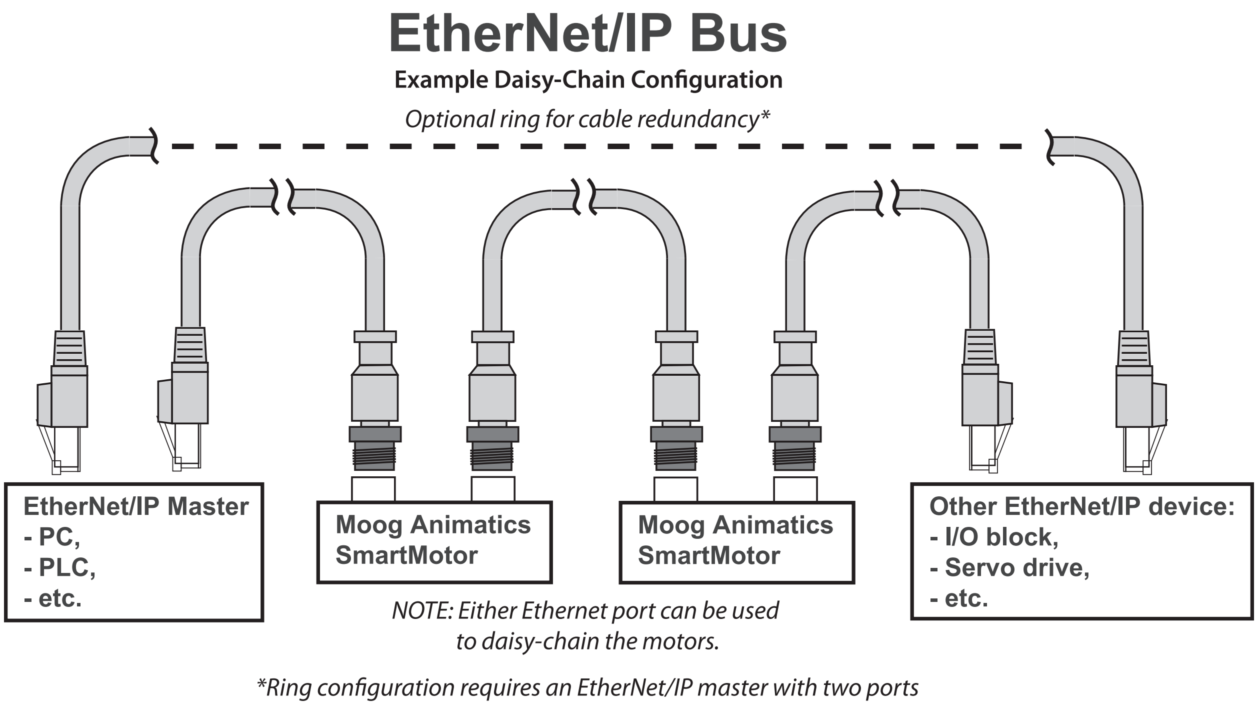
Cable Diagram

This section describes the cabling information for adding a SmartMotor to an EtherNet/IP network.

CAUTION: To minimize the possibility of electromagnetic interference (EMI), all connections should use *shielded* Ethernet Category 5 (Cat 5), or better, cables.

EtherNet/IP Cable Diagram

The following diagram shows an example EtherNet/IP network with the SmartMotors daisy chained to the EtherNet/IP master device. An optional "ring" configuration can be created if the EtherNet/IP master device has two ports.

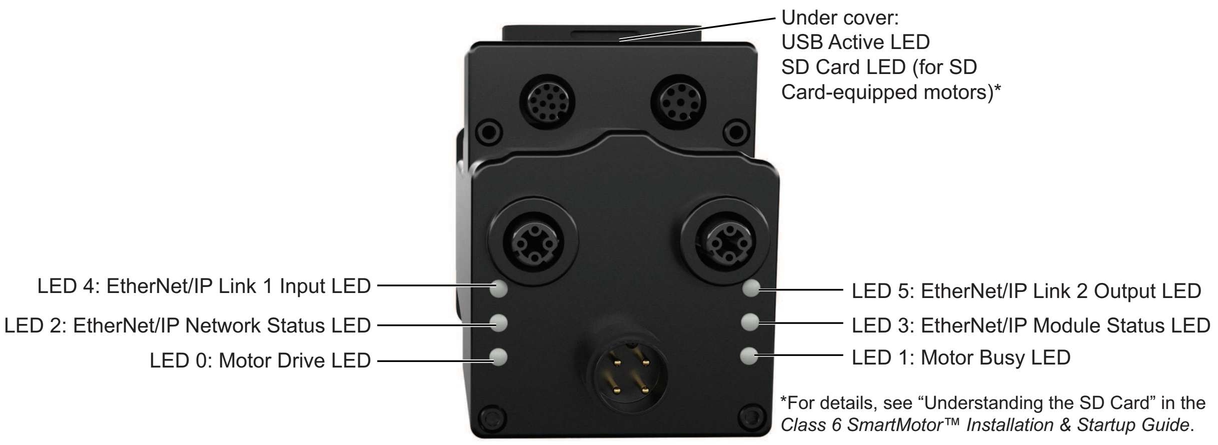

EtherNet/IP Bus
Example Daisy-Chain Configuration
Optional ring for cable redundancy*
EtherNet/IP Master
- PC,
- PLC,
- etc.
Moog Animatics SmartMotor
Moog Animatics SmartMotor
Other EtherNet/IP device:
- I/O block,
- Servo drive,
- etc.
NOTE: Either Ethernet port can be used to daisy-chain the motors.
*Ring configuration requires an EtherNet/IP master with two ports

NOTE: Unlike other fieldbus protocols, EtherNet/IP does not require terminators at each end of the network bus.

Many network configurations are possible, such as line, tree or star. Requirements for specific configurations depend on the capabilities of the EtherNet/IP controller devices, the node devices, types and lengths of cables, and use of other networking equipment. For specific details on creating an EtherNet/IP network, refer to the ODVA publication *EtherNet/IP Media Planning and Installation Manual*, which is available on the ODVA.org website.

Status LEDs

This section describes the functionality of the Status LEDs on the Class 6 SmartMotor.


Under cover:
USB Active LED
SD Card LED (for SD Card-equipped motors)*
LED 4: EtherNet/IP Link 1 Input LED
LED 2: EtherNet/IP Network Status LED
LED 0: Motor Drive LED
LED 5: EtherNet/IP Link 2 Output LED
LED 3: EtherNet/IP Module Status LED
LED 1: Motor Busy LED

*For details, see "Understanding the SD Card" in the *Class 6 SmartMotor™ Installation & Startup Guide*.

Flickering = On/Off in 0.1 sec; Blinking = On/Off in 0.5 sec; Flashing = separated by 1 sec for EtherNet/IP LEDs and 2 sec for Fault Codes

SD Card LED (for SD Card-equipped motors)

Off	No card, bad or damaged card
Blinking green	Busy, do not remove card
Solid green	Card detected
Solid red	Card with no SmartMotor data

USB Active LED

Flashing green	Active
Flashing red	Suspended
Solid red	USB power detected, no configuration

LED 0: Motor Drive LED

Off	No power
Solid green	Drive on
Blinking green	Drive off, no faults
Triple red flash	Watchdog fault
Solid red	Faulted or no drive enable input

LED 1: Motor Busy LED

Off	Not busy
Solid green	Drive on, trajectory in progress
Flashing # red	Flashes fault code* (see below) when Drive LED is solid red

LED 2: EtherNet/IP Network Status LED

Off	No power or no IP address
Flashing red/grn	Power-up self test
Flashing green	No connections
Solid green	Connected
Flashing red	Connection timeout
Solid red	Duplicate IP

LED 3: EtherNet/IP Module Status LED

Off	No power
Flashing red/grn	Power-up self test
Flashing green	Standby
Solid green	Device operational
Flashing red	Minor fault
Solid red	Major fault

LED 4: EtherNet/IP Link 1 Input LED

Off	No/bad cable; no/bad Link port
Solid green	Link established
Blinking green	Activity

LED 5: EtherNet/IP Link 2 Output LED

Off	No/bad cable; no/bad Link port
Solid green	Link established
Blinking green	Activity

LED Status on Power-up:

- With no program and the travel limit inputs are low:
  LED 0 solid red; motor is in fault state due to travel limit fault
  LED 1 off
- With no program and the travel limits are high:
  LED 0 solid red for 500 milliseconds then flashing green
  LED 1 off
- With a program that only disables travel limits:
  LED 0 red for 500 milliseconds then flashing green
  LED 1 off

LED1 Fault Codes:

Flash	**Description**
1	NOT Used
2	Bus Voltage
3	Over Current
4	Excessive Temperature
5	Excessive Position
6	Velocity Limit
7	dE/Dt - First derivative of position error is excessive
8	Hardware Positive Limit Reached
9	Hardware Negative Limit Reached
10	Software Positive Travel Limit Reached
11	Software Negative Travel Limit Reached

*Busy LED pauses for 2 seconds before flashing the code

EtherNet/IP on Class 6 SmartMotors

This section provides an overview of the EtherNet/IP communications protocol implementation on the Moog Animatics Class 6 SmartMotor.

EtherNet/IP Implementation 30

EtherNet/IP Identity 30

EtherNet/IP Software Version Numbers 30

Device Profile 30

SmartMotor Device Profile Overview 31

CIP Objects for EtherNet/IP Devices 31

Application Objects for Position Controller Devices 32

Additional Objects 32

EDS File 34

EtherNet/IP Implementation

This section describes EtherNet/IP implementation information for the Class 6 SmartMotor.

EtherNet/IP Identity

The following identity information is available when the SmartMotor is queried by the EtherNet/IP master.

- Product Codes: 10 - SM6-M
- Device Name: Factory data in nonvolatile EEPROM memory.
- Serial Number: Factory data in nonvolatile EEPROM memory.

  NOTE: These identity items match those shown on the SmartMotor name plate.

EtherNet/IP Software Version Numbers

The initial EtherNet/IP software release is 6.0.2.23.

Device Profile

The Class 6 EtherNet/IP SmartMotor profile uses the Position Controller (0x10) device. For Position Controller details, see SmartMotor Device Profile Overview on page 31.

SmartMotor Device Profile Overview

This section provides an overview of the objects used in the SmartMotor device profile. It includes: CIP required objects and network objects (the CIP objects), ODVA "Device" set of objects (the Application objects), and Moog Animatics vendor-specific objects (the Additional objects).

For a full description of each object, see the corresponding "For details..." section. For more details on the Position Controller Device, see Position Controller Device (0x10) on page 44.

CIP Objects for EtherNet/IP Devices

The following table shows the minimum objects required for any EtherNet/IP device.

Object Class	Class Code	Description	Required/ Optional	Instances	For details, see...
Identity Object	0x01	Provides identification and general device information. Object is required in every network device.	Required	1	Identity Object (0x01) on page 65
Message Router Object	0x02	Provides message handling for communicating with objects in the physical device.	Required	1	Message Router Object (0x02) on page 69
Assembly Object	0x04	Binds attributes of multiple objects, allowing data to/from each object to be sent/received through a single connection. Also used to bind input or output data.	Optional - used for the SmartMotor	2	Assembly Object (0x04) on page 70
Connection Manager Object	0x06	Establishes and manages the communications connections (exchanges of messages), including connections across multiple subnets.	Conditional (required for EtherNet/IP)	1	Connection Man-ager Object (0x06) on page 71
TCP/IP Interface Object[1]	0xF5	Configures the device’s TCP/IP network interface. For example, this includes the device’s IP Address, Network Mask, and Gateway Address.	Conditional (required for EtherNet/IP)	1	TCP/IP Interface Object (0xF5) on page 72

Object Class	Class Code	Description	Required/ Optional	Instances	For details, see...
Ethernet Link Object[1]	0xF6	Maintains link-specific counters and status information for the communications interface.	Conditional (required for EtherNet/IP)	1	Ethernet Link Object (0xF6) on page 79
1. Network-Specific Link Objects					

Application Objects for Position Controller Devices

The Position Controller Device type is 0x10; there is one instance. The following table shows the required application objects for a Position Controller device.

Object Class	Class Code	Description	Required/ Optional	Instances	For details, see...
CIP Required Objects	(see previous table)	(see previous table)	Required	(see previous table)	(see previous table)
Position Controller Supervisor	0x24	Handles errors for Position Controller, also home and registration inputs.	Required	1	Position Controller Supervisor (0x24) on page 86
Position Controller	0x25	Performs control output velocity profiling; handles input/output to/from the motor, limit switches registration, etc.	Required	1	Position Controller (0x25) on page 88

Additional Objects

In addition to the object classes in the previous tables, the following manufacturer-specific and other objects have been added for the SmartMotor.

Object Class	Class Code	Description	Required/ Optional	Instances	For details, see...
Device Level Ring (DLR) Object	0x47	Allows use of an Ethernet ring network topology		1	Device Level Ring (DLR) Object (0x47) on page 94
Quality of Ser- vice (QOS) Object	0x48	Provides priority-depend- ent control of the Eth- ernet data streams.		1	QoS Object (0x48) on page 96

Object Class	Class Code	Description	Required/ Optional	Instances	For details, see...
SmartMotor I/O Object	0x71	Manufacturer-specific object associated with the Position Controller Device		1	SmartMotor I/O Object (0x71) on page 98

EDS File

The Electronic Data Sheet (EDS) file is supplied by the equipment manufacturer. It is an ASCII text file that is structured as specified by the CIP specification. The EDS file contains all of the necessary information for the configurable parameters of the corresponding device (i.e., it contains information required by the CIP specification and may include vendor-specific information provided by the manufacturer). For example, there is an EDS file supplied by Moog Animatics for the EtherNet/IP SmartMotor.

All CIP network configuration tools have the ability to read EDS files. The information in the EDS file is used by the configuration tool to guide the user through the configuration process.

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

To obtain the EDS file for the SmartMotor:

1. Access the Download Center on the Moog Animatics website at:

   http://www.animatics.com/support/download-center.html

2. From the folder list, select Firmware And Fieldbus Downloads > Fieldbus Config > EtherNet/IP folder.
3. Locate the EDS file (.eds extension) and click it.
4. Save the file to a location on your computer.

EtherNet/IP User Program Commands

This chapter provides details on the EtherNet/IP commands used with the SmartMotor and its user program. SmartMotor programming is described in the *SmartMotor™ Developer's Guide*. The SmartMotor user program allows the motor to take on autonomous or distributed control functions needed in an application.

Network Settings and Status Commands **36**

Combitronic Addressing over Ethernet (UDP) 41

Program Example 41

Status and Diagnostic Codes **42**

Status/Error Codes 42

Diagnostic Codes 42

Network Settings and Status Commands

The SmartMotor's EEPROM can store nonvolatile EtherNet/IP information about the network. For proper EtherNet/IP operation, each SmartMotor must have a unique IP address. If a DHCP server is used in the network, then the SmartMotor default IP address (0.0.0.0) is used; if a fixed IP address is needed or there is no DHCP server, the IP address can be set using the IPCTL command. This can be accomplished: at the PLC over EtherNet/IP; with SMI and a USB connection, or RS-485 on channel 0; with a SmartMotor user program. If an IP address is assigned through any method, including the DHCP server, that address is stored and used at the next power-up.

> **NOTE:** Nonvolatile memory will be read at power-up or after the Z (reset) command has been executed.

The commands in the following table are related to the network settings and status.

Command	Description/ Parameter	Values	Non-Volatile Setting
IPCTL(action,"string")	action= 0: set IP address 1: set Mask 2: set Gateway	The drive is shipped out-of-box with an IP Address of 0.0.0.0. This address enables DHCP support for addressing. The DHCP server manages the IP Address assigned to the drive. If a value other than 0.0.0.0 is assigned then DHCP is disabled and the static IP Address is used. Assigning an IP Address of 0.0.0.0 will re-enable DHCP if desired Value is formatted as an IP address entered as a string, e.g., IPCTL (0,"192.168.0.10"). By default, these values are set to 0 (i.e., "0.0.0.0") **NOTE:** The drive must be power cycled or reset using a "Z" terminal window command before the new IP Address takes affect.	YES
RETH(0), or x=ETH(0) RETH i s the same as RETH(0) x=ETH is the same as x=ETH(0)	EtherNet/IP status	Bit 0 = Initialization failure Bit 1 = Configuration change Bit 2 = Reserved Bit 3 = Network processor failure Bit 4 = Reserved Bit 5 = Reserved	N/A
RETH(1), or x=ETH(1)	Module status	0 = No power 1 = Self test 2 = Standby 3 = Device operational 4 = Minor (recoverable) fault 5 = Major (non-recoverable) fault	
RETH(2), or x=ETH(2)	Network status	0 = Not powered, no IP address 1 = No connections 2 = Connected 3 = Connection timeout 4 = Duplicate IP 5 = Self-test	

Command	Description/ Parameter	Values	Non-Volatile Setting
RETH(3), or x=ETH(3)	Stack fault code	For details, see Status and Diagnostic Codes on page 42.	
RETH(5), or x=ETH(5)	LFW firmware version	Firmware version as 32-bit integer. E.g., 3.1.0.1 would be a value 50397185 (0x03010001).	
RETH(6), or x=ETH(6)	Network Lost user program number	The current Network Lost program label number.	
RETH(7), or x=ETH(7)	Processor type	-1 = Failed 0 = Unknown 1 = netX 10 2 = netX 50 3 = netX 51/52 4 = netX 100	
RETH(8), or x=ETH(8)	Protocol type	0 = Not defined 1 = PROFINET 2 = EtherCAT 3 = EtherNet/IP	
RETH(9), or x=ETH(9)	Network Lost action	The current value assigned to the Network Lost action.	
RETH(14)	[Moog internal use]		
RETH(15)	IP address	Value is in dotted-decimal format.	
RETH(16)	Subnet mask	Value is in dotted-decimal format.	
RETH(17)	Gateway	Value is in dotted-decimal format.	
RETH(18)	MAC ID string formatted report only	E.g., 00:01:02:a9:ff:00	
RETH(19), or x=ETH(19)	Report the detected LFW ProtocolClass. This gives a wider range of values than the known and supported protocols listed in ETH (8). Values designated according to NXF/LFW file loaded into network processor and too numerous to list here. These are the values for the supported protocols: (introduced in firmware 6.0.2.41 or later)	0 Not Defined 21 PROFIBUS 9 EtherCAT 10 EtherNet/IP	
RETH(30), or x=ETH(30)	I/O read data size	Value is configured by the master.	
RETH(31), or x=ETH(31)	I/O write data size	Value is configured by the master.	
RETH(45), or x=ETH(45)	IP address as integer	E.g., for an IP address of 192.168.1.3 (C0 A8 01 03 hex), this command reports -1062731517 (it reports as a 32-bit signed value).	
RETH(46), or x=ETH(46)	IP subnet mask as integer	E.g., for an IP netmask of 255.255.0.0 (FF FF 00 00 hex), this command reports -65536 (it reports as a 32-bit signed value).	

Command	Description/ Parameter	Values	Non-Volatile Setting
RETH(47), or x=ETH(47)	IP gateway as integer	E.g., for an IP gateway of 192.168.1.1 (C0 A8 01 01 hex), this command reports -1062731519 (it reports as a 32-bit signed value.)	
RETH(48), or x=ETH(48)	Low 3 bytes of MAC ID (device ID) as integer	E.g., for a MACID of 00:01:02:a9:ff:00, this command reports 11140864 (00 a9 ff 00 hex)	
RETH(49), or x=ETH(49)	High 3 bytes of MAC ID (device ID) as integer	E.g., for a MACID of 00:01:02:a9:ff:00, this command reports 258 (00 00 01 02 hex)	
RETH(50), or x=ETH(50)	Internal error code	For details, see Status and Diagnostic Codes on page 42	
RETH(51), or x=ETH(51)	Internal error source	For Moog Animatics use.	
RETH(54), or x=ETH(54)	Initialize error code	For details, see Status and Diagnostic Codes on page 42	
RETH(56), or x=ETH(56)	Connection size setting	Report number of bytes exchanged in EIP implicit messaging	Yes
RETH(80), or x=ETH(80)	Combitronics over Ethernet status	Bit 4 = Attempted to read broadcast address Bit 5 = Internal buffer problem Bit 6 = Timeout, did not receive response from remote SmartMotor Bit 7 = server overflow	
RETH(81), or x=ETH(81)	Combitronics over Ethernet response timeout	Reports current setting in milliseconds	
RETH(82), or x=ETH(82)	Combitronics over Ethernet response retry (doesn't apply to broadcast mode)	Reports number of times a failed response will retry	
RETH(83), or x=ETH(83)	Combitronics over Ethernet broadcast stall time	Reports current setting in milliseconds.	
RETH(84), or x=ETH(84)	Combitronics over Ethernet broadcast client delay time	Reports current setting in milliseconds.	
RETH(85), or x=ETH(85)	Combitronics over Ethernet permissions	0 no read, no write permission, port is closed. 1 read-only permission 2 write-only permission 3 read and write permissions (default)	Yes
RETH(86), or x=ETH(86)	Combitronics over Ethernet UDP port configuration	Reports port number	Yes
RETH(87), or x=ETH(87)	Combitronics over Ethernet broadcast repeat	Reports number of messages total per broadcast command	

Command	Description/ Parameter	Values	Non-Volatile Setting
RETH(100), or x=ETH(100)	TCP Serial connection encap-sulation permissions	Reports one of the following values: 0 disabled TCP communications port and UDP discovery port 1 enabled TCP communications port only 2 enabled UDP discovery port only 3 enabled TCP communications port and UDP discovery port	
RETH(101), or x=ETH(101)	Modbus TCP access permissions	Reports one of the following values: 0 no read, no write permission, and TCP port is closed 1 read-only 2 write-only 3 read and wite allowed	
ETHCTL(3,x)	Reset error code	Resets Stack Fault code RETH(3) to 0	
ETHCTL(6,<value>)	Network Lost user program label number	This setting is nonvolatile. Program label to jump to if the Network Lost action, ETHCTL (9,<value>), is either set to 4 or 5.	
ETHCTL(9,<value>)	Network Lost action	This setting is nonvolatile. 0 – Ignore, no action (default setting) 1 – Send OFF command to motor (servo off) 2 – Send X command to motor (smooth stop) 3 – Send S command to motor (hard stop) 4 – Send GOSUB(x) command, where x is the value of the user program label as defined by ETHCTL(6,<value>). 5 – Send GOTO(x) command, where x is the value of the user program label as defined by ETHCTL(6,<value>). NOTE: Loss of network is an edge-triggered event if I/O Control goes from RUN to any other state.	
ETHCTL(45,x)	Set IP address as integer	E.g., to set for an IP address of 192.168.1.3 (C0 A8 01 03 hex), x=3232235779	Yes
ETHCTL(46,x)	Set IP subnet mask as integer	E.g., to set for an IP netmask of 255.255.0.0 (FF FF 00 00 hex), x=4294901760	Yes
ETHCTL(47,x)	Set IP gateway as integer	E.g., to set for an IP gateway of 192.168.1.1 (C0 A8 01 01 hex), x=3232235777	Yes
ETHCTL(50,x)	Reset error code	Resets Internal Error code RETH (50) and Internal Error source RETH(51) to 0	
ETHCTL(51,x)	Reset error code	Resets Internal Error code RETH (50) and Internal error source RETH(51) to 0	

Command	Description/ Parameter	Values	Non-Volatile Setting
ETHCTL(56,x)	Connection size setting	Set number of bytes exchanged in EIP implicit messaging . Values 8 and 32 supported. Value 0 will configure motor to autodetect bytes 8 or 32.	Yes
ETHCTL(80,x)	Reset Combitronics error bits	Resets Combitronics over Ethernet error code RETH(80) to 0	
ETHCTL(81,x)	Combitronics over Ethernet response timeout	x in milliseconds, default is 30. Range 1 to 1000.	
ETHCTL(82,x)	Combitronics over Ethernet response retry (doesn't apply to broadcast mode)	x in number of times a retry will be allowed before giving up with timeout status. Default is 3. Range is 0 to 10.	
ETHCTL(83,x)	Combitronics over Ethernet broadcast stall time	x in milliseconds, default is 10. Range 5 to 100. Note: may affect ETHCTL(84,x) to enforce that value is less than or equal to this value.	
ETHCTL(84,x)	Combitronics over Ethernet broadcast client delay time	x in milliseconds, default is 0. Range 0 to 20. Note: limited to be less than or equal to ETHCTL(83,x)	
ETHCTL(85,x)	Combitronics over Ethernet permissions	x is: -1 Set to default 0 no read, no write permission, close port. 1 read-only permission 2 write-only permission 3 read and write permissions (default)	Yes
ETHCTL(86,x)	Combitronics over Ethernet UDP port configuration	x is port number, default is 43500. Range is 1024 to 65535.	Yes
ETHCTL(87,x)	Combitronics over Ethernet broadcast repeat	x is total number of messages per broadcast command, default is 3. Range is 1 to 7.	
ETHCTL(100,x)	TCP Serial connection encapsulation permissions	x is: -1 Set to default 0 disable TCP communications port and UDP discovery port 1 enable TCP communications port only 2 enable UDP discovery port only 3 enable TCP communications port and UDP discovery port	Yes
ETHCTL(101,x)	Modbus TCP access permissions	x is: -1 Set to default 0 no read, no write permission, close port. 1 read-only permission 2 write-only permission 3 read and write permissions (default)	Yes

Command	Description/ Parameter	Values	Non-Volatile Setting
ETHCTL(110,x)	TCP Serial connection encap-sulation keepalive interval	x is: -1 Set to default 0 disable Range 1-127 seconds Default is 3 seconds.	Yes
ETHCTL(111,x)	Modbus TCP keepalive interval	x is: -1 Set to default 0 disable Range 1-127 seconds Default is 3 seconds.	Yes
RGROUP(function), or x=GROUP(function)	Combitronic over Ethernet group addressing: report current setting	See the *SmartMotor Developer's Guide*.	
GROUP(function,value)	Combitronic over Ethernet group addressing: apply setting	See the *SmartMotor Developer's Guide*.	

Combitronic Addressing over Ethernet (UDP)

When addressing through Combitronic over Ethernet (UDP), the address after the ":" operator represents the last part of the IP address (i.e., if motor’s own IP address is 192.168.1.3, then that is accessed as "RPA:3"). That IP address range (192.168.1.) is assumed for accessing other motors on the "Combitronic network".

In other words, only motors with identical first three parts of the IP address are reachable through Combitronic point-to-point addressing. For example, motor ":5" with IP address 192.168.1.5 can communicate with another motor with IP address 192.168.1.27 (with ":27"), but it cannot generate an address to directly communicate with motor with IP address 192.168.2.27.

The following constraints also apply for Combitronic addressing:

- The address 0 (":0") is for broadcast. This means that a motor cannot have an IP address ending in x.x.x.0.
- The address 255 (":255") is for group address and should also be avoided as the last part of motor's actual IP address.
- The netmask of "255.255.255.0" is recommended, if possible, when using Combitronic over Ethernet so that the broadcast group is the same range of addresses as the directly reachable addresses.

  NOTE: If a motor is being simultaneously written to by two or more other motors, then duplication of certain commands is possible. This could create problems for certain commands such as GOSUB.

For more information on Combitronic communications, see the *SmartMotor Developer's Guide*.

Program Example

The following code example sets the device IP address.

```
IPCTL(0,"192.168.0.10") 'Set the IP address to 192.168.0.10
'Add rest of program below
```

Status and Diagnostic Codes

The following tables provide details on the status/error codes and the diagnostic codes.

Status/Error Codes

Hex Value	Decimal Value	Description
00000000	0	Status is OK
C01F0002	-1071710206	System is out of memory
C01F0003	-1071710205	Task runs out of empty packets at the local packet pool
C01F0004	-1071710204	Sending a packet failed
C01F0010	-1071710192	Assembly instance already exists
C01F0011	-1071710191	Invalid assembly instance
C01F0012	-1071710190	Invalid assembly length
C01F0020	-1071710176	No free connection buffer available
C01F0021	-1071710175	Object class is invalid
C01F0022	-1071710174	Segment of the path is invalid
C01F0023	-1071710173	Object Class is already used
C01F0024	-1071710172	Connection failed
C01F0025	-1071710171	Unknown format of connection parameter
C01F0026	-1071710170	Invalid connection ID
C01F0027	-1071710169	No resource for creating a new class object available
C01F0028	-1071710168	Invalid request parameter
C01F0029	-1071710167	General connection failure
C01F0031	-1071710159	Access denied, instance is read only
C01F0032	-1071710158	DPM address is already used by an other instance
C01F0033	-1071710157	Set Output command is already running
C01F0034	-1071710156	EtherNet/IP Object Task is running a reset
C01F0035	-1071710155	Object Service already exists

Diagnostic Codes

Hex Value	Decimal Value	Description
00000000	0	Status is OK
C01F0001	-1071710207	No free packet available to create a response of the request
C01F0002	-1071710206	No free packet available to send the input data
C01F0003	-1071710205	Routing a request to an object failed; an error occurred at the destination packet queue
C01F0004	-1071710204	Sending the confirmation of a request failed; an error occurred at the packet queue
C01F0005	-1071710203	Getting a confirmation of a request from an unknown object

Hex Value	Decimal Value	Description
C01F0006	-1071710202	Instance of the CC object could not be created; no free memory available
C01F0007	-1071710201	Completing a Connection Close command failed; sending the command to the packet queue failed
C01F0008	-1071710200	Completing a Connection Open command failed; sending the command to the packet queue failed
C01F0009	-1071710199	Sending the Delete Transport command failed; Encap Queue signal an error
C01F000A	-1071710198	Sending the Forward Open command failed; Encap Queue signal an error
C01F000B	-1071710197	Sending the Start Transport command failed; Encap Queue signal an error
C01F000C	-1071710196	Connection manager received a confirmation of unknown service
C01F000D	-1071710195	Sending the Forward Close command failed; Encap Queue signal an error
C01F000E	-1071710194	Failed the Complete Reset command; did not get a empty packet

Position Controller Device (0x10)

This chapter provides information on the Position Controller Device (0x10). For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

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Position Controller Device Application Objects

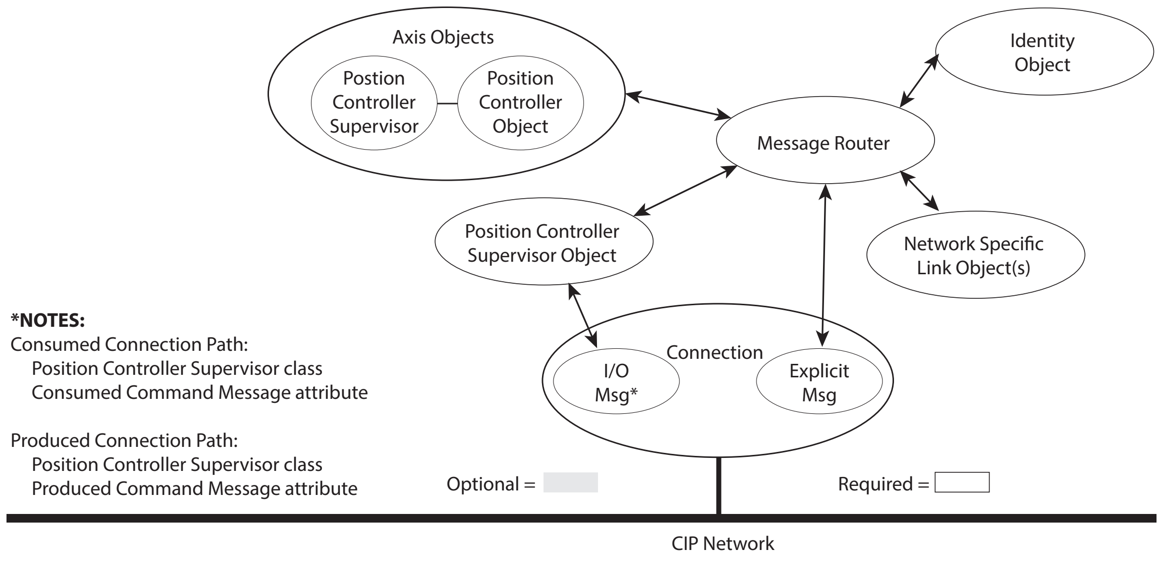
The following table shows the application objects for the Position Controller device and describes their functions. For a full description of each object, see the corresponding "For details..." section.

Object Class	Class Code	Description	Required/ Optional	Instances	For details, see...
Position Controller Supervisor	0x24	Handles errors for the Position Controller as well as Home and Registration inputs.	Required	1	Position Controller Supervisor (0x24) on page 86
Position Controller	0x25	Performs the control output velocity profiling and handles input and output to and from the motor drive unit, limit switches registration etc.	Required	1	Position Controller (0x25) on page 88

Note that these objects are the Application Objects in the overall SmartMotor device profile. For a listing of all objects in the device profile used for the SmartMotor, see SmartMotor Device Profile Overview on page 31.

Position Controller Device Object Model

The following figure provides a diagram of the Position Controller Device object model.


Axis Objects
Postion Controller Supervisor
Position Controller Object
Identity Object
Message Router
Position Controller Supervisor Object
Network Specific Link Object(s)
*NOTES:
Consumed Connection Path:
Position Controller Supervisor class
Consumed Command Message attribute
Produced Connection Path:
Position Controller Supervisor class
Produced Command Message attribute
Connection
I/O Msg*
Explicit Msg
Optional = ▨
Required = ☐
CIP Network

Position Controller Device Object Model

Position Controller Implicit I/O Messages

This section describes the details about implicit I/O messages for the device.

General Command and Response Message Types

This section describes the formats for consumed and produced general messages.

- The standard CIP Position Controller I/O connection messages are 8-byte messages.
- The Class 6 EtherNet/IP SmartMotor supports both the standard 8-byte format and an extended 32-byte format.
- The first eight bytes of the 32-byte format match the 8-byte format defined in the ODVA CIP Position Controller specification. The SmartMotor will select which message format to use based on the host controller connection size.

Connection Size	Description
8 bytes	The motor will use the CIP standard communication format and Command Message Types
32 bytes	The motor will use: • CIP Standard 8 byte messages • Additional Data Fields in the Command / Response Message frames • Extended Command Message Types 6 (Position Move) & 7 (Velocity Move)
Any other	The motor will respond with an error

The default connection size used in the Class 6 EtherNet/IP SmartMotor EDS file is 32-bytes.

To change the configuration, see ETHCTL(56,x) on page 40; to report the configured value, see RETH(56), or x=ETH(56) on page 38

NOTE: Implicit I/O messages are the most efficient method of exchanging cyclic data, such as Target Position and Actual Position, with the SmartMotor. These message types for the Position Controller Polled I/O Connection are typically the best choice for commanding the SmartMotor shaft position or applied torque.

Polled I/O: Consumed General Message Format

NOTE: 32-byte Extended fields are shown with gray-highlighted rows.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Enable	Reg. Arm[1]	Hard Stop	Smooth Stop	Direction (Vel. mode)	Incremental	Start Block[1]	Load Data/ Start Profile
1	Block #							
2	Command Axis Number				Command Message Type (1 through 7)			
3	Response Axis Number				Response Message Type (1 through 7)			
4–7	Command Data[3]							
8–11	Target Position[3]							
12–15	Target Velocity[3]							
16–20	Acceleration[3]							
20–23	Deceleration[3]							
24	Attribute to Get Axis Number				Attribute to Get Message Type (0x1A, 0x1B)			
25	Reserved							
26–27	Attribute to Get Number[4]							
28–31	Reserved							

Notes:
1. Byte 0 bits 6 and 1 are not supported in Class 5 motors.
2. For Semantics, refer to Command Message Semantics on page 53.
3. Byte alignment for 4-byte values is Little Endian (Low byte, Middle Low byte, Middle High byte, High Byte).
4. Byte alignment for 2-byte values is Little Endian (Low byte, High Byte).

Polled I/O: Produced General Message Format

NOTE: 32-byte Extended fields are shown with gray-highlighted rows.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Enable	Reg. Level[1]	Home Level[1]	Current Direction	General Fault	On Target Position	Block in Execution[1]	Profile in Progress
1	Block #							
2	Load Complete	Block Fault[1]	Following Error Fault	Negative Limit	Positive Limit	Reverse Limit	Forward Limit	Fault Input[1,2]
3	Response Axis Number			Response Message Type (1 through 5)				
4–7	Response Data[4]							
8–11	Actual Position[4]							
12–15	Actual Velocity[4]							
16–19	Reserved							
20	Attribute to Get Axis Number			Attribute to Get Message Type (0x1A, 0x1B)				
21	Reserved							
22–23	Attribute to Get Number[5]							
24–27	Attribute to Get Data No data if Attribute to Get Axis Number and Message Type are zero							
28–31	Reserved							

Notes:
1. Not supported.
2. Byte 2 bit 0 can be configured as the Servo Bus Voltage Okay status.
3. For semantics, refer to Response Message Semantics on page 54.
4. Byte alignment for 4-byte values is Little Endian (Low byte, Middle Low byte, Middle High byte, High Byte).
5. Byte alignment for 2-byte values is Little Endian (Low byte, High Byte).

General Command / Response Message Types

Command / Response Message Type	Command Data	Response Data	Class 0x25 Attr #3 Mode Setting
1[a]	Target Position	Actual Position	0
2[a]	Target Velocity	Command Position	1
3	Acceleration	Actual Velocity	N/A
4	Deceleration	Command Velocity	N/A
5[a]	Torque	Torque	2
6[a,b]	Position Profile Move - See description below	N/A	0
7[a,b]	Velocity Profile Move - See description below	N/A	1

Notes:
a. The drive Control Mode must match the desired command type in order to start a profile move or apply torque.
b. Only available for 32-byte connections.

Standard Command Types

The standard CIP Command Types 1–5 will load individual motor parameters, such as Acceleration, Deceleration, etc. A Profile Move will be started or a torque will be applied when the command type in the message is Target Position, Target Velocity or Torque, and the Control Mode is set to Position, Velocity or Torque, respectively.

The normal flow for a Position Move:

1. Set the Control Mode to Position Control.
2. Set the Acceleration value.
3. Set the Deceleration value.
4. Set the Target Velocity value.
5. Set the Target Position value (this message would start the Position Move).

The normal flow for a Velocity Move:

1. Set the Control Mode to Velocity Control.
2. Set the Acceleration value.
3. Set the Deceleration value.
4. Set the Target Velocity value (this message would start the Velocity Move).

The normal flow for a apply Torque:

1. Set the Control Mode to Torque Control.
2. Set the Torque value (this message would start Torque Control).

Extended Profile Move Command Types (32-byte message format only)

There are two additional command types when the host I/O connection size is 32 bytes: 6 (Move Position) and 7 (Move Velocity). These commands take advantage of the additional fields in the 32-byte format, allowing a move to be started with one command.

The normal flow for a Position Move:

1. Set the control mode to Position Control.
2. Send a Move Position message (Command type 6) with Target Position, Target Velocity, Acceleration and Deceleration values (this message would start the Position Move).

The normal flow for a Velocity Move:

1. Set the Control Mode to Velocity Control.
2. Send a Velocity Position message (Command type 7) with Target Velocity, Acceleration and Deceleration values (this message would start the Position Move).

   NOTE: A Velocity Move command sent to a motor already in motion with either Position Control or Velocity Control, will immediately change the Target Velocity to the value in the message.

Extended Attribute to Get (32-byte message format only)

The 32-byte format also has fields allowing the Class 6 SmartMotor to send parameter data back to the controller independent of the Command and Response Message types set in the first eight bytes.

- When the "Attribute to Get Message Type" field is set to 26 (0x1A - Position Controller Supervisor) or 27 (0x1B - Position Controller) the motor will return the value of the Object Attribute specified in field "Attribute to Get Number" (bytes 26-27). The value will be returned in the "Attribute to Get Data" field of the response (bytes 24 - 27).
- If there are any errors in the request, the motor will respond with:
  - A Message Type of 0x14 in the Attribute to Get Message Type field of the response
  - The General Error Code in byte 24 of the response
  - The Additional Error Code in byte 25 of the response
  - A value of 0x00 in byte 26 of the response
  - A copy of the Attribute to Get Axis Number / Message Type (byte 24) from the request in byte 27 of the response
- When the "Attribute to Get Message Type" field is set to a value of zero, the motor will set the entire "Attribute to Get" structure and "Attribute to Get Data" of the response (bytes 20 -27) to zeroes.

The general flow when using the Extended Attribute to Get fields: (Assumes the Attribute to Get fields start out loaded with 0x00).

1. Load the "Attribute to Get Number" with the desired Attribute Number.
2. Load the "Attribute to Get Axis Number" with a value of 0 or 1.
3. Load the "Attribute to Get Message Type" with the number for the desired object 0x1A (Position Controller Supervisor) or 0x1B (Position Controller).
4. Wait for the "Attribute to Get Message Type" and "Attribute to Get Number" in the response to match the requested values. If the "Attribute to Get Message Type" becomes 0x14 there is an error in the request, follow the logic for errors in section Error Response Message Type (0x14) on page 52.
5. When the "Attribute to Get Message Type" and "Attribute to Get Number" match the requested values, process the data in the response.
6. Clear the "Attribute to Get Message Axis Number / Type" and "Attribute to Get Number" values to values of 0x00.
7. Wait for the "Attribute to Get Message Type" field changes to zero in the response.

The motor will respond with the current value of the requested Attribute to Get each time the motor processes the I/O message independent of the Implicit Message handshaking.

Attribute GET/SET Command Types 0x1A and 0x1B

This section describes the formats for consumer and producer GET/SET messages. These message types allow the set and get services of the Position Controller Supervisor(type 0x1A) and Position Controller(type 0x1B) classes and their objects attributes. This is a form of indirect addressing over the Polled I/O Connection instead of using an Explicit Connection transfer.

Polled I/O: Consumed Message Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Enable	Reg. Arm[1]	Hard Stop	Smooth Stop	Direction (Vel. mode)	Incremental	Start Block[1]	Load Data/ Start Profile
1	Attribute Number to GET							
2	Command Axis Number			Command Message Type (**0x1A or 0x1B**)				
3	Attribute Number to SET							
4	Command (SET) Data Low Byte							
5	Data Middle Low							
6	Data Middle High							
7	Command Data High Byte							

Notes:
1. Byte 0 bits 6 and 1 are not supported Class 5 motors.
2. For Semantics, refer to Command Message Semantics on page 53.

Polled I/O: Produced Message Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Enable	Reg. Level[2]	Home Level[2]	Current Direction	General Fault	On Target Position	Block in Execution[2]	Profile in Progress
1	GET Attribute Number for the Response Data							
2	Load Complete	Block Fault[2]	Following Error Fault	Negative Limit	Positive Limit	Reverse Limit	Forward Limit	Fault Input Fault[1]
3	Response Axis Number			Response Message Type (**0x1A or 0x1B**)				
4	Response (GET) Data Low Byte							
5	Data Middle Low							
6	Data Middle High							
7	Response Data High Byte							

Notes:
1. Byte 2 bit 0 can be configured as the Servo Bus Voltage Okay status.
2. Not supported.
3. For Semantics, refer to Response Message Semantics on page 54.

Attribute Message Types

NOTE: See byte 3 in the previous tables.

Message Type	Class Number	Class Description	Command Data	Response Data
26(0x1A)	36(0x24)	Position Controller Supervisor	Attribute Value to Set	Attribute Value to Get
27(0x1B)	37(0x25)	Position Controller	Attribute Value to Set	Attribute Value to Get

Error Response Message Type (0x14)

This section describes the formats for producer Error Response messages. It also provides the error codes for the Position Controller Device.

Polled I/O: Produced Error Response Message Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Enable	Reg. Level[1]	Home Level[1]	Current Direction	General Fault	On Target Position	Block in Execution[1]	Profile in Progress
1	Reserved = 0							
2	Load Complete	Block Fault[1]	Following Error Fault	Negative Limit	Positive Limit	Reverse Limit	Forward Limit	Fault Input[1,2]
3	Response Axis Number			Response Message Type (0x1A or 0x1B)				
4	General Error Code							
5	Additional Error Code							
6	Copy of Command message Byte 2							
7	Copy of Command Message Byte 3							

Notes:
1. Not supported.
2. Byte 2 bit 0 can be configured as the Servo Bus Voltage Okay status.
3. For Semantics, refer to Response Message Semantics on page 54.

Error Codes for Position Controller Device

General Error Code	Additional Error Code	Error Description	Semantics
0x08	0x01	Service Not Supported	Command message type is not supported; this will take precedence over additional code 2
	0x02	Service Not Supported	Response message type not supported
0x05	0x01	Path Destination Unknown	Consumed axis number was requested that does not exist
	0x02	Path Destination Unknown	Asked to produce data for a axis number that does not exist
0x09	0xFF	Invalid Attribute Value	Value typically out of range
0x0E	0xFF	Attribute Not Settable	Requested to modify something not changeable
0x13	0xFF	Not Enough Data	I/O Command message was lees then 8 bytes
0x14	0xFF	Attribute Not Supported	Requested or specified attribute is not supported

Semantics for Command and Response Messages

This section provides semantic information for the command and response messages in the previous tables.

Command Message Semantics

This following table provides semantic information for the command messages.

Item	Cmd Msg Type	Description
Load Data/ Start Profile		Set from zero to one to load command data. The transition of this bit from zero to one will also start a Profile Move when the command message type contained in the command message field is the message type that starts a Profile Move for the mode selected.
Start Block		Not supported.
Incremental		This bit is used to define the position value as either absolute or incremental. 0 = absolute position value and 1 = incremental position value.
Direction (V. Mode)		This bit is used to control the direction of the motor in Velocity mode. 1 = forward, positive; 0 = reverse, negative.
Smooth Stop		This bit is used to bring the motor to a controlled stop at the currently implemented deceleration rate.
Hard Stop		This bit is used to bring the motor to an immediate stop.
Registration Arm		Not supported.
Enable		This bit is used to control the enable output. Clearing this bit will set the enable output inactive and the currently executing motion profile will be aborted.
Block #		This byte defines the block number to be executed when the Start Block bit transitions from zero to one.
Command Message Type		This field defines the Command Message Type
Response Message Type		This field defines the Response Message Type
Command Axis Number		These three bits define the Consumed Axis Connection attribute of the Position Controller Supervisor class. This attribute value specifies the instance number of all of the axis objects whose data are contained in the I/O command message. The SmartMotor is a single-axis device. Therefore, only axis 1 is used, which can be specified by either 0 or 1.
Target Position	0x01	This double word defines the Profile Move's Target Position in position units, when the Load Data /Start Profile bit transitions from zero to one.
Target Velocity	0x02	This double word defines the Profile Move's Target Velocity in profile units, when the Load Data /Start Profile bit transitions from zero to one

Item	Cmd Msg Type	Description
Acceleration	0x03	This double word defines the Profile Move's Acceleration in profile units, when the Load Data /Start Profile bit transitions from zero to one.
Deceleration	0x04	This double word defines the Profile Move's Target Position in profile units, when the Load Data /Start Profile bit transitions from zero to one.
Torque	0x05	This double word is used to set the output torque, when the Load Data /Start Profile bit transitions from zero to one. The torque value will only take effect when in torque mode. (Position Controller Object Attribute 3 = 2)
Attribute Value	0x1A–0x1B	This double word defines the value of the attribute to set, when the Load Data/Start Profile bit transitions from zero to one.
Object Attribute to Get	0x1A–0x1B	This byte defines the object attribute to get the value of and return in the response message.
Object Attribute to Set	0x1A–0x1B	This byte defines the object attribute to set to the new value defined by the Attribute Value when the Load Data/Start Profile bit transitions from zero to one.

Response Message Semantics

This following table provides semantic information for the response messages.

Item	Description
Profile in Progress	This bit indicates that a profile move is in progress.
Block in Execution	Not supported.
On Target Position	This bit indicates whether or not the motor is on the last targeted position. (1 = Current position equals the last target position.)
General Fault	This bit indicates the logical "or" of all fault conditions.
Current Direction	This bit shows the current direction of the motor. If the motor is not moving the bit indicates the direction of the last commanded move. 0 = reverse, negative direction; 1 = forward, positive direction.
Home Level	Not supported.
Registration Level	Not supported.
Enable	This bit indicates the state of the enable output. A 1 indicates the enable output is active.
Executing Block #	This byte defines the currently executing block if the Block In Execution bit is active.
Fault Input	Not supported.
Forward Limit	This bit indicates that the forward input is active.
Reverse Limit	This bit indicates that the reverse input is active.

Item	Description
Positive Limit	This bit indicates that the motor has attempted to travel past the programmed positive limit position. This bit remains valid until the motor is moved within the limits or the programmed limit value is set greater than the current position.
Negative Limit	This bit indicates that the motor has attempted to travel past the programmed negative limit position. This bit remains valid until the motor is moved within the limits or the programmed limit value is set less than the current position.
Following Error Fault	This bit indicates that a following error fault has occurred. This fault occurs when the following error, or difference between the commanded and actual position, exceeds the programmed allowable following error.
Block Fault	Not supported.
Load Complete	This bit indicates that the command data contained in the command message has been successfully loaded into the device.
Response Message Type	This byte defines the Response Message Type
Response Axis Number	These three bits report the Produced Axis Connection attribute of the Position Controller Supervisor class. This attribute value specifies the instance number of all of the axis objects whose data is contained in the I/O response message. The SmartMotor is a single-axis device. Therefore, only axis 1 is used, which can be reported as either 0 or 1.
Actual Position	This double word reflects the actual position in position units. If position feedback is not used, this word will report the commanded position.
Commanded Position	This double word reflects the commanded or calculated position in position units.
Actual Velocity	This double word reflects the actual velocity in profile units.
Command Velocity	This double word reflects the commanded or calculated velocity in profile units.
Torque	This double word reflects the torque.
Home Position	This double word reflects the captured home position in position units.
Index Position	This double word reflects the captured index position in position units.
Registration Position	This double word reflects the captured registration position in position units.
General Error Code	This byte identifies an error has been encountered. The specific behavior for the Position Controller Profile is summarized in Error Response Message Type (0x14) on page 52. For a complete list of General Error codes, see Appendix B in *THE CIP NETWORKS LIBRARY Volume 1 - Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.
Additional Code	This byte contains an object/service-specific value that further describes the error condition. If the responding object has no additional information to specify, then the value 0xFF is placed within this field.
Attribute Value	This double word reflects the value of the attribute to get.
Object Attribute to Get	This byte defines the object attribute from which to get the value.

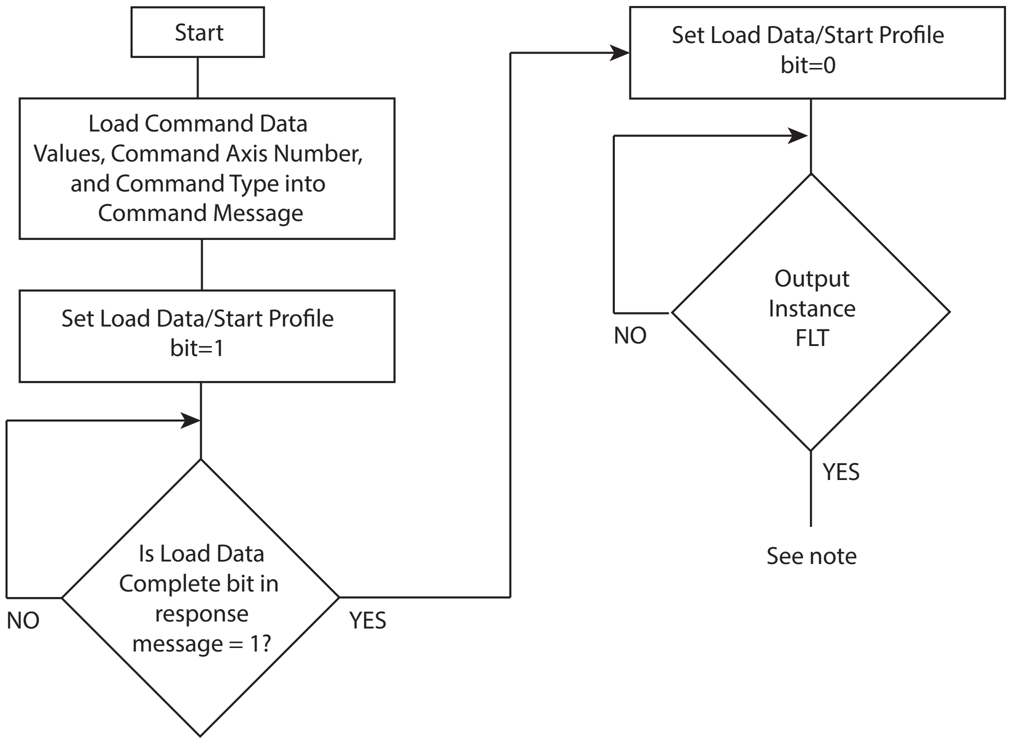
Position Controller I/O Handshaking

This section describes I/O handshaking for the Position Controller device.

NOTE: References to "client" are from the viewpoint of the Master device.

Client Data Loading Procedure

The following figure describes the client data loading procedure.

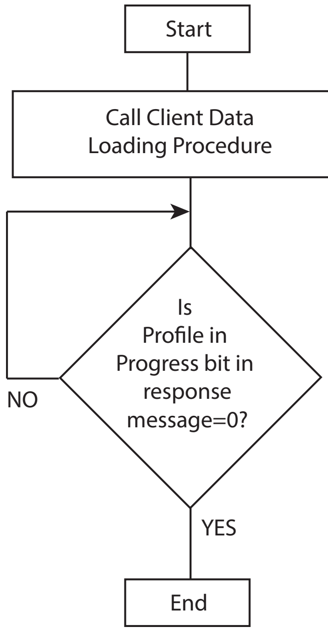

Start
Load Command Data Values, Command Axis Number, and Command Type into Command Message
Set Load Data/Start Profile bit=1
Is Load Data Complete bit in response message = 1?
NO
YES
Set Load Data/Start Profile bit=0
Output Instance FLT
NO
YES
See note

Client Data Loading Procedure

NOTE: When the Event Data Block is present, additional elements are included based on the Event Checking Status element. If the Extended Format bit is set in the Event Checking Status word, then the following are included: Reg Data Ack, Home Data Ack, and Watch Data Ack. The Event Block Count field determines the repetition (from zero to seven times) of the following elements: Event ID #, Event Status #, Event Type #, Event Position #, and Event Time Stamp #.

Client Profile Move Procedure

The following figure describes the client profile move procedure.

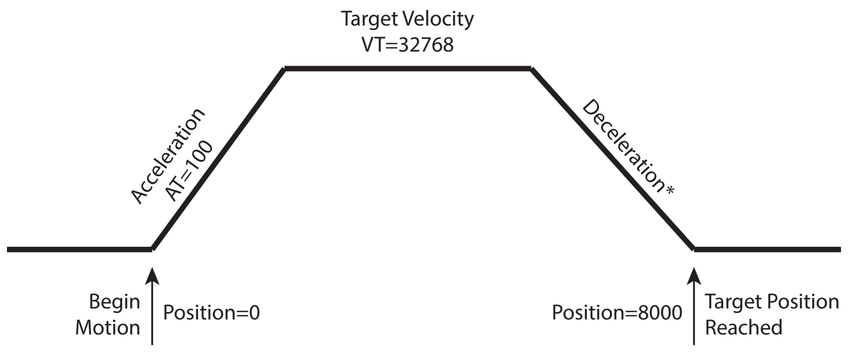

Start
Call Client Data Loading Procedure
Is Profile in Progress bit in response message=0?
NO
YES
End

Client Profile Move Procedure

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

Profile Moves

Attribute 3 of the Position Controller Object determines how the device operates and responds for a profile move. A profile move uses Acceleration (and Deceleration) and a Target Velocity to operate the device at the Target Velocity or move it to a Target Position. It can also output a Torque if the Position Controller (0x25) Attribute 3 value is set for that. Refer to the following figure—the values shown are the same ones used in the I/O Assembly Examples later in this section.



*NOTE: For the SmartMotor, there is an override that automatically sets DT equal to AT if the motor power is turned on and only AT is set.

Motion Profile For I/O Assembly Examples

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

Torque Command

Attribute 3 of the Position Controller Object determines how the device operates. The SmartMotor can output a Torque command to the integrated motor if the Position Controller (0x25) Attribute 3 value is set for Torque mode using a setting of 2 for the attribute.

Refer to the *SmartMotor™ Developer's Guide* for further information on Torque mode.

Control Mode Change - Change Dynamic

With the SmartMotor, it is possible to change from one control mode to another during operation or while in a move profile in any other mode. In other words, while operating in Position mode with Position Controller mode Attribute 3 set to the value 0 and using Implicit Message Type 1, the programmer can change to Torque mode by setting Attribute 3 to the value 2 and then executing a new "Start Profile" with Implicit Message Type 5.

This "Change Dynamic" feature can be fully executed using the Implicit Messages of the Position Controller Device. This is facilitated using Message Type 0x1B during a profile once it has started, and then starting another profile after changing the mode attribute.

Position Controller Implicit I/O Message Examples

These examples are meant for reference only. They depict the Frame data on the bus over the Implicit Connection for the Position Controller Device (0x10) I/O assembly to create a profile move (refer to the following description). When operating on DeviceNet, these frames are for the Polled I/O Implicit Connection.

> **NOTE:**
> To simplify the presentation, these examples do not include extended data transfer across the network.
>
> All but the last example show the standard 8-byte command/response frames. If the drive is configured for the extended 32-byte frames, the extra 24 bytes are assumed to be set to values of zero.

SmartMotor Notes

For proper operation, external hardware input conditions must be satisfied to get the desired results. For example, to enable the drive stage on the model SM23166MT SmartMotor, the drive-enable input (pin 8 of the 12-pin I/O connector) must be at 24 Volts (enabled).

The SmartMotor is a single axis. Therefore, the value 0 or 1 may be used for the axis number in the I/O Data (the examples typically use 0 for easier reading). Also, the symbol "0x??" is used to indicate there are bits within the byte that are determined by the present state of the SmartMotor.

The following are further assumptions for the SmartMotor:

- Motor sample rate set to: 16 kHz
- Motor counts per revolution: 4000
- Motor mode: Position
- Hardware Travel Limits are Satisfied or Disabled
- SmartMotor Hardware Enable is Satisfied

Set Acceleration

For the following example, Command Frame = CF, Response Frame = RF.

Frame Type		**Frame Data (Hexadecimal Bytes)**	**Result**
CF	0–7	01 00 23 21 7D 01 00 00	Axis 1 ADT=100
RF	0–7	?? 00 8? 21 00 00 00 00	Axis 1 at Position 0
Clear the Load Data, Power Stage ON			
CF	0–7	80 00 01 01 00 00 00 00	Ask for position
RF	0–7	8? 00 0? 01 00 00 00 00	Axis 1 ON, Position 0

Set Velocity, Leave Drive ON

For the following example, Command Frame = CF, Response Frame = RF.

Frame Type		**Frame Data (Hexadecimal Bytes)**	**Result**
CF	0–7	8D 00 02 01 A0 0F 00 00	Axis 1 VT=32768
RF	0–7	8? 00 8? 01 00 00 00 00	Axis 1 at Position 0
Clear the Load Data			
CF	0–7	80 00 01 01 00 00 00 00	Ask for position
RF	0–7	8? 00 0? 01 00 00 00 00	Axis 1 ON, Position 0

Set Target Position, Perform Move

For the following example, Command Frame = CF, Response Frame = RF.

Frame Type		**Frame Data (Hexadecimal Bytes)**	**Result**
CF	0–7	81 00 01 01 40 1F 00 00	PT=8000 G
RF	0–7	81 00 8? 01 00 00 00 00	Axis 1 at Position 0
Clear the Load Data (assumes motor completed move)			
CF	0–7	80 00 01 01 00 00 00 00	Ask for position
RF	0–7	80 00 0? 01 40 1F 00 00	Position 8000

Disable Hardware Limits (Object 0x25, Attribute 49)

For the following example, Command Frame = CF, Response Frame = RF.

Frame Type		**Frame Data (Hexadecimal Bytes)**	**Result**
CF	0–7	01 31 1B 31 E0 00 00 00	
RF	0–7	0? 31 8? 1B E0 00 00 00	
Clear the Load Data			
CF	0–7	00 00 01 01 00 00 00 00	Ask for position
RF	0–7	0? 00 0? 01 00 00 00 00	At Position 0
NOTE: If the SmartMotor is on, this will turn it off.			

Extended Position Move (32-byte frame)

For the following example, Command Frame = CF, Response Frame = RF.

Frame Type		Frame Data (Hexadecimal Bytes)	Result

CF	0–15
	16–31
		8d 00 06 01 00 00 00 00 60 e3 16 00 90 e2 00 00
		ac 0d 00 00 10 0e 00 00 00 00 00 00 00 00 00 00
			AT=3500 DT=3600
			VT=58000
			PRT=1500000 G

RF	0–15 16–31	91 00 80 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	Axis 1 at Position 0, Velocity 0 Load Complete set
RF	0–15 16–31	91 00 00 01 01 00 00 00 01 00 00 00 7f 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	Axis 1 at Position 1, Velocity 127 Load Complete clear
The move continues until the target position is reached			
RF	0–15 16–31	94 00 00 01 60 e3 16 00 60 e3 16 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	Axis 1 at Position 1500000, Velocity 0 Load Complete clear

Object Reference

This chapter provides details on the EtherNet/IP protocol objects used with the Moog Animatics SmartMotor. The following TOC provides a listing of those objects.

The Moog Animatics Class 6 SmartMotor device profile supports the required object classes of the Position Controller Device 0x10 (see Volume 1 of the ODVA CIP specification). For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

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Required Objects

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Identity Object (0x01)

The following tables provide the Class and Identity Attributes, and the Supported Services for the Identity Object (0x01).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 1	If updates require an increased value, the value increases by 1.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 1	The largest instance number this object.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 1	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Identity Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Vendor ID	UINT	Identification of each vendor by number. Default Value: 810	Vendor ID. Zero is not valid.
2	Get	Device Type	UINT	Indication of general type of product. Default Value: 16	
3	Get	Product Code	UINT	Identification of a particular product of an individual vendor. Default Value: 10	Product code (vendor assigned).

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
4	Get	Revision	STRUCT of:	Revision of the item the Identity Object represents. Default Value: 1.1	Zero is not valid for either the Major or Minor Revision fields.
		Major Revision	USINT	Incremented by the vendor when there is a significant change to the product "fit, form, or function".	Limited to values between 1 and 127; the eighth bit (representing, when set to one, values of 128 – 255) is reserved by CIP and shall have a value of zero.
		Minor Revision	USINT	Identifies product changes that do not affect user configuration choices.	Displayed as three digits with leading zeros as necessary.
5	Get	Status	WORD	Summary status of device.	See below: Attribute 5: Status
6	Get	Serial Number	UDINT	Serial number of device	Set by factory.
7	Get	Product Name	SHORT_STRING	Human readable identification.	Set by factory; will match motor's name plate.
8	Get	State	USINT	Present state of the device as represented by the state transition diagram.	0 = Nonexistent 1 = Device Self Testing 2 = Standby 3 = Operational 4 = Major Recoverable Fault 5 = Major Unrecoverable Fault 6 – 254 = Reserved 255 = Default Value
9	Get	Configuration Consistency Value	UINT	Contents identify configuration of device.	
10	Get	Heartbeat Interval	USINT	The nominal interval between heartbeat messages in seconds.	

Instance Attributes Semantics

Attribute 5: Status

Bits	Name	Description
0	Owned	TRUE indicates the device (or an object within the device) has an owner. Within the Master/Slave paradigm the setting of this bit means that the Predefined Master/Slave Connection Set has been allocated to a master. Outside the Master/Slave paradigm the meaning of this bit is TBD.
1		Reserved; 0.
2	Configured	TRUE indicates the application of the device has been configured to do something different than the "out–of–box" default. This shall not include configuration of the communications.
3		Reserved; 0.
4-7	Extended Device Status	Vendor–specific or as defined by the following table. The EDS shall indicate if the device follows a vendor-specific definition for these bits by using the DeviceStatusAssembly keyword. See Default Values for Bits 4-7.
8	Minor Recoverable Fault	TRUE indicates the device detected a problem with itself, which is thought to be recoverable. The problem does not cause the device to go into one of the faulted states.
9	Minor Unrecoverable Fault	TRUE indicates the device detected a problem with itself, which is thought to be unrecoverable. The problem does not cause the device to go into one of the faulted states.
10	Major Recoverable Fault	TRUE indicates the device detected a problem with itself, which caused the device to go into the "Major Recoverable Fault" state.
11	Major Unrecoverable Fault	TRUE indicates the device detected a problem with itself, which caused the device to go into the "Major Unrecoverable Fault" state.
12-15	Extended Device Status 2	Reserved; eiter 0 or vendor specific.

Default Values for Bits 4-7

Value	Description
0	Self-Testing or Unknown
1	Firmware Update in Progress
2	At least one faulted I/O connection
3	No I/O connections established
4	Non-Volatile Configuration bad
5	Major Fault – either bit 10 or bit 11 is true (1)
6	At least one I/O connection in run mode
7	At least one I/O connection established, all in idle mode
8-9	Reserved

Value	Description
10-15	Vendor specific[1]
1. No mechanism is provided to enumerate the vendor-specific use of these values in the EDS file.	

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x01	•	•	Get_Attributes_All	Returns a predefined listing of this object's attributes
0x05			Reset	Invokes the Reset service for the device.
0x0E	•	•	Get_Attribute_Single	Returns the contents of the specified attribute
0x10	•	•	Set_Attribute_Single	Modifies an attribute (required if Heartbeat Interval is defined)

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

Message Router Object (0x02)

The following tables provide the Class and Identity Attributes, and the Supported Services for the Message Router Object (0x02).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 1	The current assigned value is 1. If updates require an increased value, the value increases by 1.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 1	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 1	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Instance Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x0E	•	•	Get_Attribute_Single	Returns the contents of the specified attribute

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

Assembly Object (0x04)

The following tables provide the Class and Identity Attributes, and the Supported Services for the Assembly Object (0x04).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 2	The current value assigned to this attribute is 2.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 0xFFFF	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 0	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Instance Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
3	Get	Data	ARRAY of BYTE	Assembly Data	
4	Get	Size	UINT	Number of bytes in Attribute 3.	

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x0E	•	•	Get_Attribute_Single	Returns contents of the specified attribute
0x10		•	Set_Attribute_Single	Modifies an attribute value.

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

Connection Manager Object (0x06)

The following tables provide the Class and Identity Attributes, and the Supported Services for the Connection Manager Object (0x06).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 1	The current assigned value is 1. If updates require an increased value, the value increases by 1.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 1	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 1	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Instance Attributes

None.

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x0E	•	•	Get_Attribute_Single	Returns the contents of the specified attribute
0x10		•	Set_Attribute_Single	Modifies an attribute value.
0x4E	•		Forward_Close	Closes a connection
0x54	•		Forward_Open	Opens a connection

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

TCP/IP Interface Object (0xF5)

The following tables provide the Class and Identity Attributes, and the Supported Services for the TCP/IP Interface Object (0xF5).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 3	
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 1	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 1	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Instance Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Status	DWORD	Interface status	See below: Attribute 1: Status
2	Get	Configuration Capability	DWORD	Interface capability flags. Default Value: 0x95	Bitmap of capability flags. See below: Attribute 2: Configuration Capability
3	Set/Get (NV)	Configuration Control	DWORD	Interface control flags Default Value: 0	Bitmap of control flags. See below: Attribute 3: Configuration Control

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
4	Get	Physical Link Object	STRUCT of:	Path to physical link object.	E.g., 0x20, 0xF6, 0x24, 0x01; where: [20] = 8 bit class segment type; [F6] = Ethernet Link Object class; [24] = 8 bit instance segment type; [01] = instance 1
		Path size	UINT	Size of Path	Number of 16 bit words in Path
		Path	Padded EPATH	Logical segments identifying the physical link object.	Path is restricted to one logical class segment and one logical instance segment. Max size is 12 bytes.

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
5[a]	Set/Get (NV)	Interface Configuration	STRUCT of:	TCP/IP network interface configuration. Default Value: 0	Contains the configuration parameters required for a device to operate as a TCP/IP node.
		IP Address(a)	UDINT		0 = no IP address has been configured. Otherwise, set IP address to valid Class A, B, or C address. Loopback address (127.0.0.1) is not allowed.
		Network Mask	UDINT	The device's network mask	0 = network mask address not configured
		Gateway Address	UDINT	Default gateway address	0 = no gateway address has been configured. Otherwise, set address to valid Class A, B, or C address. Loopback address (127.0.0.1) is not allowed.
		Name Server	UDINT	Primary name server	0 = no name server address has been configured. Otherwise, set address to valid Class A, B, or C address.
		Name Server 2	UDINT	Secondary name server	0 = no secondary name server address has been configured. Otherwise, set address to valid Class A, B, or C address.
		Domain Name	STRING	Default domain name	ASCII characters. Maximum length is 48 characters. 0 = no Domain Name is configured.
6	Set/Get (NV)	Host Name	STRING	Host name. Default Value: ""	ASCII characters. Maximum length is 64 characters. Pad to an even number of characters (pad not included in length). 0 = no Host Name is configured.

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
7	Get	Safety Network Number	6 octets	See CIP Safety Specification, Volume 5, Chapter 3 (available from ODVA.org). Default Value: 0	
8	Set/Get (NV)	TTL Value	USINT	TTL value for EtherNet/IP multicast packets. Default Value: 1	Time-to-Live value for IP multicast packets. Default value is 1. Minimum is 1; maximum is 255
9	Set/Get (NV)	Mcast Config	STRUCT of:	IP multicast address configuration. Default Value: 0	0 = default allocation algorithm 1 = allocated according to the values specified in Num Mcast and Mcast Start Addr 2 = Reserved
		Alloc Control	USINT	Multicast address allocation control word. Determines how addresses are allocated.	Determines whether multicast addresses are generated via algorithm or are explicitly set.
		Reserved	USINT	Reserved.	0
		Num Mcast	UINT	Number of IP multicast addresses to allocate for EtherNet/IP.	The number of IP multicast addresses allocated, starting at “Mcast Start Addr”. Maximum value is device specific. However, shall not exceed the number of EtherNet/IP multicast connections supported by the device.
		Mcast Start Addr	UDINT	Starting multicast address from which to begin allocation.	IP multicast address (Class D). A block of “Num Mcast” addresses is allocated starting with this address.
10	Set/Get (NV)	SelectAcd	BOOL	Activates the use of ACD. Default Value: 1	1 = enable ACD (default), 0 = disable ACD

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
11	Set/Get (NV)	Last Conflict Detected	STRUCT of:	Structure containing information related to the last conflict detected. Default Value: 0	ACD Diagnostic Parameters. See below: Attribute 11: LastConflictDetected
		AcdActivity	USINT	State of ACD activity when last conflict detected. Default Value: 0	ACD activity
		RemoteMAC	Array of 6 USINT	MAC address of remote node from the ARP PDU in which a conflict was detected. Default Value: 0	MAC from Eth Pkt Hdr.
		ArpPdu	ARRAY of 28 USINT	Copy of the raw ARP PDU in which a conflict was detected. Default Value: 0	ARP PDU
12	Set/Get (NV)	EtherNet/IP QuickConnect	BOOL	Enable/Disable of QuickConnect feature. Default Value: 0	0 = Disable (default) 1 = Enable
13	Set/Get (NV)	Encapsulation Inactivity Timeout	UINT	Number of seconds of inactivity before TCP connection is closed. Default Value: 120	0 = disabled 1-3600 = timeout (sec)

a. The drive is shipped out-of-box with an IP Address of 0.0.0.0. This address enables DHCP support for addressing. The DHCP server manages the IP Address assigned to the drive. If a value other than 0.0.0.0 is assigned then DHCP is disabled and the static IP Address is used. Assigning an IP Address of 0.0.0.0 will re-enable DHCP. Value is formatted as an IP address entered as a string, e.g., IPCTL(0,"192.168.0.10"). By default, these values are set to 0 (i.e., "0.0.0.0")

NOTE: The drive must be power cycled or reset using a "Z" terminal window command before the new IP Address takes affect.

Instance Attributes Semantics

Attribute 1: Status

Bits	Name	Description
0-3	Interface Configuration Status	0 = Interface Configuration attribute has not been configured. 1 = Interface Configuration attribute contains configuration obtained from BOOTP, DHCP or nonvolatile storage. 2 = IP address member of the Interface Configuration attribute contains configuration, obtained from hardware settings (e.g.: pushwheel, thumbwheel, etc.) 3-15 = Reserved
4	Mcast Pending	Indicates a pending configuration change in the TTL Value and/or Mcast Config attributes. This bit is set when either the TTL Value or Mcast Config attribute is set; it is cleared the next time the device starts.

Bits	Name	Description
5	Interface Configuration Pending	Indicates a pending configuration change in the Interface Configuration attribute. This bit is 1 (TRUE) when Interface Configuration attribute are set and the device requires a reset in order for the configuration change to take effect (as indicated in the Configuration Capability attribute). The intent of the Interface Config Pending bit is to allow client software to detect that a device's IP configuration has changed, but will not take effect until the device is reset.
6	AcdStatus	Indicates when an IP address conflict has been detected by ACD. This bit shall default to 0 (FALSE) on startup. If ACD is supported and enabled, then this bit is set to 1 (TRUE) any time an address conflict is detected as defined by the [ConflictDetected] transitions.
7	AcdFault	Indicates when an IP address conflict has been detected by ACD or the defense failed, and that the current Interface Configuration cannot be used due to this conflict. This bit is 1 (TRUE) if an address conflict has been detected and this interface is currently in the Notification & FaultAction or AcquireNewIpv4Parameters ACD state, and is 0 (FALSE) otherwise.When this bit is set, then this CIP port will not be usable. However, for devices with multiple ports, this bit provides a way of determining if the port has an ACD fault and thus cannot be used.
8-31	Reserved	0

Attribute 2: Configuration Capability

Bits	Name	Description
0	BOOTP Client	1 (TRUE) = device is capable of obtaining its network configuration via BOOTP.
1	DNS Client	1 (TRUE) = device is capable of resolving host names by querying a DNS server.
2	DHCP Client	1 (TRUE) = device is capable of obtaining its network configuration via DHCP.
3	DHCP-DNS Update	0
4	Configuration Settable	1 (TRUE) = the Interface Configuration attribute is settable.
5	Hardware Configurable	If 1 (TRUE), the IP Address member of the Interface Configuration attribute can be obtained from hardware settings. If this bit is FALSE the Status Instance Attribute (1), Interface Configuration Status field value shall never be 2. (The Interface Configuration attribute contains valid configuration, obtained from hardware settings.)
6	Interface Configuration Change Requires Reset	If 1 (TRUE), the device requires a restart in order for a change to the Interface Configuration attribute to take effect. If this bit is FALSE a change in the Interface Configuration attribute will take effect immediately.
7	AcdCapable	1 (TRUE) = device is ACD capable
8-31	Reserved	0

Attribute 3: Configuration Control

Bits	Name	Description
0-3	Configuration Method	0 = device shall use statically-assigned IP configuration values. 1 = device shall obtain its interface configuration values via BOOTP. 2 = device shall obtain its interface configuration values via DHCP. 3-15 = Reserved.
4	DNS Enable	If 1 (TRUE), the device shall resolve host names by querying a DNS server.
5-31	Reserved	0

Attribute 11: LastConflictDetected

AcdActivity

Value	AcdMode	Description
0	NoConflictDetected (Default)	No conflict has been detected since this attribute was last cleared.
1	ProbeIpv4Address	Last conflict detected during ProbeIpv4Address state.
2	OngoingDetection	Last conflict detected during OngoingDetection state or subsequent DefendWithPolicyB state.
3	SemiActiveProbe	Last conflict detected during SemiActiveProbe state or subsequent DefendWithPolicyB state.

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x01		•	Get_Attributes_All	Returns a predefined listing of this objects attributes
0x0E	•	•	Get_Attribute_Single	Returns the contents of the specified attribute
0x10		•	Set_Attribute_Single	Modifies an attribute value.

For more details, see *THE CIP NETWORKS LIBRARY, Volume 2: EtherNet/IP Adaptation of CIP*, which is available on the ODVA.org website.

Ethernet Link Object (0xF6)

The following tables provide the Class and Identity Attributes, and the Supported Services for the Ethernet Link Object (0xF6).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 3	The minimum value = 1. Use ≥2 if instance attribute 6 is implemented. Use 3 if any instance attributes 7-10 are implemented. Max value = 3.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 2	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 2	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Instance Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Interface Speed	UINT	Interface speed currently in use. Default Value: 100	Speed in Mbps (e.g., 0, 10, 100, 1000, etc.)
2	Get	Interface Flags	DWORD	Interface status flags. Default Value: 0x20	Bit map of interface flags. See Attribute 2: Interface Flags.

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
3	Get	Physical Address	ARRAY of 6 USINTs	MAC layer address	Assigned by the manufacturer, per IEEE 802.3 requirements.
4	Get	Interface Counters	STRUCT of:		Counters relevant to the receipt of packets on the interface.
		In Octets	UDINT	Octets received on the interface	
		In Ucast Packets	UDINT	Unicast packets received on the interface	
		In NUcast Packets	UDINT	Non-unicast packets received on the interface	
		In Discards	UDINT	Inbound packets received on the interface but discarded	
		In Errors	UDINT	Inbound packets that contain errors (does not include In Discards)	
		In Unknown Protos	UDINT	Inbound packets with unknown protocol	
		Out Octets	UDINT	Octets sent on the interface	
		Out Ucast Packets	UDINT	Unicast packets sent on the interface	
		Out NUcast Packets	UDINT	Non-unicast packets sent on the interface	
		Out Discards	UDINT	Outbound packets discarded	
		Out Errors	UDINT	Outbound packets that contain errors	

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
5	Get	Media Counters	STRUCT of:	Media-specific counters	Contains counters specific to Ethernet media.
		Alignment Errors	UDINT	Frames received that are not an integral number of octets in length	
		FCS Errors	UDINT	Frames received that do not pass the FCS check	
		Single Collisions	UDINT	Successfully transmitted frames which experienced exactly one collision	
		Multiple Collisions	UDINT	Successfully transmitted frames which experienced more than one collision	
		SQE Test Errors	UDINT	Number of times SQE test error message is generated	
		Deferred Transmissions	UDINT	Frames for which first transmission attempt is delayed because the medium is busy	
		Late Collisions	UDINT	Number of times a collision is detected later than 512 bit-times into the transmission of a packet	
		Excessive Collisions	UDINT	Frames for which transmission fails due to excessive collisions	
		MAC Transmit Errors	UDINT	Frames for which transmission fails due to an internal MAC sublayer transmit error	
		Carrier Sense Errors	UDINT	Times that the carrier sense condition was lost or never asserted when attempting to transmit a frame	
		Frame Too Long	UDINT	Frames received that exceed the maximum permitted frame size	
		MAC Receive Errors	UDINT	Frames for which reception on an interface fails due to an internal MAC sublayer receive error	

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
6	Set/Get (NV)	Interface Control	STRUCT of:	Configuration for physical interface. Default Value: 0	See Attribute 6: Interface Control.
		Control Bits	WORD	Interface Control Bits	
		Forced Interface Speed	UINT	Speed at which the interface is set to operate.	Speed in Mbps (10, 100, 1000, etc.)
7	Get	Interface Type	USINT	Type of interface: twisted pair, fiber, internal, etc. Default Value: 0x02	See Attribute 7: Interface Type.
8	Get	Interface State	USINT	Current state of the interface: operational, disabled, etc. Default Value: 0	See Attribute 8: Interface State.
9	Set/Get (NV)	Admin State	USINT	Administrative state: enable, disable. Default Value: 0	See Attribute 9: Admin State.
10	Get	Interface Label	SHORT_ STRING	Human readable identification. Default Value: "port1", "port2"	Text string that describes the interface; content of the string is vendor specific.

Instance Attributes Semantics

Attribute 2: Interface Flags

Bits	Name	Description
0	Link Status	Indicates whether or not the IEEE 802.3 communications interface is connected to an active network: 0 = inactive link; 1 = active link. The determination of link status is implementation specific. In some cases, devices can tell whether the link is active via hardware/driver support. In other cases, the device may only be able to tell whether the link is active by the presence of incoming packets.
1	Half/Full Duplex	Indicates the duplex mode currently in use by the interface: 0 = half duplex; 1 = full duplex. Note that if the Link Status flag is 0, then the value of the Half/Full Duplex flag is indeterminate.

Bits	Name	Description
2-4	Negotiation Status	Indicates the status of link auto-negotiation: 0 = Auto-negotiation in progress. 1 = Auto-negotiation and speed detection failed. Using default values for speed and duplex. Default values are product-dependent; recommended defaults are 10 Mbps and half duplex. 2 = Auto negotiation failed but detected speed. Duplex was defaulted. Default value is product-dependent; recommended default is half duplex. 3 = Successfully negotiated speed and duplex. 4 = Auto-negotiation not attempted. Forced speed and duplex.
5	Manual Setting Requires Reset	Indicates whether or not the device requires a reset to apply changes made to the Interface Control attribute (#6): 0 = the device automatically applies changes made to the Interface Control attribute (#6) and, therefore, does not require a reset in order for changes to take effect. This is the value this bit shall have when the Interface Control attribute (#6) is not implemented. 1 = the device does not automatically apply changes made to the Interface Control attribute (#6) and, therefore, will require a reset in order for changes to take effect.
6	Local Hardware Fault	0 = the interface detects no local hardware fault; 1 = a local hardware fault is detected. The meaning of this is product-specific. Examples are an AUI/MII interface detects no transceiver attached or a radio modem detects no antennae attached. In contrast to the soft, possible self-correcting nature of the Link Status being inactive, this is assumed a hard-fault requiring user intervention.
7-31	Reserved	Set to zero.

Attribute 6: Interface Control

Control Bits

Bits	Name	Description
0	Auto-negotiate	Auto-negotiation is enabled or disabled: 0 = 802.3 link auto-negotiation is disabled; 1 = auto-negotiation is enabled. If auto-negotiation is disabled, then the device shall use the settings indicated by the Forced Duplex Mode and Forced Interface Speed bits.
1	Forced Duplex Mode	If the Auto-negotiate bit is 0, the Forced Duplex Mode bit indicates whether the interface shall operate in full or half duplex mode: 0 = half duplex; 1 = full duplex. Interfaces not supporting the requested duplex shall return a GRC hex 0x09 (Invalid Attribute Value). If auto-negotiation is enabled, attempting to set the Forced Duplex Mode bits shall result in a GRC hex 0x0C (Object State Conflict).
2-15	Reserved	Set to zero.

Attribute 7: Interface Type

Value	Description
0	Unknown interface type.
1	The interface is internal to the device, for example, in the case of an embedded switch.
2	Twisted-pair (e.g., 10Base-T, 100Base-TX, 1000Base-T, etc.)
3	Optical fiber (e.g., 100Base-FX)
4-255	Reserved.

Attribute 8: Interface State

Value	Description
0	Unknown interface type.
1	The interface is enabled and is ready to send and receive data.
2	The interface is disabled.
3	The interface is testing.
4-255	Reserved.

Attribute 9: Admin State

Value	Description
0	Reserved.
1	Enable the interface.
2	Disable the interface.
3-255	Reserved.

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x01	●	●	Get_Attributes_All	Returns a predefined listing of this objects attributes
0x0E	●	●	Get_Attribute_Single	Returns the contents of the specified attribute
0x10		●	Set_Attribute_Single	Modifies an attribute value.

For more details, see *THE CIP NETWORKS LIBRARY, Volume 2: EtherNet/IP Adaptation of CIP*, which is available on the ODVA.org website.

Application Objects

The following sections/tables list the attributes for each of the Application objects (ODVA "device" set of objects).

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Position Controller Supervisor (0x24)

The following tables provide the Class and Identity Attributes, and the Supported Services for the Position Controller Supervisor Object (0x24).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Value = 2	The current assigned value is 2. If updates require an increased value, the value increases by 1.
2	Get	Max Instance	UINT	Maximum instance number of an object currently created in this class level of the device.	
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device.	
6	Get	Max ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Max ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	
32	Get	Consumed Axis Selection Number	USINT	Specifies the axis number to which the data contained in the I/O Command Message is routed.	SmartMotor value is typ-ically 1 for this attribute.
33	Get	Produced Axis Selection Number	USINT	Specifies the axis number to which the data contained in the I/O Response Message is routed.	SmartMotor value is typ-ically 1 for this attribute.

Object Instance 1 Attributes

Attr ID	Access Rule	Name	Data Type	Description
1	Get	Number of Attributes	USINT	Returns the total number of attributes supported by this object in this device.
2	Get	Attribute List	Array of USINT	Returns an array with a list of the attributes supported by this object in this device.
3	Get	Axis Number	USINT	Returns the axis number which is the same as the instance of the object.
4				Reserved
5	Get	General Fault	BOOL	Bit is a logical OR of all fault condition attribute flags. 1 = Fault condition
6	Set/Get	Command Message Type	USINT	Command message type that is being sent by the controlling device
7	Set/Get	Response Message Type	USINT	Response message type that is returned to the controlling device
15	Set/Get	Index Arm	BOOL	Used to arm the index input Values: 1 = arm index input, 0 = trigger occurred
18	Get	Index Position	DINT	The position at the time the home input is triggered.
25	Set/Get	Follow Enable	BOOL	Enables following of the Follow Axis. Values: 0 = disabled, 1 = enabled
27	Set/Get	Follow Divisor	DINT	Used to calculate the Command Position by dividing the Follow Axis position with this value.
28	Set/Get	Follow Multiplier	DINT	Used to calculate the Command Position by multiplying the Follow Axis position with this value.
100	Set/Get	Follow Type	USINT	Values: 0 = Step Dir, 1 = AqB

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x0E	•	•	Get_Attribute_Single	Returns contents of specified attribute
0x10		•	Set_Attribute_Single	Modifies the attribute value

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

Position Controller (0x25)

The following tables provide the Class and Identity Attributes, and the Supported Services for the Position Controller Object (0x25).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 2	The current assigned value is 2. If updates require an increased value, the value increases by 1.
2	Get	Max Instance	UINT	Maximum instance number of an object currently created in this class level of the device.	
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device.	
6	Get	Max ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Max ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Instance Attributes

In the following table, a "unit" is one count of the encoder resolution returned by attribute 40 (the Feedback resolution).

NOTE: The user program commands are not in the same units shown below. In other words, the report RVT value shown in the SMI Terminal window will not equal a get of Attr ID 7.

Attr ID	Access Rule	Name	Data Type	Description
1	Get	Number of Attributes	USINT	Returns the total number of attributes supported by this object in this device
2	Get	Attribute List	Array of USINT	Returns an array with a list of the attributes supported by this object in this device

Attr ID	Access Rule	Name	Data Type	Description
3	Set/Get	Mode	USINT	Operating Mode: 0 = Position mode (default) 1 = Velocity mode 2 = Torque mode
6	Set/Get	Target Position	DINT	Profile Position value to set in Profile units (see Attr ID 40)
7	Set/Get	Target Velocity	DINT	Profile Velocity in units/sec, positive only
8	Set/Get	Acceleration	DINT	Profile Acceleration in units/sec-sec, positive only
9	Set/Get	Deceleration	DINT	Profile Deceleration in units/sec-sec, positive only.
10	Set/Get	Incremental Position Flag	BOOL	Defines Attr ID 6 as being either absolute or incremental: 0 = absolute move 1 = incremental move
11	Set/Get	Load Data/ Start Profile/ Profile in Progress	BOOL	On set, loads data and starts the current profile. On get, reports Profile in Progress
13	Set/Get	Actual Position	DINT	Actual absolute position. Can be Set to redefine actual position.
14	Get	Actual Velocity	DINT	Reports actual velocity in units/sec.
15	Get	Commanded Position	DINT	The instantaneous calculated position
16	Get	Commanded Velocity	DINT	The instantaneous velocity in units/sec.
17	Set/Get	Enable	BOOL	On the enable edge, commanded position is set to equal actual position. Values: 0=disable 1=enable
20	Set/Get	Smooth Stop	BOOL	Smooth Stop motor
21	Set/Get	Hard Stop	BOOL	Hard Stop motor
23	Set/Get	Direction	BOOL	Instantaneous Direction Values: 0=reverse 1=forward Is set to change or select direction on Velocity Mode
24	Set/Get	Reference Direction	BOOL	Shaft Rotation Direction (forward facing shaft): 0 = CW 1 = CCW
25	Set/Get	Torque	DINT	Output Torque Range: -32767 to 32767

Attr ID	Access Rule	Name	Data Type	Description
29	Get	Wrap Around	BOOL	Position Wrap Around Indicator Flag If 1, the motor has gone past its maximum position.
30	Set/Get	Kp	INT	Proportional Gain Range: 0 to 32767
31	Set/Get	Ki	INT	Integral Gain Range: 0 to 32767
32	Set/Get	Kd	INT	Derivative Gain Range: 0 to 32767
33	Set/Get	MaxKi	INT	Integration Limit Range: 0 to 32767
35	Set/Get	Velocity Feed Forward	INT	Velocity feed forward gain value Range: 0 to 32767
37	Get	Sample Rate	INT	Update sample rate in micro-seconds
40	Get	Feedback Resolution	DINT	Number of actual position feedback counts per revolution
41	Get	Motor Resolution	DINT	Motor resolution in motor steps. Number of motor steps in one revolution of the motor.
45	Set/Get	Max Dynamic Following Error	DINT	Maximum allowable following error when the motor is in motion
46	Set/Get	Following Error Action	USINT	Following Error Action code: 0=Servo off 1=Hard Stop 2=Smooth Stop 128=MTB
47	Set/Get	Following Error Fault	BOOL	Following error occurrence flag
48	Get	Actual Following Error	DINT	Actual Following error
49	Set/Get	Hard Limit Action	USINT	Hard Limit Action code: 0 = Servo off 1 = Hard Stop 2 = Smooth Stop 128 = MTB 224 = Both hardware limits disabled
50	Get	Forward Limit	BOOL	Forward Limit stop input status active
51	Get	Reverse Limit	BOOL	Reverse Limit stop input status active
52	Set/Get	Soft Limits Enable	BOOL	Enables Soft Limits

Attr ID	Access Rule	Name	Data Type	Description
53	Set/Get	Soft Limit Action	USINT	Soft Limit Action Code: 0 = Servo off 1 = Hard Stop 2 = Smooth Stop 128 = MTB
54	Set/Get	Positive Soft Limit Position	DINT	Soft limit positive boundary in position counts, enable BOTH soft limits
55	Set/Get	Negative Soft Limit Position	DINT	Soft limit negative boundary in position counts, enable BOTH soft limits
56	Get	Positive Limit Triggered	BOOL	Hard or Soft limit forward limit occurrence flag
57	Get	Negative Limit Triggered	BOOL	Hard or Soft limit forward limit occurrence flag
58	Get	Load Data Complete	BOOL	Valid data for a valid I/O command message type has been loaded into the position controller
100	Set/Get	Current Limit	DINT	Current limit of motor 0 to 1023
101	Set/Get	Reset Motor Faults	BOOL	Set to 1 for RESET action, the Get returns the Drive Ready Status
102	Set/Get	Reset Motor	BOOL	Set to 1 for RESET action, the Get returns the Drive Ready Status
103	Set/Get	Overheat Setpoint	USINT	Overheat setpoint 0-70 or 0-85 degrees C
104	Get	Temperature	INT	Real time temperature
105	Set/Get	Variable u	DINT	Motor user variable u
106	Set/Get	Variable v	DINT	Motor user variable v
107	Set/Get	Variable w	DINT	Motor user variable w
108	Set/Get	Variable x	DINT	Motor user variable x
109	Set/Get	GOSUBnnn	UINT	Setting executes a user program command GOSUBnnn. The Get returns the program running status.
110	Get	Loss of Network Action	USINT	Action if DeviceNet network heartbeat lost: 0 = IGNORE (No Command) 1 = OFF (Motor Off) 2 = X (Smooth Stop) 3 = S (Hard Stop) 4 = GOSUB 5 = GOTO
111	Get	Status Word	WORD	Motor status word
112	Get	Angle Match	BOOL	Commutation Angle Match bit

Attr ID	Access Rule	Name	Data Type	Description
113	Set/Get	EtherNet/IP Attribute	UINT	Setting executes a user program command GOSUBnnn. Getting returns the subroutine number (nnn) while the subroutine is executing and -1 when complete. Only one GOSUB from the network can be active at a given time. Executing a STACK command clears any executing GOSUB status. The motor will respond with a value of -1.

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x0E	•	•	Get_Attribute_Single	Returns the contents of the specified attribute
0x10		•	Set_Attribute_Single	Modifies the attribute value

Error Responses

Error Code	Additional Code	Name	Description
0x02	None	CIP_RESOURCE_UNAVAILABLE	Attribute 113 - Network GOSUB already active
0x09	None	CIP_INVALID_ATTRIB_VALUE	Attribute 113 - Invalid GOSUB number
0x10	None	CIP_DEVICE_STATE_CONFLICT	Attribute 113 - GOSUB stack overflow

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

Additional Objects

The following sections/tables list the attributes for the manufacturer-specific and other objects that don't fall into the previous categories.

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Device Level Ring (DLR) Object (0x47)

The following tables provide the Class and Identity Attributes, and the Supported Services for the Device Level Ring (DLR) Object (0x47).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 3	The current value assigned to this attribute is 3.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 1	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 1	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Instance Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Network Topology	USINT	Current network topology mode	0 = Linear 1 = Ring
2	Get		USINT	Current status of network	0 = Normal 1 = Ring Fault 2 = Unexpected Loop 3 = Partial Fault 4 = Rapid Fault/Restore Cycle

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
10	Get	Active Supervisor Address	STRUCT of:	IP and/or MAC address of the active ring supervisor. Default Value: 0	
			UDINT	Supervisor IP Address	0 = No configured IP address
			ARRAY of 6 USINTs	Supervisor MAC Address	Ethernet MAC address
12	Get	Capability Flags	DWORD	Describes the DLR capabilities of the device	See below: Attribute 12: Capability Flags

Instance Attributes Semantics

Attribute 12: Capability Flags

Bits	Name	Description
0	Announce-based Ring Node[1]	Set if device's ring node implementation is based on processing of Announce frames.
1	Beacon-based Ring Node[1]	Set if device's ring node implementation is based on processing of Beacon frames.
2-4	Reserved	Set to zero.
5	Supervisor Capable	Set if device is capable of providing the supervisor function.
6	Redundant Gateway Capable	Set if device is capable of providing the redundant gateway function.
7	Flush_Table frame Capable	Set if device is capable of supporting the Flush_Tables frame.
8-31	Reserved	Set to zero.
1. Bits 0 and 1 are mutually exclusive. Only one of these bits can be set in the attribute value that a device reports.		

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x01		•	Get_Attributes_All	Returns a predefined listing of this objects attributes
0x0E	•	•	Get_Attribute_Single	Returns the contents of the specified attribute

For more details, see *THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™)*, which is available on the ODVA.org website.

QoS Object (0x48)

The following tables provide the Class and Identity Attributes, and the Supported Services for the QoS Object (0x48).

Class Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 3	The current assigned value is 1. If updates require an increased value, the value increases by 1.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 1	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 1	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	

Instance Attributes

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
1[a]	Set/Get (NV)	802.1Q Tag Enable	USINT	Enables or disables sending 802.1Q frames on CIP and IEEE 1588 messages. Default Value: 0	0 = disabled 1 = enabled Value change takes effect the next time the device restarts.
2	Set/Get (NV)	DSCP PTP Event	USINT	DSCP value for PTP (IEEE 1588) event messages. Default Value: 59	DSCP field size is 6 bits, valid range: 0-63
3	Set/Get (NV)	DSCP PTP General	USINT	DSCP value for PTP (IEEE 1588) general messages. Default Value: 47	DSCP field size is 6 bits, valid range: 0-63

Attrib ID	Access Rule	Name	Data Type	Description	Semantics
4	Set/Get (NV)	DSCP Urgent	USINT	DSCP value for CIP transport class 0/1 urgent priority messages. Default Value: 55	DSCP field size is 6 bits, valid range: 0-63
5	Set/Get (NV)	DSCP Scheduled	USINT	DSCP value for CIP transport class 0/1 scheduled priority messages. Default Value: 47	DSCP field size is 6 bits, valid range: 0-63
6	Set/Get (NV)	DSCP High	USINT	DSCP value for CIP transport class 0/1 high priority messages. Default Value: 43	DSCP field size is 6 bits, valid range: 0-63
7	Set/Get (NV)	DSCP Low	USINT	DSCP value for CIP transport class 0/1 low priority messages. Default Value: 31	DSCP field size is 6 bits, valid range: 0-63
8	Set/Get (NV)	DSCP Explicit	USINT	DSCP value for CIP explicit messages (transport class 2/3 and UCMM) and all other EtherNet/IP encapsulation messages. Default Value: 27	DSCP field size is 6 bits, valid range: 0-63
a. The 802.1Q VLAN tagging mechanism can be turned on and off by setting or clearing the value of attribute 1 (802.1Q Tag Enable) of the QoS object.					

Services

Service Code	Supported in:		Name	Description
	Class	Instance		
0x0E	•	•	Get_Attribute_Single	Returns the contents of the specified attribute
0x10		•	Set_Attribute_Single	Modifies the contents of the specified attribute

For more details, see *THE CIP NETWORKS LIBRARY, Volume 2: EtherNet/IP Adaptation of CIP*, which is available on the ODVA.org website.

SmartMotor I/O Object (0x71)

The following tables describe the attributes and instances for the SmartMotor I/O Object (0x71).

Attribute Table (Instance 0)

Attr ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 1	The current value assigned to this attribute is 1.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 1	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 1	The number of object instances at this class hierarchy level.
6	Get	Maximum ID Number Class Attributes	UINT	The attribute ID number of the last class attribute of the class definition implemented in the device.	
7	Get	Maximum ID Number Instance Attributes	UINT	The attribute ID number of the last instance attribute of the class definition implemented in the device.	
8	Get	I/O Word State	WORD	Returns the value of first 16 I/O points; bit 0 is I/O 0 (zero)	

Attribute Table (One instance per I/O pin)

Attr ID	Access Rule	Name	Data Type	Description	Semantics
1	Set/Get	Function	USINT	Sets (or gets) the function as Output, Input or Special.	Values: 1 = Input 2 = Special
2	Set/Get	Output State	BOOL	Sets (or gets) the output states as ON or OFF.	Values: 0 = OFF 1 = ON
3	Get	I/O State	BOOL	Returns present state of the I/O, either ON or OFF.	Values: 0 = OFF 1 = ON
4	Get	Analog Raw Value	INT	Hardware dependent	

Instance	I/O Number	Function
1	0 – Input	
2	1 – Input	
3	2 – Input	Positive Limit
4	3 – Input	Negative Limit
5	4 – Input	
6	5 – Input	
7	6 – Input	Go
8	7 – Input	Drive Enable
9	8 – Output	External Brake
10	9 – Output	Fault

SmartMotor User Variable Object (0x72)

The following tables describe the attributes and instances for the SmartMotor User Variable Object (0x72). This object allows access to all defined User Variables with an explicit message. See the Instance Description table below for details of the Instance and Attribute values needed to address a particular User Variable.

Class Attribute (Instance 0)

Attr ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Revision	UINT	Revision of this object. Default Value: 1	The current value assigned to this attribute is 1.
2	Get	Max Instance	UINT	Maximum instance number of this object. Default Value: 7	The largest instance number of a created object at this class hierarchy level.
3	Get	Number of Instances	UINT	Number of object instances currently created at this class level of the device. Default Value: 7	The number of object instances at this class hierarchy level.

Instance Attributes (Instance 1-7)

Attr ID	Access Rule	Name	Data Type	Description	Semantics
1	Get	Instance Name	SHORT-STRING	A human–readable string representing the instance name. (E.G., a-z, aa-zz, etc.)	See below
2	Get	Number of User Variables	UINT	Number of User Variables in this instance	
3	Get/Set	1st User Variable for this Instance	SINT, INT, DINT, REAL depending on instance	Returns/Sets the value of the 1st user variable for the selected instance	
...					
n	Get/Set	Last User Variable for this Instance	SINT, INT, DINT, REAL depending on instance	Returns/Sets the value of the 1st user variable for the selected instance	See below.

Semantics

Instance Attribute 1: Instance Name

A human readable string representing the block of user variables being accessed. This value is returned as a SHORT-STRING, a 1-byte length (SINT) followed by up to 16 ASCII bytes of data.

Instance Attribute 3 - n: User Variable Value

There is one Instance Attribute for each User Variable in the Instance.

Error Responses

Error Code	Additional Code	Name	Description
0x08	None	CIP_SERVICE_NOT_SUPPORTED	Invalid Service value
0x0E	None	CIP_ATTRIBUTE_NOT_SETTABLE	Attribute Not settable
0x13	None	CIP_NOT_ENOUGH_DATA	Source Length is too small
0x14	None	CIP_ATTRIBUTE_NOT_SUPPORTED	Invalid Attribute number
0x15	None	CIP_TOO_MUCH_DATA	Source Length is too large
0x16	None	CIP_OBJECT_DOES_NOT_EXIST	Invalid Instance number

Instance Descriptions

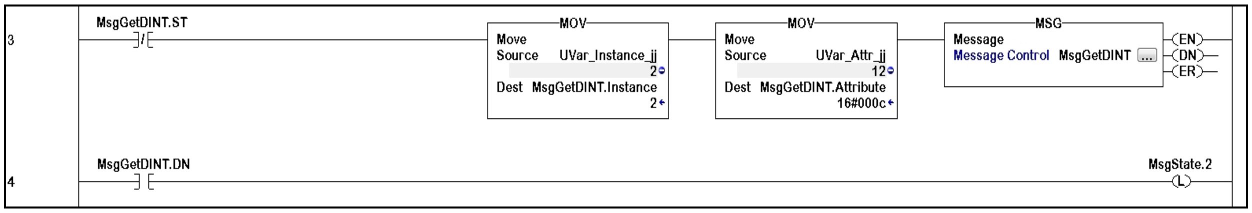
User Variable Size	**4-bytes DINT**	**4-bytes DINT**	**4-bytes DINT**	**4-bytes DINT**	**2-bytes INT**	**1-byte SINT**	**4-bytes REAL**
Attribute	**Instance 1**	**Instance 2**	**Instance 3**	**Instance 4**	**Instance 5**	**Instance 6**	**Instance 7**
1	"a-z"	"aa-zz"	"aaa-zzz"	"al"	"aw"	"ab"	"af"
2	26	26	26	51	102	204	8
3	a	aa	aaa	**al[**0]	aw[0]	ab[0]	af[0]
4	b	bb	bbb	al[1]	aw[1]	ab[1]	af[1]
5	c	cc	ccc	al[2]	aw[2]	ab[2]	af[2]
6	d	dd	ddd	al[3]	aw[3]	ab[3]	af[3]
7	e	ee	eee	al[4]	aw[4]	ab[4]	af[4]
8	f	ff	fff	al[5]	aw[5]	ab[5]	af[5]
9	g	gg	ggg	al[6]	aw[6]	ab[6]	af[6]
10	h	hh	hhh	al[7]	aw[7]	ab[7]	af[7]
11	i	ii	iii	al[8]	aw[8]	ab[8]	
12	j	jj	jjj	al[9]	aw[9]	ab[9]	
13	k	kk	kkk	al[10]	aw[10]	ab[10]	
14	l	ll	lll	al[11]	aw[11]	ab[11]	
15	m	mm	mmm	al[12]	aw[12]	ab[12]	
16	n	nn	nnn	al[13]	aw[13]	ab[13]	
17	o	oo	ooo	al[14]	aw[14]	ab[14]	
18	p	pp	ppp	al[15]	aw[15]	ab[15]	
19	q	qq	qqq	al[16]	aw[16]	ab[16]	
20	r	rr	rrr	al[17]	aw[17]	ab[17]	
21	s	ss	sss	al[18]	aw[18]	ab[18]	
22	t	tt	ttt	al[19]	aw[19]	ab[19]	
23	u	uu	uuu	al[20]	aw[20]	ab[20]	
24	v	vv	vvv	al[21]	aw[21]	ab[21]	
25	w	ww	www	al[22]	aw[22]	ab[22]	
26	x	xx	xxx	al[23]	aw[23]	ab[23]	
27	y	yy	yyy	al[24]	aw[24]	ab[24]	
28	z	zz	zzz	al[25]	aw[25]	ab[25]	
...				...	...	...	
n				al[50]	aw[101]	ab[203]	
For Instances 4 through 7, n = User Variable Index + 3							

Examples

Letter User Variables

The following Rockwell RSLogix 500 ladder logic snippets and Explicit Message configurations demonstrate how to access the Letter User Variables (a-z, aa-zz, aaa-zzz).

Get User Variable jj



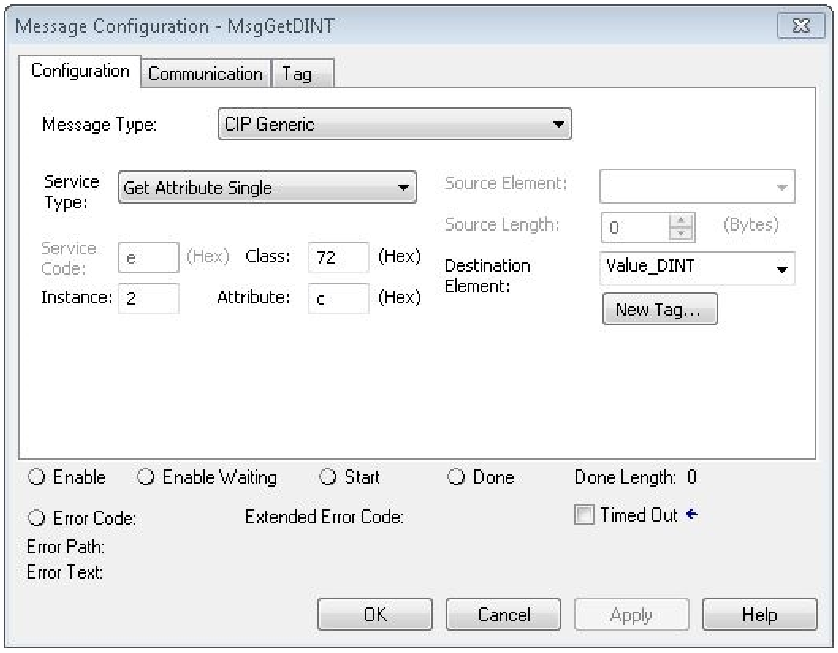
3 MsgGetDINT.ST]/[

MOV Move Source UVar_Instance_jj 2 Dest MsgGetDINT.Instance 2

MOV Move Source UVar_Attr_jj 12 Dest MsgGetDINT.Attribute 16#000c

MSG Message Message Control MsgGetDINT (EN) (DN) (ER)

4 MsgGetDINT.DN] [MsgState.2 (L)



Message Type: CIP Generic

Service Type: Get Attribute Single

Service Code: e (Hex) Class: 72 (Hex)

Instance: 2 Attribute: c (Hex)

Source Element:

Source Length: 0 (Bytes)

Destination Element: Value_DINT

Enable Enable Waiting Start Done Done Length: 0

Error Code: Extended Error Code: Timed Out

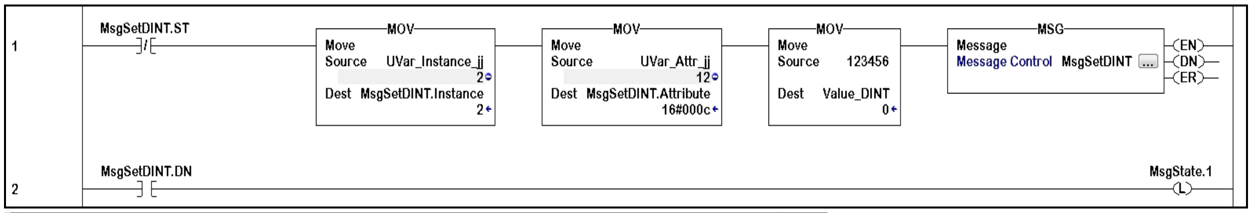
Error Path:

Error Text:

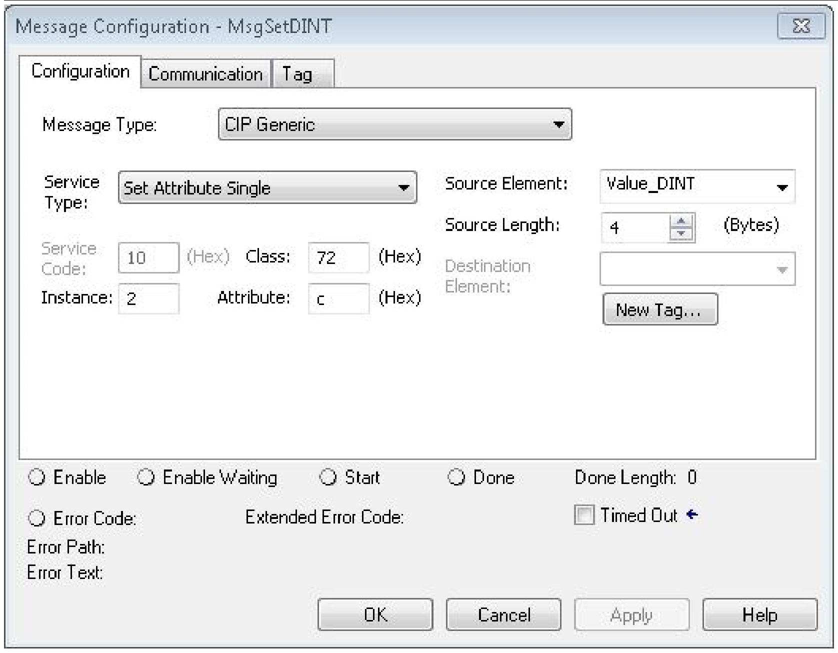
The following table describes the Message Configuration fields that must be filled in.

Field	Instructions
Message Type	Must be "CIP Generic"
Service Type	Must be "Get Attribute Single"
Class	Must be 72(hex); this field is entered as a hexadecimal number on the configuration screen
Attribute	Selects the user variable to access; this field is entered as a hexa-decimal number on the configuration screen
Instance	Selects the block of user variables to access
Destination element	The PLC tag where the data will be stored; the size of the tag entered in this field should match the number of bytes being retrieved. The top of each column in the "Instance Description table" indicates the number of bytes of data retrieved for each instance and the equi-valent data type used in the PLC program.

Set User Variable jj to a value of 123456



```
1  MsgSetDINT.ST  ]/[
   MOV  Move  Source UVar_Instance_jj 2   Dest MsgSetDINT.Instance 2
   MOV  Move  Source UVar_Attr_jj 12      Dest MsgSetDINT.Attribute 16#000c
   MOV  Move  Source 123456               Dest Value_DINT 0
   MSG  Message  Message Control MsgSetDINT ...   (EN) (DN) (ER)
2  MsgSetDINT.DN  ] [                                      MsgState.1 (L)
```



Message Configuration - MsgSetDINT

Configuration | Communication | Tag

Message Type:	CIP Generic
Service Type:	Set Attribute Single
Service Code:	10 (Hex)
Class:	72 (Hex)
Instance:	2
Attribute:	c (Hex)
Source Element:	Value_DINT
Source Length:	4 (Bytes)
Destination Element:	

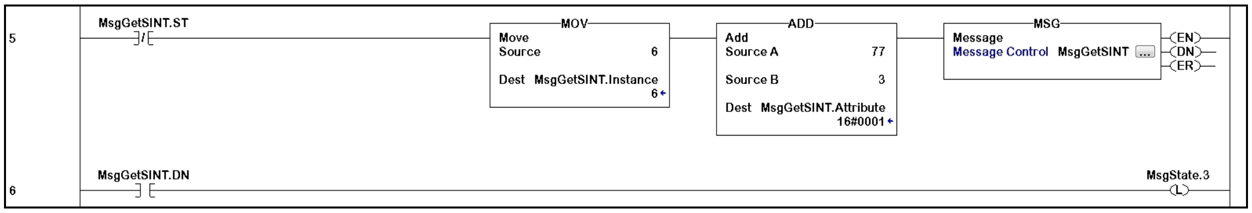
The following table describes the Message Configuration fields that must be filled in.

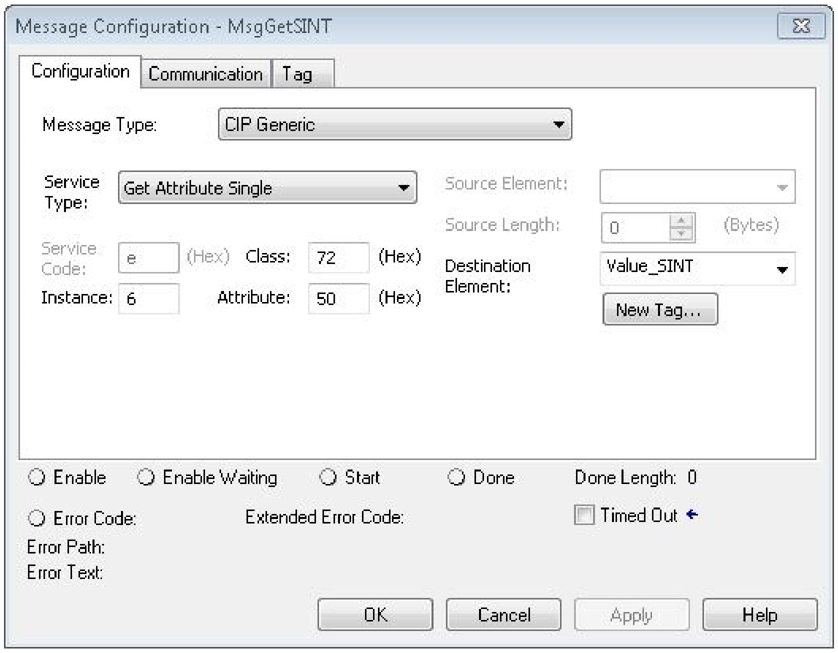
Field	Instructions
Message Type	Must be "CIP Generic"
Service Type	Must be "Get Attribute Single"
Class	Must be 72(hex); this field is entered as a hexadecimal number on the configuration screen
Instance	Selects the block of user variables to access
Attribute	Selects the user variable to access; this field is entered as a hexa-decimal number on the configuration screen
Source element	Indicates the PLC tag with the data to send
Source Length	The number of bytes of data to send; this field must match the num-ber of bytes in the User Variable being set. The top of each column in the "Instance Description table" indicates the number of bytes of data to send for each user variable instance and the equivalent data type used in the PLC program.

Array User Variables

The following Rockwell RSLogix 500 ladder logic snippets and Explicit Message configurations demonstrate how to access the Array User Variables (al, aw, ab, af).

Get User Variable ab[77]





Message Type: CIP Generic

Service Type: Get Attribute Single

Service Code: e (Hex) Class: 72 (Hex)

Instance: 6 Attribute: 50 (Hex)

Source Element:

Source Length: 0 (Bytes)

Destination Element: Value_SINT

Enable Enable Waiting Start Done Done Length: 0

Error Code: Extended Error Code: Timed Out

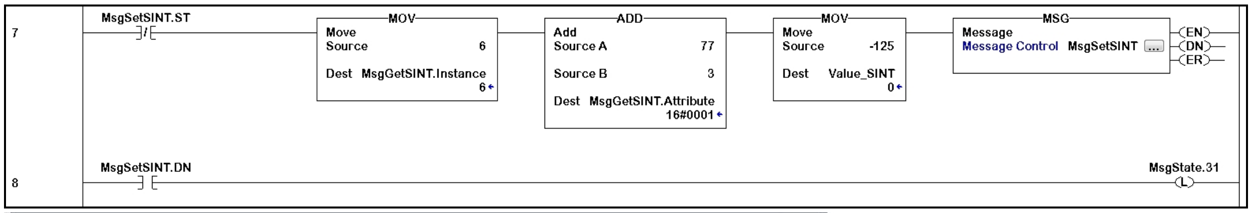
Error Path:

Error Text:

The following table describes the Message Configuration fields that must be filled in.

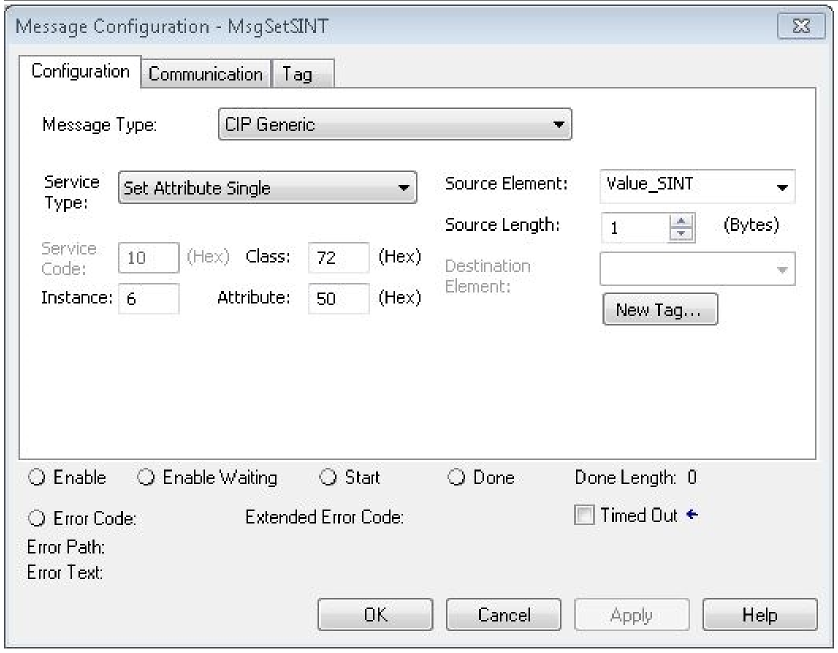
Field	Instructions
Message Type	Must be "CIP Generic"
Service Type	Must be "Get Attribute Single"
Class	Must be 72(hex); this field is entered as a hexadecimal number on the configuration screen
Attribute	Selects the user variable to access; this field is entered as a hexadecimal number on the configuration screen
Instance	Selects the block of user variables to access
Destination element	The PLC tag where the data will be stored; the size of the tag entered in this field should match the number of bytes being retrieved. The top of each column in the "Instance Description table" indicates the number of bytes of data retrieved for each instance and the equivalent data type used in the PLC program.

Set User Variable ab[77] to a value of -125.



7 MsgSetSINT.ST
MOV Move Source 6 Dest MsgGetSINT.Instance 6
ADD Add Source A 77 Source B 3 Dest MsgGetSINT.Attribute 16#0001
MOV Move Source -125 Dest Value_SINT 0
MSG Message Message Control MsgSetSINT ... EN DN ER

8 MsgSetSINT.DN MsgState.31 L



Message Configuration - MsgSetSINT

Configuration | Communication | Tag

Message Type: CIP Generic

Service Type: Set Attribute Single

Source Element: Value_SINT

Source Length: 1 (Bytes)

Service Code: 10 (Hex) Class: 72 (Hex)

Instance: 6 Attribute: 50 (Hex)

Destination Element:

New Tag...

Enable Enable Waiting Start Done Done Length: 0

Error Code: Extended Error Code: Timed Out

Error Path:

Error Text:

OK Cancel Apply Help

The following table describes the Message Configuration fields that must be filled in.

Field	Instructions
Message Type	Must be "CIP Generic"
Service Type	Must be "Get Attribute Single"
Class	Must be 72(hex); this field is entered as a hexadecimal number on the configuration screen
Instance	Selects the block of user variables to access
Attribute	Selects the user variable to access; this field is entered as a hexadecimal number on the configuration screen
Source element	Indicates the PLC tag with the data to send
Source Length	The number of bytes of data to send; this field must match the number of bytes in the User Variable being set. The top of each column in the "Instance Description table" indicates the number of bytes of data to send for each user variable instance and the equivalent data type used in the PLC program.

AOI Descriptions - Allen Bradley PLC

This chapter describes the Add On Instructions (AOIs) that are available for use with the EtherNet/IP SmartMotor and Allen Bradley PLCs. The AOIs can be used "as is" or modified for end-user-specific solutions.

NOTE: Typically, only one AOI should be active at a time.

The AOIs write to a common command structure stored in the DriveStore tag, which is initialized in the SM6_Drive AOI and passed into all the other AOIs. The exception to this is when a 32-byte connection is used. The 32-byte message frames make available the Attribute to Get fields. When loaded with proper values, the Attribute to Get fields cause the targeted drive to return the value of a selected Drive Attribute in the Attribute to Get fields of the response. The Attribute to Get fields can be used in conjunction with the normal command/response fields.

SM6_Attribute_Ext_Clear - Clear Attribute to Get (Extended Command) 108

SM6_Attribute_Ext_Get - Load Attribute to Get ID & Wait (Extended Command) 109

SM6_Attribute_Ext_Load - Load Attribute to Get ID (Extended Command) 110

SM6_Attribute_Ext_Value - Return Attribute data (Extended Command) 112

SM6_Clear_Flags - Reset System State Flag 114

SM6_Disable - Disable Drive 115

SM6_Drive - Drive Data Exchange 116

SM6_Enable - Enable Drive 118

SM6_Get_Attribute - Get Drive Attribute 119

SM6_Move_Position_Ext - Position Move(Extended Command) 120

SM6_Move_Velocity_Ext - Velocity Move(Extended Command) 122

SM6_Move_Torque - Apply Torque 124

SM6_Set_Acceleration - Set Drive Acceleration 125

SM6_Set_Attribute - Set Drive Attribute 126

SM6_Set_Deceleration - Set Drive Deceleration 127

SM6_Set_Mode - Set Drive Mode 128

SM6_Set_Position - Set Drive Position 129

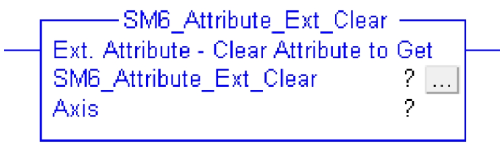
SM6_Set_Variable_u - Set Drive Variable "u" 130

SM6_Set_Velocity - Set Drive Target Velocity 131

SM6_Stop_Hard - Perform a Hard Stop 132

SM6_Stop_Smooth - Perform a Smooth Stop 133

SM6_Attribute_Ext_Clear - Clear Attribute to Get (Extended Command)


SM6_Attribute_Ext_Clear
Ext. Attribute - Clear Attribute to Get
SM6_Attribute_Ext_Clear ?
Axis ?
...

Description

Clears the Extended Attribute to Get fields in the Axis Command buffer. This will cause the drive to clear the Attribute to Get fields in the Response buffer.

Operands

Operand	Data Type	Operand Type	Description
SM6_Attribute_Ext_Clear	SM6_Attribute_Ext_Clear	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive

Structure

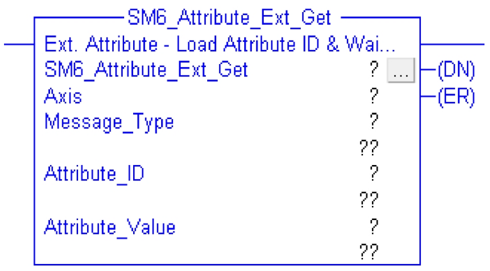
Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Clears the Extended Attribute to Get fields in the Axis Command buffer.

NOTE: This command requires a connection size of 32 bytes.

SM6_Attribute_Ext_Get - Load Attribute to Get ID & Wait (Extended Command)



Description

Use the Extended Attribute to Get Type and ID fields to get the value of the requested Attribute and copy the response to the Attribute_Value tag.

Operands

Operand	Data Type	Operand Type	Description
SM6_Attribute_Ext_Get	SM6_Attribute_Ext_Get	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Message_Type	SINT	Immediate Value	16#1a - Position Controller Supervisor 16#1b - Position Controller
Attribute_ID	DINT	Immediate Value	The index to one of these application objects: Position Controller Supervisor (0x24) on page 86 or Position Controller (0x25) on page 88.
Attribute_Value	DINT	Tag	The value of the attribute.

Structure

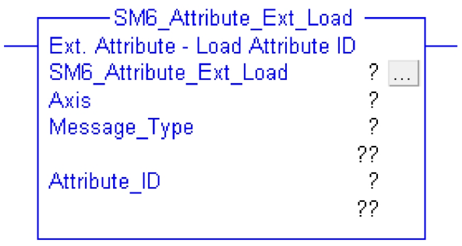
Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Load the Extended Attribute to Get Type and ID fields, wait for a response, copy the response to the Attribute_Value tag, clear the Extended Attribute to Get Type and ID fields.

NOTE: This command requires a connection size of 32 bytes.

SM6_Attribute_Ext_Load - Load Attribute to Get ID (Extended Command)


```
SM6_Attribute_Ext_Load
Ext. Attribute - Load Attribute ID
SM6_Attribute_Ext_Load        ? ...
Axis                          ?
Message_Type                  ?
                             ??
Attribute_ID                  ?
                             ??
```

Description

Load the Extended Attribute to Get Type and ID fields to with the Message Type and Attribute ID to get the value of the requested Attribute. Use the "SM6_Attribute_Ext_Value" AOI to wait for and return the response. See SM6_Attribute_Ext_Value - Return Attribute data (Extended Command) on page 112.

These two AOIs can be used to monitor a drive attribute over a period of time without reloading the Extended Attribute to Get fields. Loading a Message_Type and Attribute_ID of zero (0) will cause the drive to stop updating the Attribute to Get Response data.

Operands

Operand	Data Type	Operand Type	Description
SM6_Attribute_Ext_Load	SM6_Attribute_Ext_Load	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Message_Type	SINT	Immediate Value	16#1a - Position Controller Supervisor 16#1b - Position Controller
Attribute_ID	DINT	Immediate Value	The index to one of these application objects: Position Controller Supervisor (0x24) on page 86 or Position Controller (0x25) on page 88.

Structure

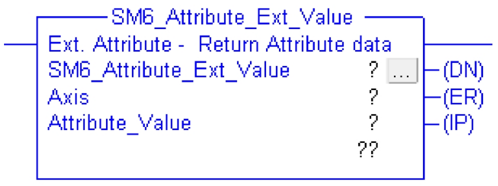
Field	Type	Description
N/A		

Operation

Scan Mode	Description
Prescan	N/A
Rung-condition-in is FALSE	N/A
Rung-condition-in is TRUE	Copy Message_Type and Attribute ID to the Extended Attribute to Get fields of the Axis Command buffer

NOTE: This command requires a connection size of 32 bytes.

SM6_Attribute_Ext_Value - Return Attribute data (Extended Command)


SM6_Attribute_Ext_Value
Ext. Attribute - Return Attribute data
SM6_Attribute_Ext_Value ?
Axis ?
Attribute_Value ?
??
(DN)
(ER)
(IP)

Description

Returns the Extended Attribute to Get response value for the current axis.

- When the Extended Attribute to Get Message Type in the axis command buffer is zero then a value of zero is returned.
- When the Extended Attribute to Get Message Type in the axis command buffer does not match the Message Type in the axis response buffer the .IP flag will be set (1) and the .DN flag will be clear (0).
- When the Extended Attribute to Get Message Type in the axis command buffer matches the Message Type in the axis response buffer the .IP flag will be clear (0) and the .DN flag will be set (1).

Operands

Operand	Data Type	Operand Type	Description
SM6_Attribute_Ext_Value	SM6_Attribute_Ext_Value	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Attribute_Value	DINT	Tag	The value of the attribute.

Structure

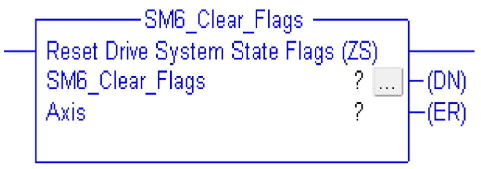
Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.
.IP	BOOL	Set when the Extended Attribute to Get Message Type in the axis command buffer is not zero and does not match the Extended Attribute to Get Message Type in the axis response buffer.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Wait for a response from the drive, copy the response Attribute_Value tag, clear the Extended Attribute to Get Type and ID fields.

NOTE: This command requires a connection size of 32 bytes.

SM6_Clear_Flags - Reset System State Flag



Description

Reset the SmartMotor system flags. For instruction details, see the ZS command in the SmartMotor Developer's Guide.

Operands

Operand	Data Type	Operand Type	Description
SM6_Clear_Flags	SM6_Clear_Flags	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive

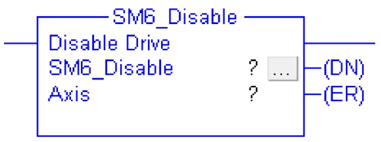
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables and clear timeout.
Rung-condition-in is FALSE	Initialize variables and clear timeout.
Rung-condition-in is TRUE	Send command to the SmartMotor to execute a ZS command to reset the motor system flags.

SM6_Disable - Disable Drive



Description

Clear the Axis Drive Enable flag and wait for the Axis Drive Status flag to indicate the drive is disabled.

Operands

Operand	Data Type	Operand Type	Description
SM6_Disable	SM6_Disable	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive

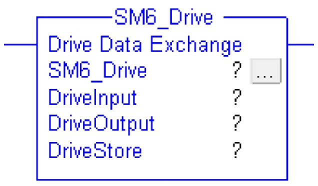
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout errors.

Operation

Scan Mode	Description
Prescan	Reset timeout.
Rung-condition-in is FALSE	Reset timeout.
Rung-condition-in is TRUE	Clear the Axis Drive Enable flag. Set the .DN output when the Axis Drive Status Enable flag is cleared.

SM6_Drive - Drive Data Exchange



Description

This AOI manages the connections to the drive.

- The Response from the drive is copied from the Drive Input tag and stored in the Response buffer of the Drive Store tag.
- The Drive Status data is extracted and copied to the Drive Store Status variable.
- The Drive Response data is extracted and copied to the Drive Store Response data variables.
- (32-byte connections only) The Attribute to Get data is retrieved from the response if the Attribute to Get fields are set in the Drive Store Command buffer.
- The Drive Output connection is loaded from the Drive Store Command buffer.

Operands

Operand	Data Type	Operand Type	Description
SM6_Drive	SM6_Drive	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
DriveInput	_032A:Class6_ xxxxxxxx:I:0	Tag	Module defined Input Connection tag to Drive Response data
DriveOutput	_032A:Class6_ xxxxxxxx:O:0	Tag	Module defined Output Connection tag to Drive Command data
DriveStore	SM6_Axis	Tag	Tag to Store Axis Command and Response data

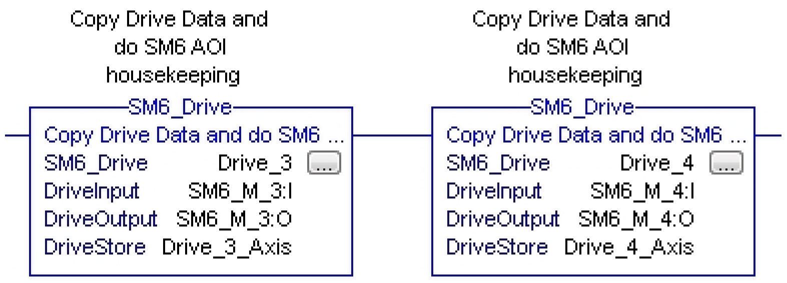
Structure

Field	Type	Description
N/A		

Operation

Scan Mode	Description
Prescan	Initialize axis variables.
Rung-condition-in is FALSE	N/A
Rung-condition-in is TRUE	Copies any response data from the input connection to the Drive Store response buffer. Extracts the data from the response. Builds and Copies a Command from the Drive Store Command buffer to the output connection.

NOTE: An instance of this AOI will need to be included in the ladder logic for each drive being controlled. Each instance of this AOI is usually placed at the top of the main loop. For example, in the following figure, this AOI is included twice for a two-drive system.



Error Handling

If the response from the drive is an error response, the error information will be extracted from the message and stored in one of two structures within DriveStore:

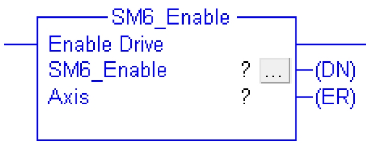
- Drivestore.Error_Info: Standard 8-byte message errors
- DriveStore.Error_Info_Ext: Extended attribute to get errors

There are four fields within the Error_Info structures:

- Error_Code: Main error code being returned
- Additional_Code: Additional error code information
- Copy_Cmd: Copy of the Command Message Type that caused the error
- Copy_Att_Num: Attribute number of the command that caused the error

For information on the error information, see bytes 4–7 in Error Response Message Type (0x14) on page 52.

SM6_Enable - Enable Drive



Description

Set the Axis Drive Enable flag and wait for the Axis Drive Status flag to indicate the drive is enabled.

Operands

Operand	Data Type	Operand Type	Description
SM6_Enable	SM6_Enable	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive

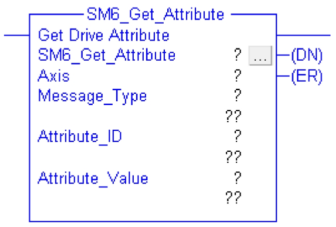
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout errors.

Operation

Scan Mode	Description
Prescan	Reset timeout.
Rung-condition-in is FALSE	Reset timeout.
Rung-condition-in is TRUE	Set the Axis Drive Enable flag. Set the .DN output when the Axis Drive Status Enable flag is set.

SM6_Get_Attribute - Get Drive Attribute



Description

Get the value of the requested Attribute and copy the response to the Attribute_Value tag.

Operands

Operand	Data Type	Operand Type	Description
SM6_Get_Attribute	SM6_Get_Attribute	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Message_Type	SINT	Immediate Value	16#1a - Position Controller Supervisor 16#1b - Position Controller
Attribute_ID	DINT	Immediate Value	The index to one of these application objects: Position Controller Supervisor (0x24) on page 86 or Position Controller (0x25) on page 88.
Attribute_Value	DINT	Tag	The value of the attribute

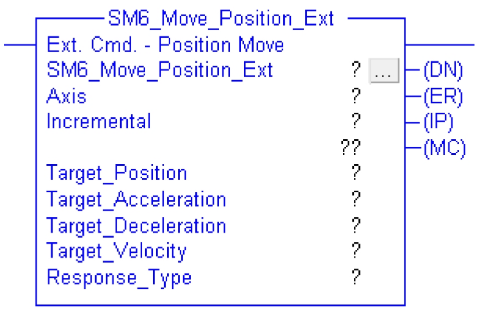
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables and reset timeout.
Rung-condition-in is TRUE	Send a message to the SmartMotor to get the value of a Position Controller Supervisor or Position Controller object attribute, wait for a response, copy the response to the Attribute_Value tag.

SM6_Move_Position_Ext - Position Move (Extended Command)



Description

Send a message to the SmartMotor to generate a profile move to an absolute or relative position. The message can also specify a standard data response.

> **NOTE:** The 32-byte Extended Response Message always includes the Actual Position and Actual Velocity. See the Polled I/O: Produced General Message Format on page 48.

Operands

Operand	Data Type	Operand Type	Description
SM6_Move_Position_Ext	SM6_Move_Position_Ext	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Incremental	BOOL	Immediate Value	Move Type 0 - Absolute 1 - Incremental
Target_Position	DINT	Tag	Requested Position
Target_Acceleration	DINT	Tag	Requested Acceleration
Target_Deceleration	DINT	Tag	Requested Deceleration
Target_Velocity	DINT	Tag	Requested Velocity
Response_Type	SINT	Immediate Value	0 - None 1 - Actual Position 2 - Command Position 3 - Actual Velocity 4 - Command Velocity 5 - Torque

Structure

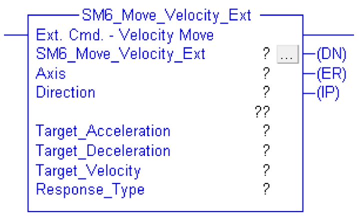
Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.
.IP	BOOL	In Progress—set while the drive is reporting a command is in progress.
.MC	BOOL	Move Complete—set when there is no move in progress and the drive is on the target position.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Send the Extended Move Position message to the drive and monitor move progress.

NOTE: This command requires a connection size of 32 bytes.

SM6_Move_Velocity_Ext - Velocity Move (Extended Command)



Description

Send a message to the SmartMotor to generate a profile move to a requested Velocity.

> **NOTE:** The 32-byte Extended Response Message always includes the Actual Velocity. See the Polled I/O: Produced General Message Format on page 48.

Operands

Operand	Data Type	Operand Type	Description
SM6_Move_Velocity_Ext	SM6_Move_Velocity_Ext	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Direction	BOOL	Immediate Value	Requested Direction 0=Reverse 1=Forward
Target_Acceleration	DINT	Tag	Requested Acceleration
Target_Deceleration	DINT	Tag	Requested Deceleration
Target_Velocity	DINT	Tag	Requested Velocity
Response_Type	SINT	Immediate Value	0 - None 1 - Actual Velocity 2 - Command Velocity 3 - Actual Velocity 4 - Command Velocity 5 - Torque

Structure

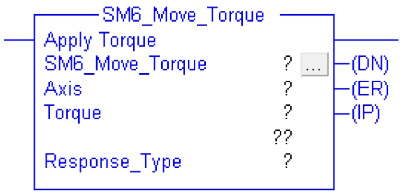
Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.
.IP	BOOL	In Progress—set while the drive is reporting a command is in progress.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables and reset timeout.
Rung-condition-in is TRUE	Send the Extended Move Velocity message to the drive and monitor move progress.

NOTE: This command requires a connection size of 32 bytes.

SM6_Move_Torque - Apply Torque



Description

Send a message to the SmartMotor to apply the requested torque.

Operands

Operand	Data Type	Operand Type	Description
SM6_Move_Torque	SM6_Move_Torque	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Torque	DINT	Tag	Requested Torque
Response_Type	SINT	Immediate Value	0 - None 1 - Actual Position 2 - Command Position 3 - Actual Velocity 4 - Command Velocity 5 - Torque

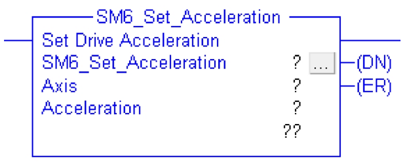
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.
.IP	BOOL	In Progress—set while the drive applying torque.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Send the Apply Torque message to the drive and monitor drive performance.

SM6_Set_Acceleration - Set Drive Acceleration



Description

Send a message to the SmartMotor to set the acceleration to the requested value.

Operands

Operand	Data Type	Operand Type	Description
SM6_Set_Acceleration	SM6_Set_Acceleration	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Acceleration	DINT	Tag	Requested Acceleration

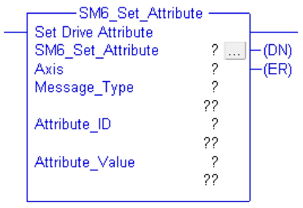
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Send the Set Acceleration message to the drive.

SM6_Set_Attribute - Set Drive Attribute



Description

Set the attribute specified by Attribute ID to the Attribute_Value passed in.

Operands

Operand	Data Type	Operand Type	Description
SM6_Set_Attribute	SM6_Set_Attribute	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Message_Type	SINT	Immediate Value	16#1a - Position Controller Supervisor 16#1b - Position Controller
Attribute_ID	DINT	Immediate Value	The index to one of these application objects: Position Controller Supervisor (0x24) on page 86 or Position Controller (0x25) on page 88.
Attribute_Value	DINT	Tag	The value of the attribute.

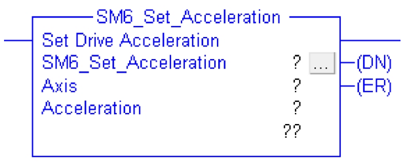
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables and reset timeout.
Rung-condition-in is FALSE	Initialize variables and reset timeout.
Rung-condition-in is TRUE	Send a message to the SmartMotor to set the attribute specified by Attribute_ID to Attribute_Value.

SM6_Set_Deceleration - Set Drive Deceleration



Description

Send a message to the SmartMotor to set the Deceleration to the requested value.

Operands

Operand	Data Type	Operand Type	Description
SM6_Set_Deceleration	SM6_Set_Deceleration	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Acceleration	DINT	Tag	Requested Acceleration

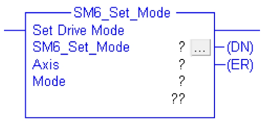
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Send the Set Deceleration message to the drive.

SM6_Set_Mode - Set Drive Mode



Description

Send a message to the SmartMotor to set the Drive Mode to the requested value.

Operands

Operand	Data Type	Operand Type	Description
SM6_Set_Mode	SM6_Set_Mode	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Mode	SINT	Tag	Requested Drive Mode 0 = Position 1 = Velocity 2 = Torque

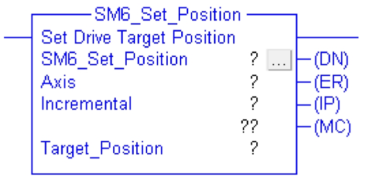
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Send the Set Mode message to the drive.

SM6_Set_Position - Set Drive Position



Description

Send a message to the SmartMotor to generate a profile move to an absolute or relative position. The current drive Acceleration, Deceleration and Velocity settings will be used. The Command Response Message Type will return the Actual Position in the Response Message.

Operands

Operand	Data Type	Operand Type	Description
SM6_Set_Position	SM6_Set_Position	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Incremental	BOOL	Immediate Value	Move Type 0 - Absolute 1 - Incremental
Target_Position	DINT	Tag	Requested Position

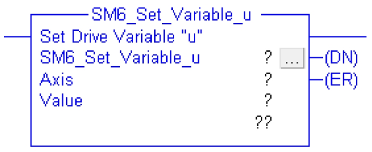
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.
.IP	BOOL	In Progress—set while the drive is reporting a command is in progress.
.MC	BOOL	Move Complete—set when there is no move in progress and the drive is on the target position.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Send a Set Position message to the drive and monitor move progress. This command will set the Response Message Type to return the Actual Position.

SM6_Set_Variable_u - Set Drive Variable "u"



Description

Send a message to the SmartMotor to set the drive variable "u" to the requested value.

Operands

Operand	Data Type	Operand Type	Description
SM6_Set_Variable_u	SM6_Set_Variable_u	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Value	DINT	Immediate value	New variable value

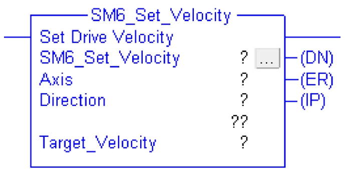
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Send a message to the drive to set the drive variable "u" to the requested value.

SM6_Set_Velocity - Set Drive Target Velocity



Description

Send a message to the SmartMotor to generate a profile move to a requested Velocity. The current drive Acceleration and Deceleration settings will be used. The Response Message Type to return the Actual Velocity.

Operands

Operand	Data Type	Operand Type	Description
SM6_Set_Velocity	SM6_Set_Velocity	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive
Direction	BOOL	Immediate Value	Requested Direction 0=Reverse 1=Forward
Target_Velocity	DINT	Tag	Requested Velocity

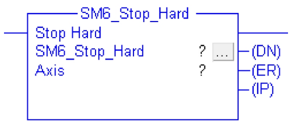
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.
.IP	BOOL	In Progress—set while the drive is reporting a command is in progress.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Send a Set Velocity message to the drive and monitor move progress. This command will set the Response Message Type to return the Actual Velocity.

SM6_Stop_Hard - Perform a Hard Stop



Description

Set the Hard Stop flag in the Command Control byte. This will cause the drive to stop with no deceleration.

Operands

Operand	Data Type	Operand Type	Description
SM6_Stop_Hard	SM6_Stop_Hard	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive

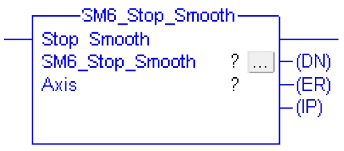
Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.
.IP	BOOL	In Progress—set while the drive is reporting a command is in progress.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Set the Hard Stop flag in the Command Control byte.

SM6_Stop_Smooth - Perform a Smooth Stop



Description

Set the Smooth Stop flag in the Command Control byte. This will cause the drive to decelerate to a stop.

Operands

Operand	Data Type	Operand Type	Description
SM6_Stop_Smooth	SM6_Stop_Smooth	Tag	Control tag for this AOI
Axis	SM6_Axis	Tag	The targeted drive

Structure

Field	Type	Description
.DN	BOOL	Set when the drive indicates the instruction has been processed.
.ER	BOOL	Set if there are any timeout or processing errors.
.IP	BOOL	In Progress—set while the drive is reporting a command is in progress.

Operation

Scan Mode	Description
Prescan	Initialize variables.
Rung-condition-in is FALSE	Initialize variables.
Rung-condition-in is TRUE	Set the Smooth Stop bit in the Command Control byte.

Adding AOI Support - Allen Bradley PLC

This chapter contains procedures that describe the steps for adding Add on Instruction (AOI) SmartMotor support to a new project using Allen Bradley Studio 5000 Logix Designer software.

Extracting the SmartMotor Support files **135**

Adding a SmartMotor Module **136**

Importing the UDTs **143**

Importing the AOIs **147**

SmartMotor AOI Example **151**

Extracting the SmartMotor Support files

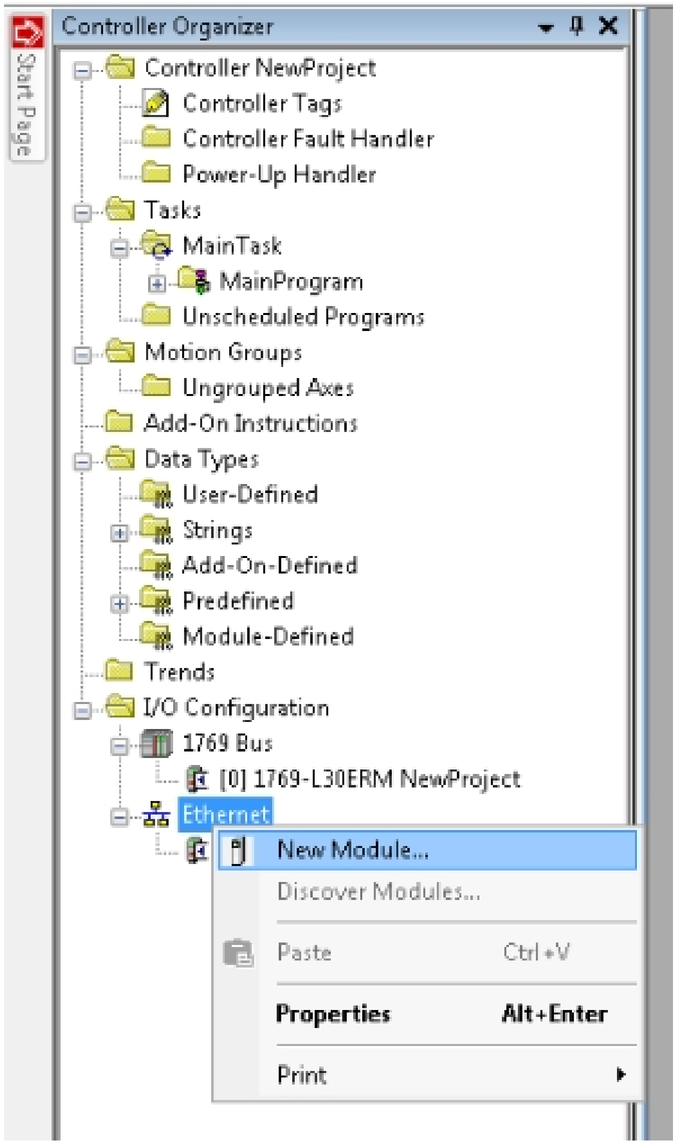
The support files for the SmartMotor are in a file named SM6_Support_Files.zip. Extract all of the files to a location accessible to the Studio 5000 Logix Designer software. The extracted folder contains three sub-folders:

Sub-folder	Description
SM6_Examples	Sample Studio 5000 Logix Designer project files
SM6_AOIs	The SmartMotor Add-On Instruction library
SM6_UDT	The SmartMotor Add-On Instruction data type library

Adding a SmartMotor Module

This section describes the procedure for adding a SmartMotor module to the Ethernet port.

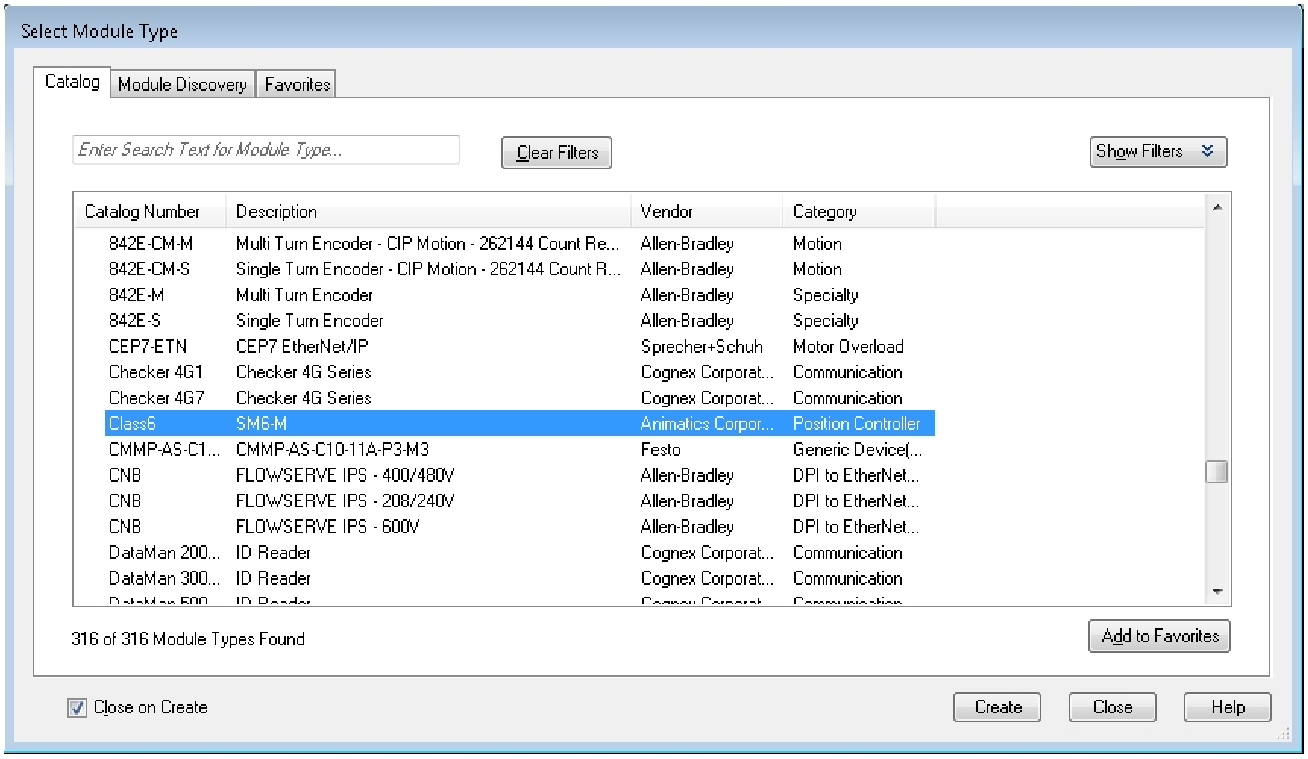
1. Start the Studio 5000 Logix Designer software and open a new project. See that software's help file for details.
2. In the I/O Configuration folder, right-click the Ethernet port and then click New Module.



Adding a new Ethernet module

3. In the Select Module Type dialog, select the "Class6 - SM6-M" item and then click Create. The module is created and the New Module dialog opens.

   NOTE: Select the Close on Create option at the bottom of the dialog.

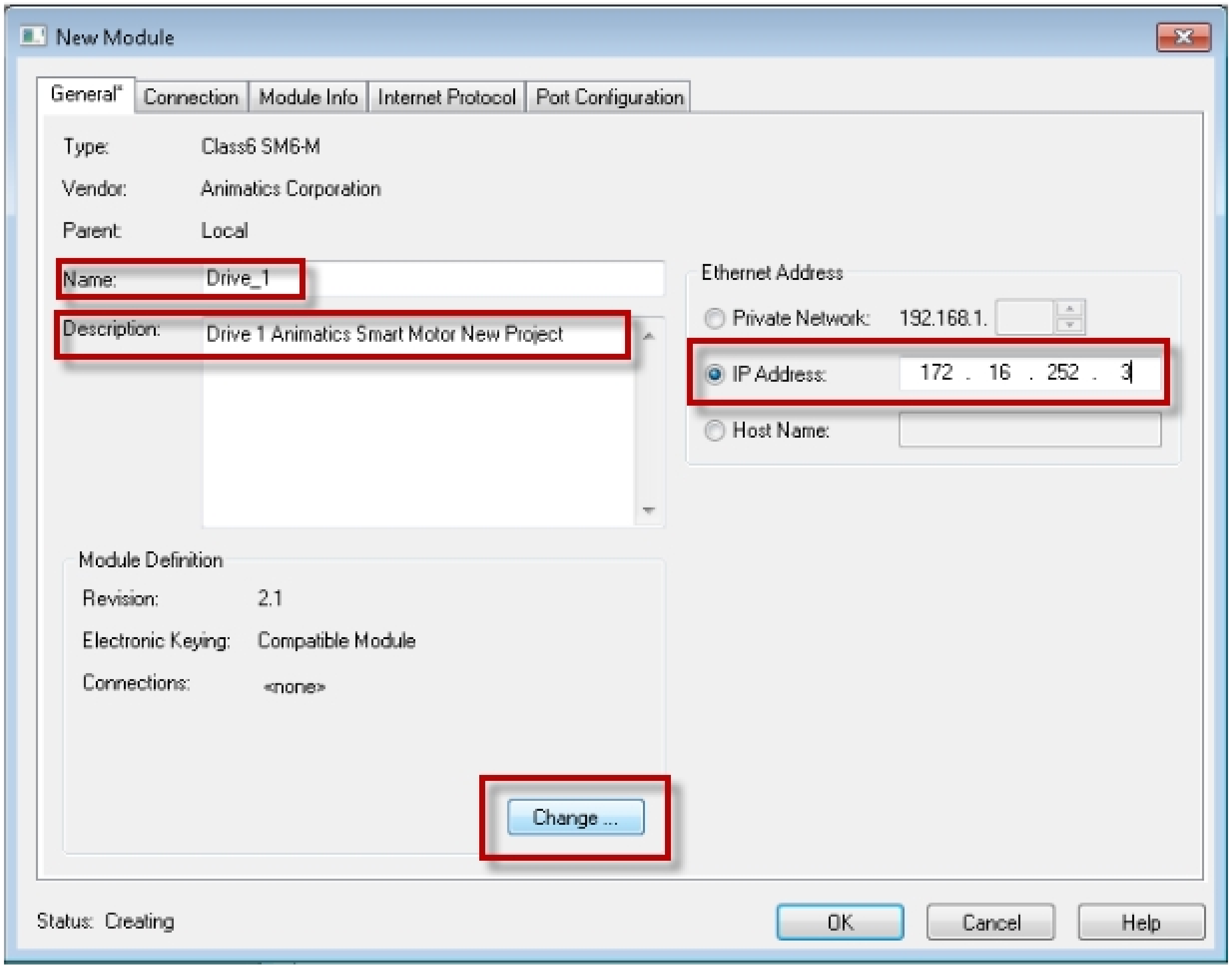


Catalog Number	Description	Vendor	Category
842E-CM-M	Multi Turn Encoder - CIP Motion - 262144 Count Re...	Allen-Bradley	Motion
842E-CM-S	Single Turn Encoder - CIP Motion - 262144 Count R...	Allen-Bradley	Motion
842E-M	Multi Turn Encoder	Allen-Bradley	Specialty
842E-S	Single Turn Encoder	Allen-Bradley	Specialty
CEP7-ETN	CEP7 EtherNet/IP	Sprecher+Schuh	Motor Overload
Checker 4G1	Checker 4G Series	Cognex Corporat...	Communication
Checker 4G7	Checker 4G Series	Cognex Corporat...	Communication
Class6	SM6-M	Animatics Corpor...	Position Controller
CMMP-AS-C1...	CMMP-AS-C10-11A-P3-M3	Festo	Generic Device(...
CNB	FLOWSERVE IPS - 400/480V	Allen-Bradley	DPI to EtherNet...
CNB	FLOWSERVE IPS - 208/240V	Allen-Bradley	DPI to EtherNet...
CNB	FLOWSERVE IPS - 600V	Allen-Bradley	DPI to EtherNet...
DataMan 200...	ID Reader	Cognex Corporat...	Communication
DataMan 300...	ID Reader	Cognex Corporat...	Communication

316 of 316 Module Types Found

Select Module Type

4. On the New Module - General Tab:
   a. Type the Name, Description and Ethernet Address in the corresponding boxes.
   b. Click Change to configure the Module Definition. The Module Definition dialog opens.



Type: Class6 SM6-M
Vendor: Animatics Corporation
Parent: Local
Name: Drive_1
Description: Drive 1 Animatics Smart Motor New Project

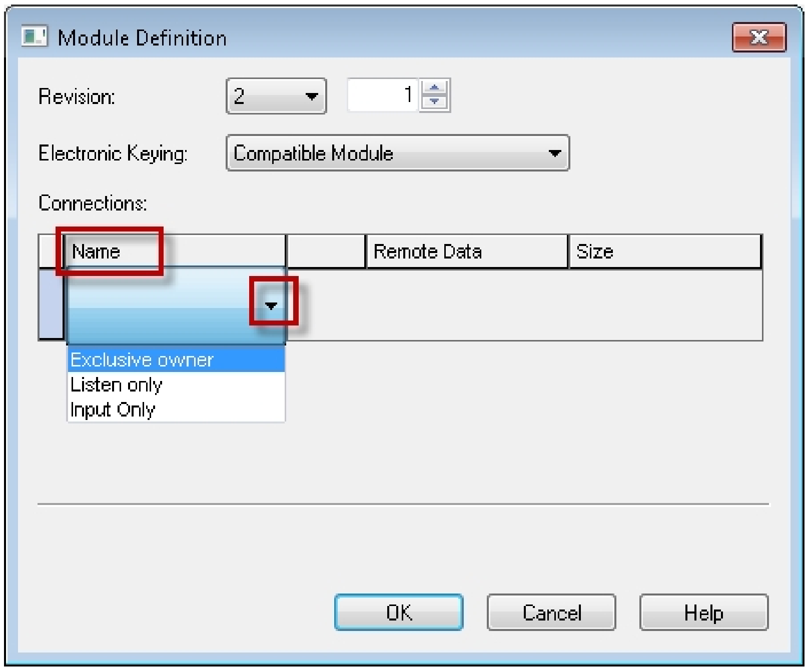
Ethernet Address
( ) Private Network: 192.168.1.
(●) IP Address: 172 . 16 . 252 . 3
( ) Host Name:

Module Definition
Revision: 2.1
Electronic Keying: Compatible Module
Connections: <none>

Status: Creating

New Module Configuration - General Tab

5. In the Connections group, click the arrow in the Name column, and then click Exclusive owner.


Module Definition

Revision: 2 1

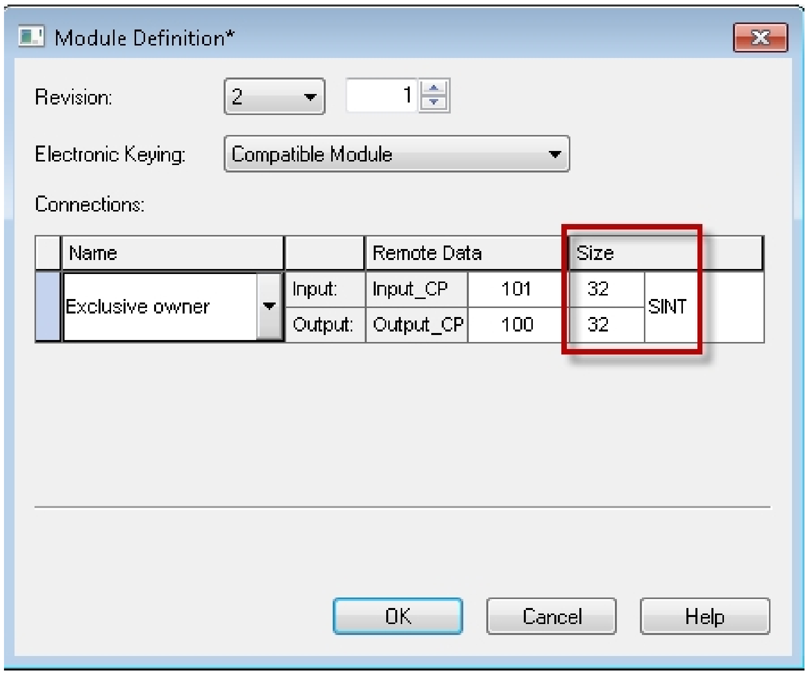
Electronic Keying: Compatible Module

Connections:

Name		Remote Data	Size

New Module Configuration - Module Definition

The Input and the Output sizes should be 32 SINT.


Module Definition*

Revision: 2 1

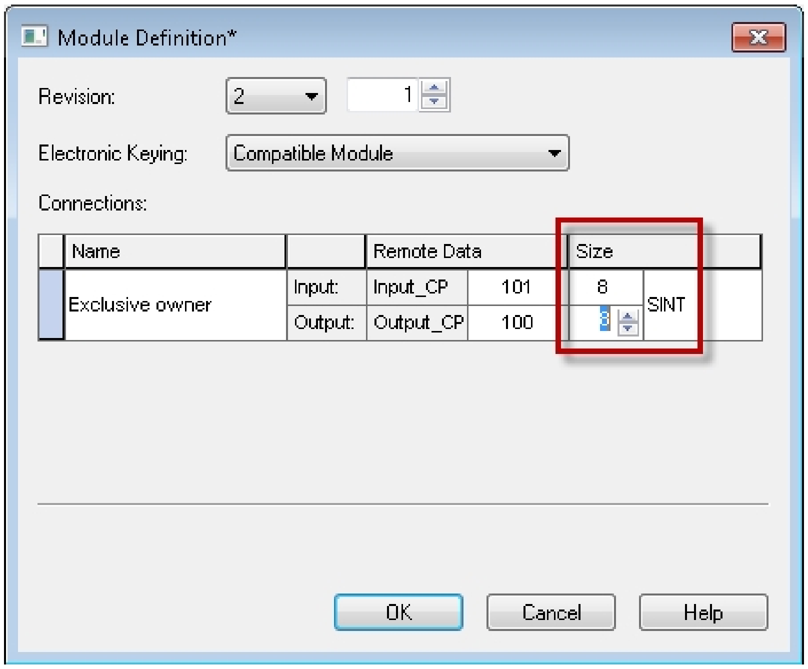
Electronic Keying: Compatible Module

Connections:

Name		Remote Data		Size	
Exclusive owner	Input:	Input_CP	101	32	SINT
	Output:	Output_CP	100	32	

New Module Configuration - Module Definition - Extended 32 byte format

To change the connection to support only the Standard 8-byte Position Controller messaging, change the Input and Output size to "8 SINT" by selecting each size and changing the value from 32 to 8.


Module Definition*

Revision: 2 1

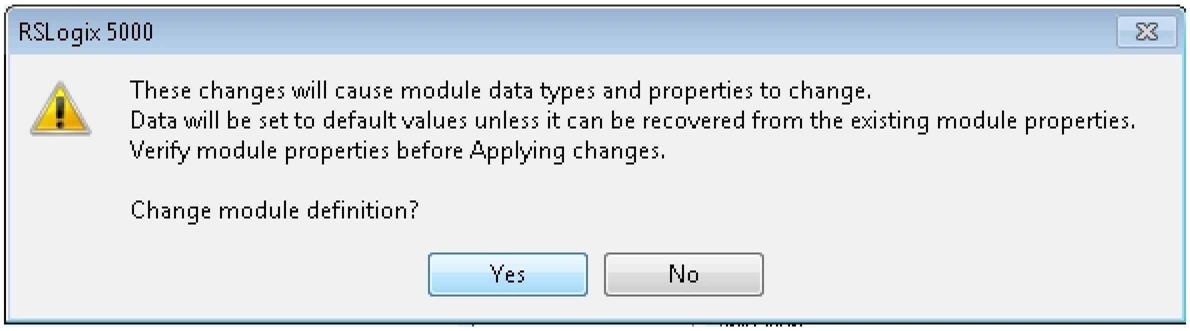
Electronic Keying: Compatible Module

Connections:

Name		Remote Data		Size	
Exclusive owner	Input:	Input_CP	101	8	SINT
	Output:	Output_CP	100	8	

New Module Configuration - Module Definition - Standard 8-byte format

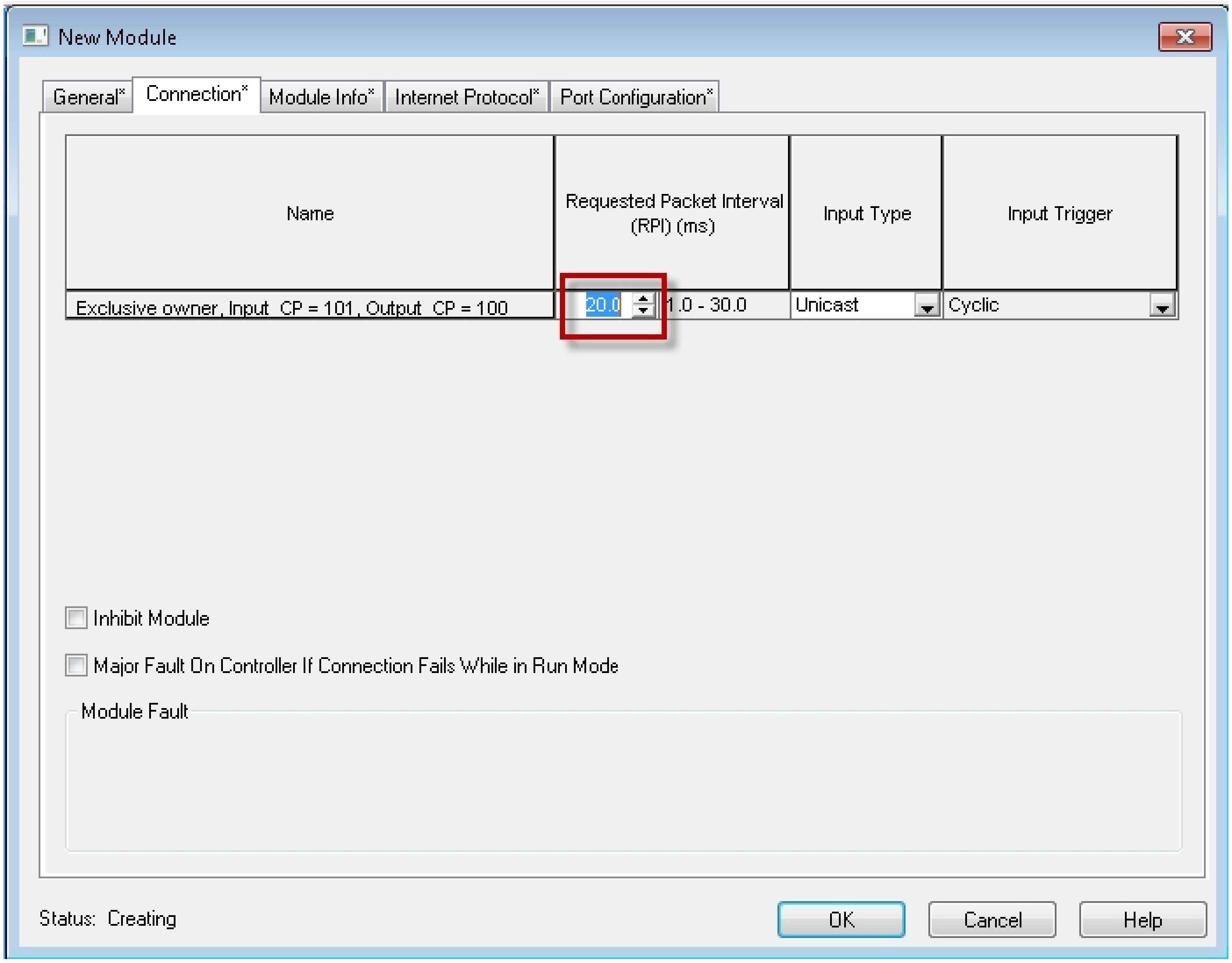
Click OK. The dialog box closes. If the following prompt is displayed, click Yes.


RSLogix 5000

These changes will cause module data types and properties to change.
Data will be set to default values unless it can be recovered from the existing module properties.
Verify module properties before Applying changes.

Change module definition?

The Requested Packet Interval (RPI) can be changed from the New Module Configuration - Connection tab. The default value is 20 ms.



Name	Requested Packet Interval (RPI) (ms)		Input Type	Input Trigger
Exclusive owner, Input CP = 101, Output CP = 100	20.0	1.0 - 30.0	Unicast	Cyclic

☐ Inhibit Module

☐ Major Fault On Controller If Connection Fails While in Run Mode

Module Fault

Status: Creating

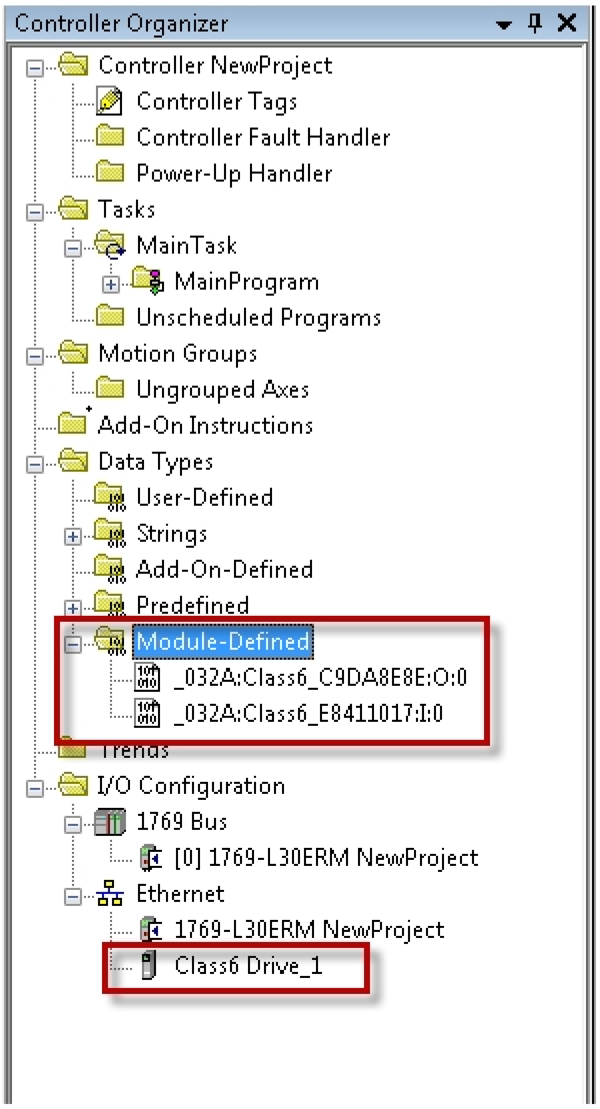
New Module - Changing the Requested Packet Interval

Click OK when finished with the New Module Configuration. The dialog box closes.

NOTE: If the "Close on Create" option was not selected in Step 3, click Close to close the Select Module Type dialog.

6. The SmartMotor should now be configured. It is displayed in the Controller Organizer's I/O Configuration folder, Ethernet port item.

   NOTE: When the SmartMotor is added, two Module-Defined data types will also be added that match the module configuration.



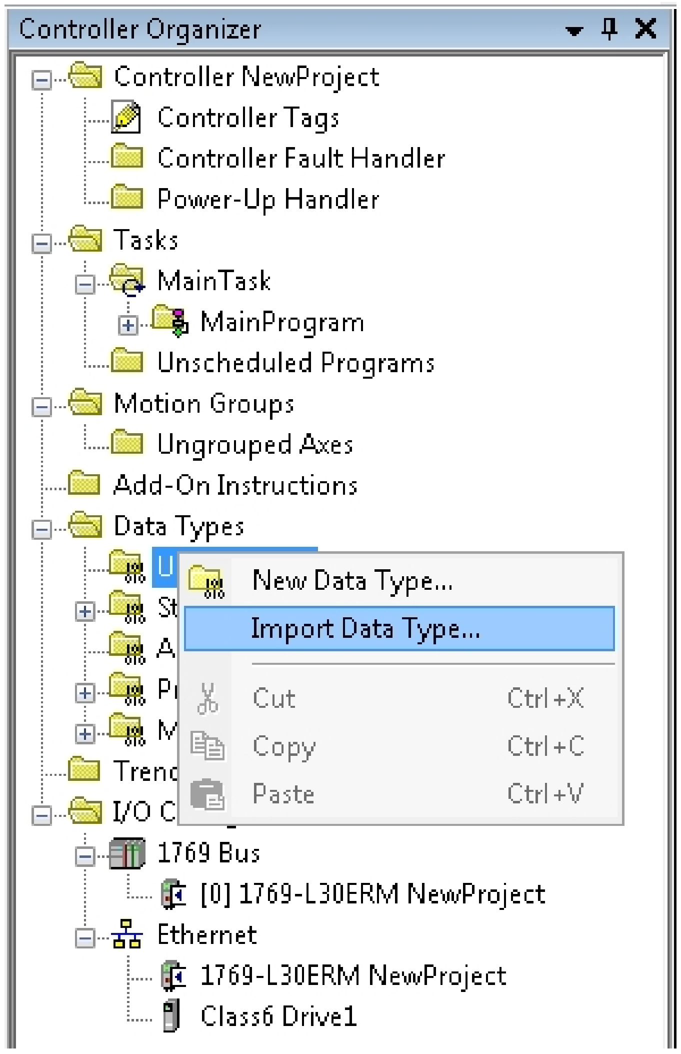
Controller Organizer with SmartMotor and Module-Defined items added

Importing the UDTs

This section describes the procedure for importing the User-Defined Data Types (UDTs) used in the Add-On Instructions (AOIs).

NOTE: The UDTs should be imported before the AOIs.

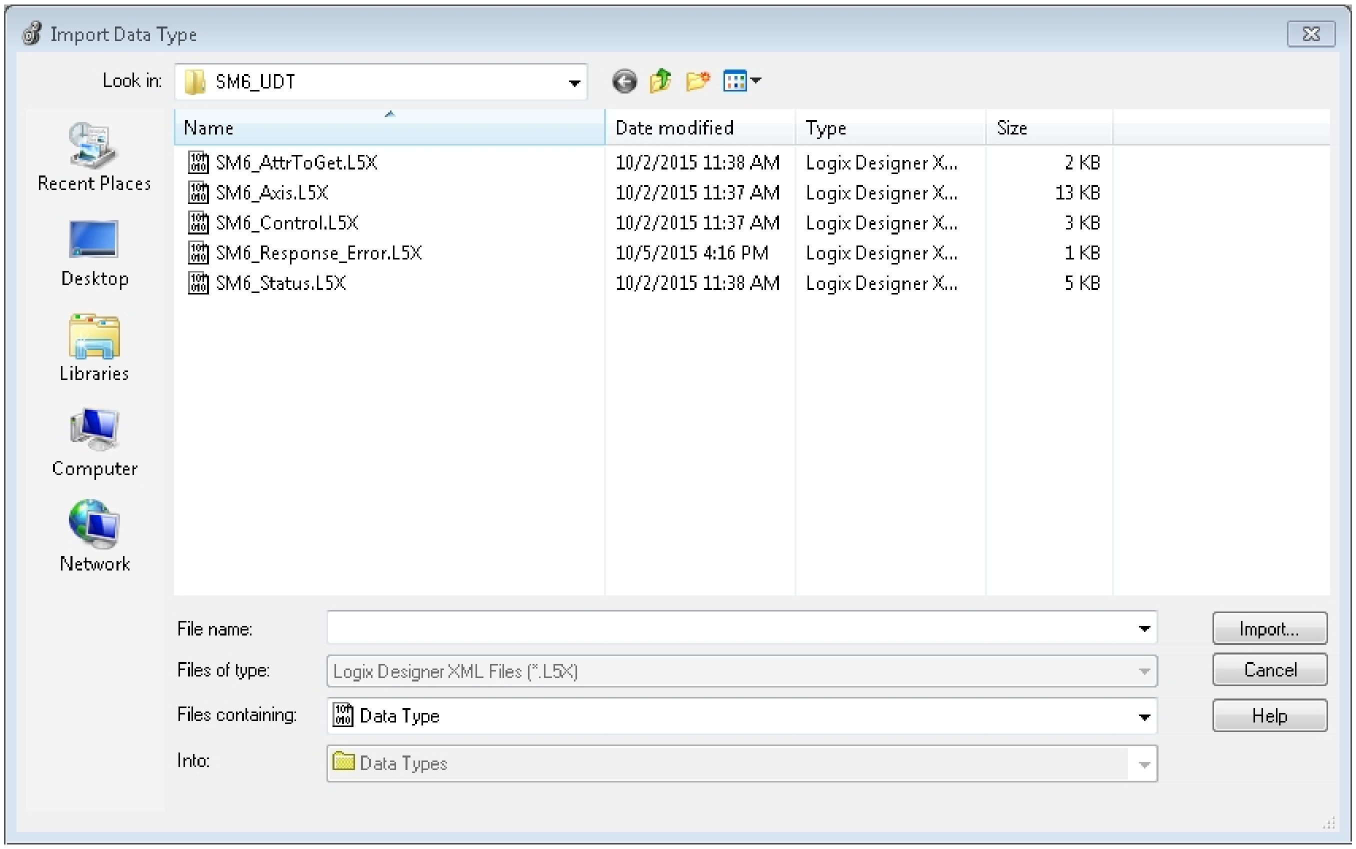
1. In the Controller Organizer, right-click the Data Types > User-Defined folder and select Import Data Type.



Importing a User Data Type

The Import Data Type dialog opens.

2. In the Import Data Type dialog, browse to the location of the UDT library.



Import Data Type

Look in: SM6_UDT

Name	Date modified	Type	Size
SM6_AttrToGet.L5X	10/2/2015 11:38 AM	Logix Designer X...	2 KB
SM6_Axis.L5X	10/2/2015 11:37 AM	Logix Designer X...	13 KB
SM6_Control.L5X	10/2/2015 11:37 AM	Logix Designer X...	3 KB
SM6_Response_Error.L5X	10/5/2015 4:16 PM	Logix Designer X...	1 KB
SM6_Status.L5X	10/2/2015 11:38 AM	Logix Designer X...	5 KB

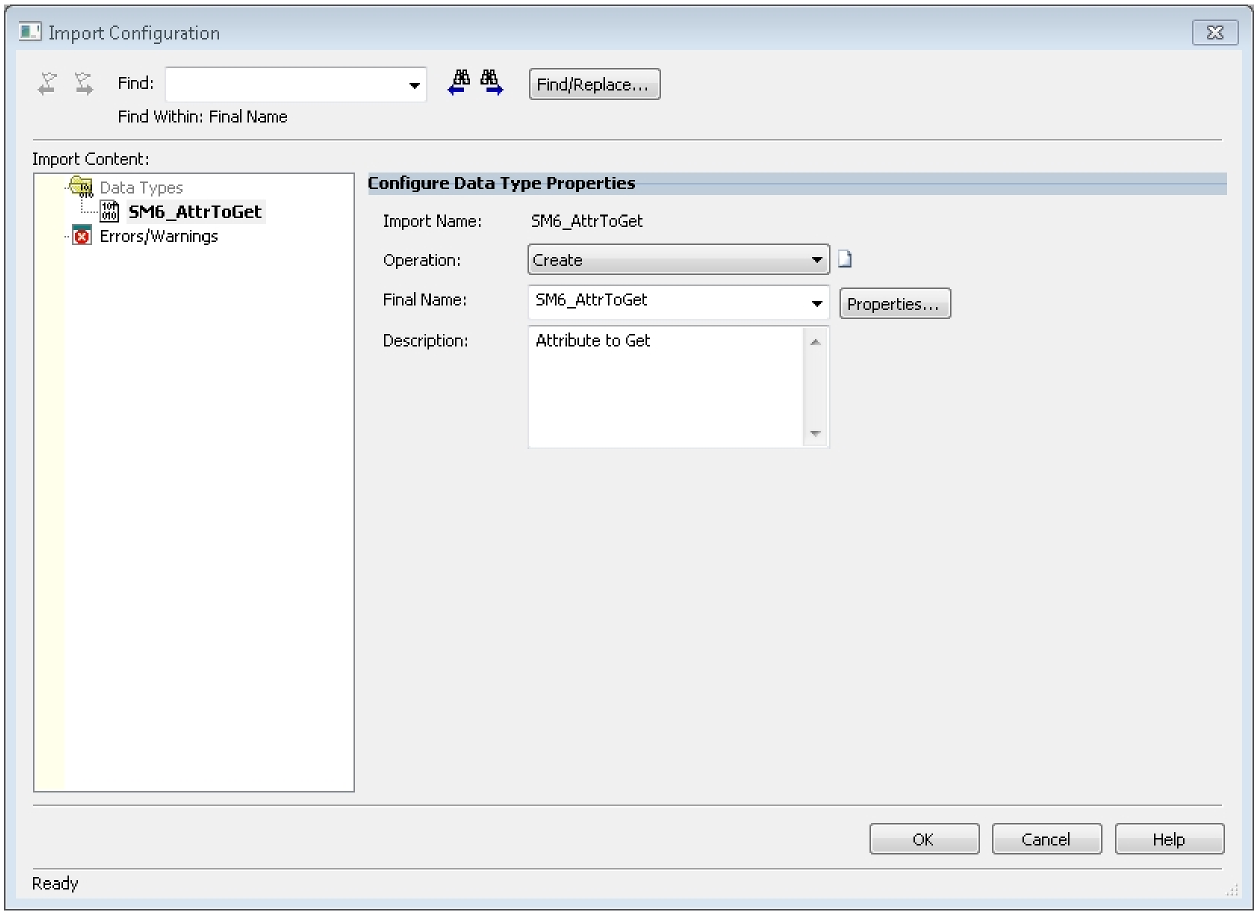
File name:
Files of type: Logix Designer XML Files (*.L5X)
Files containing: Data Type
Into: Data Types

Selecting a UDT file

3. Select the next UDT file to be imported, and then click Import. The Import Configuration dialog opens.

   NOTE: The UDT file SM6_Axis.L5X should be imported last.

4. On the Import Configuration dialog, click OK.

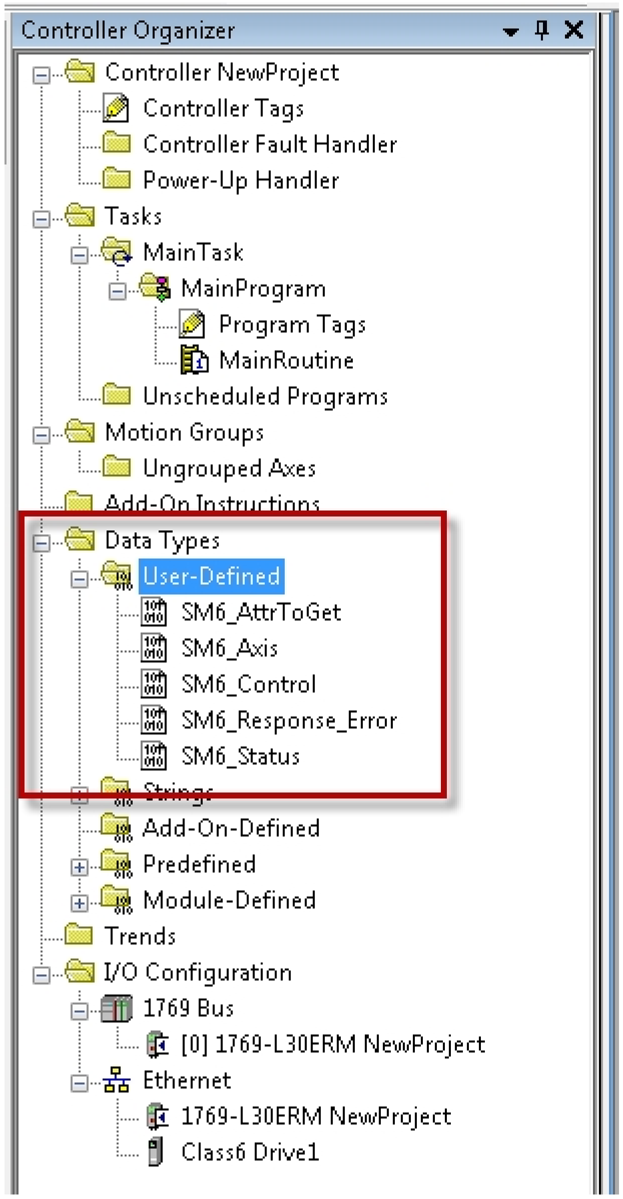


Import Name: SM6_AttrToGet
Operation: Create
Final Name: SM6_AttrToGet
Description: Attribute to Get

Ready

Import Configuration - Complete UDT File Import

5. Repeat steps 1 through 4 for all of the UDT files in the library. When finished the data types should all show in the Controller Organizer under "Data-Types > User-Defined"

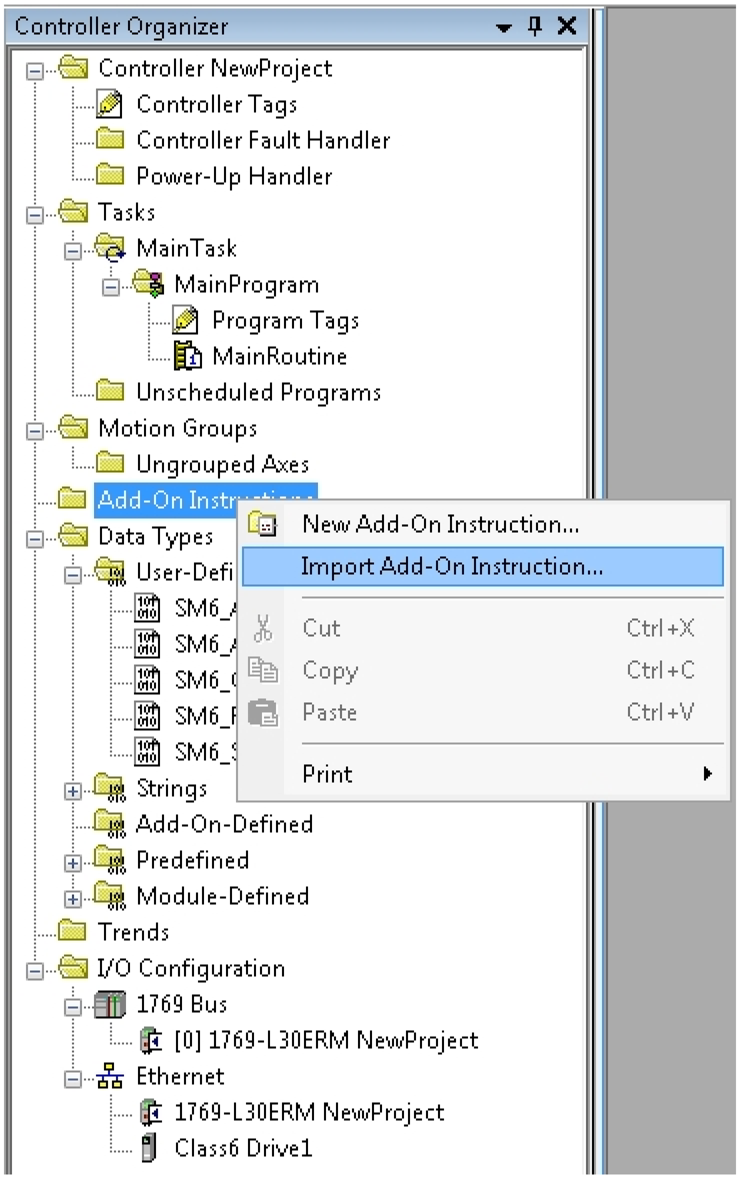


Controller Organizer - Imported UDTs

Importing the AOIs

This section describes the procedure for importing the Add-On Instructions (AOIs).

1. In the Controller Organizer, right-click the Add-On Instructions folder and select Import Add-On Instruction.

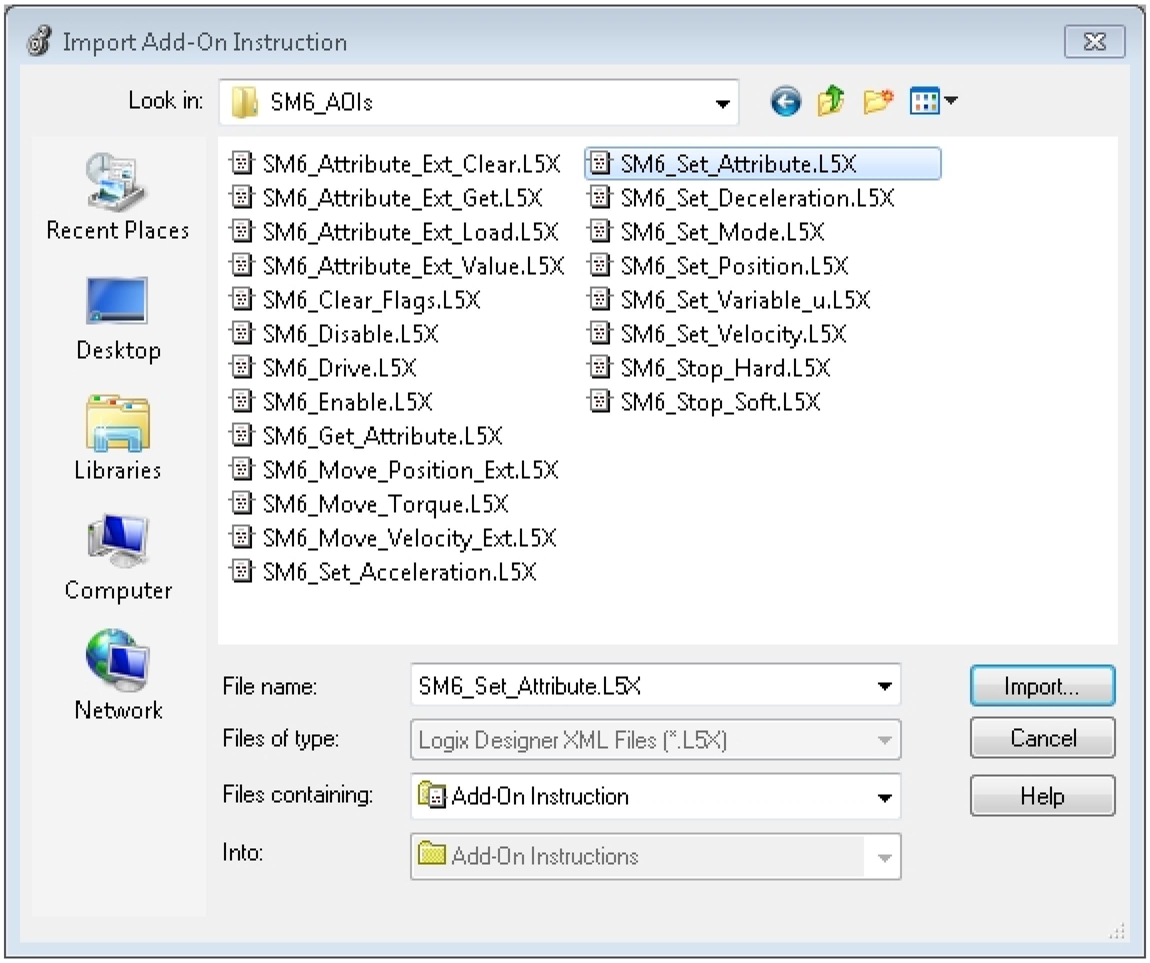


Importing Add-On Instructions

The Import Add-On Instruction dialog opens.

2. In the Import Add-On Instruction dialog, browse to the location of the AOI library.

   NOTE: Import the file SM6_Set_Attribute.L5X first; it is used for some of the other AOIs.

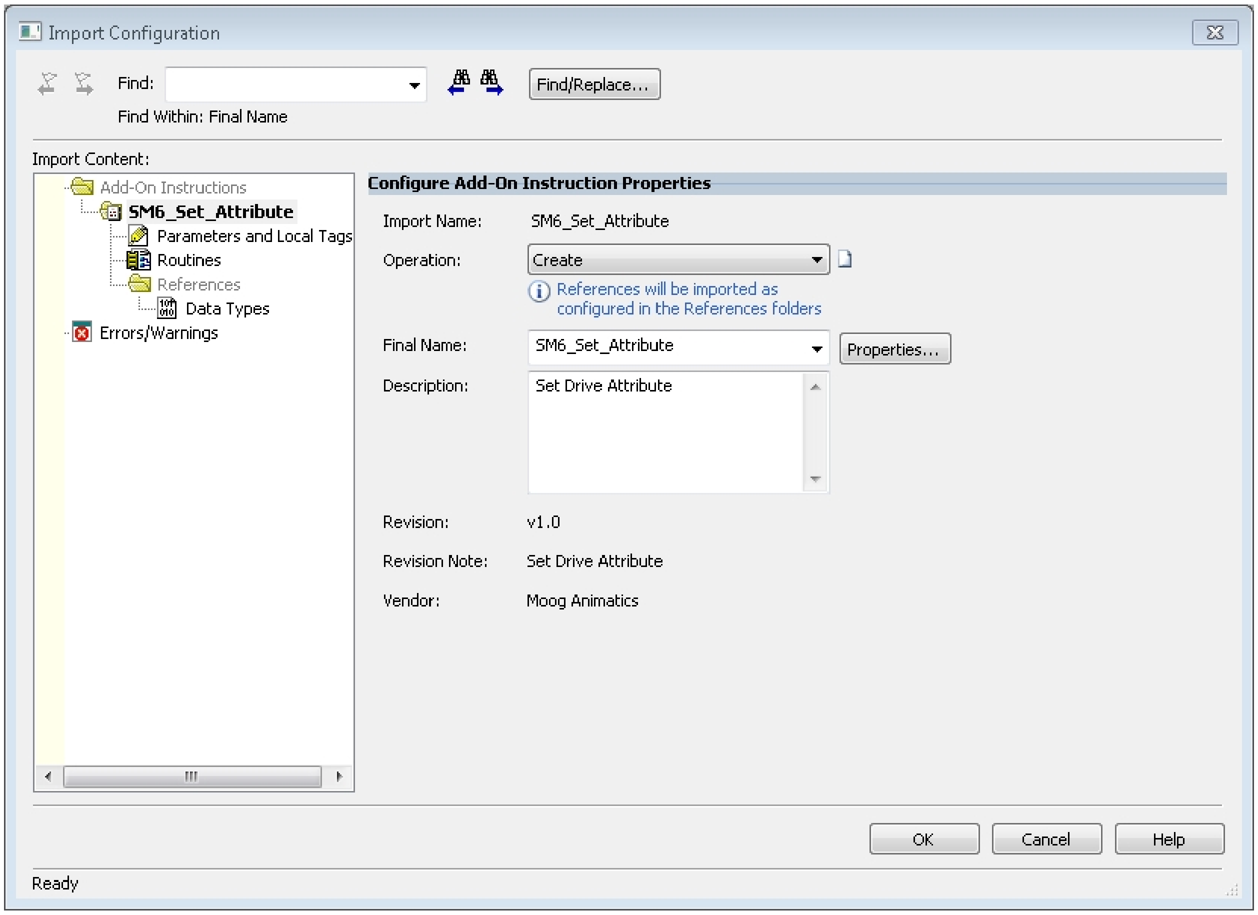


File name: SM6_Set_Attribute.L5X
Files of type: Logix Designer XML Files (*.L5X)
Files containing: Add-On Instruction
Into: Add-On Instructions

SM6_Set_Attribute.L5X AOI File Import

3. Select the AOI file to be imported, and then click Import. The Import Configuration dialog opens.

4. On the Import Configuration dialog, click OK.



Import Configuration

Find:

Find Within: Final Name

Import Content:

- Add-On Instructions
  - SM6_Set_Attribute
    - Parameters and Local Tags
    - Routines
    - References
      - Data Types
- Errors/Warnings

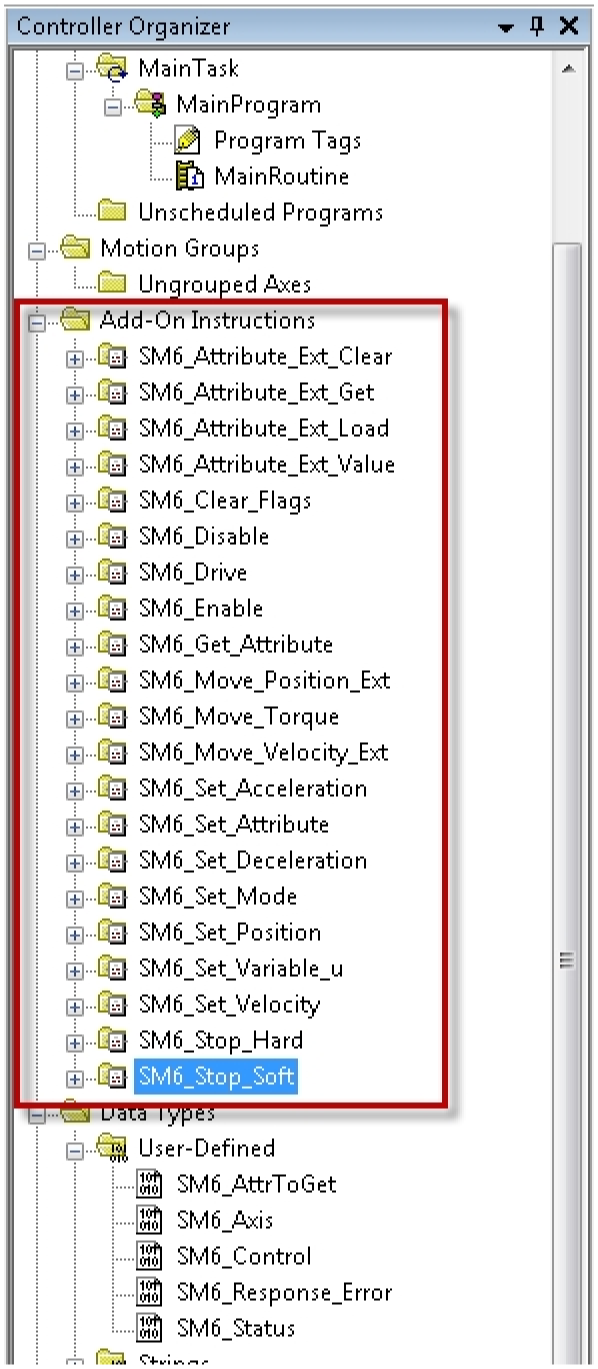
Configure Add-On Instruction Properties

Import Name:	SM6_Set_Attribute
Operation:	Create
	References will be imported as configured in the References folders
Final Name:	SM6_Set_Attribute
Description:	Set Drive Attribute
Revision:	v1.0
Revision Note:	Set Drive Attribute
Vendor:	Moog Animatics

AOI File Import Configuration

5. Repeat steps 1 through 4 for all AOI files in the library. When finished, the data types should be listed in the Controller Organizer under the Add-On Instructions folder.

   NOTE: It is not required to import all AOI files; however, an AOI must be imported before it can be used. If an AOI references an AOI file that has not yet been imported, the Studio 5000 Logix Designer software will automatically import it.


Controller Organizer
- MainTask
  - MainProgram
    - Program Tags
    - MainRoutine
  - Unscheduled Programs
- Motion Groups
  - Ungrouped Axes
- Add-On Instructions
  - SM6_Attribute_Ext_Clear
  - SM6_Attribute_Ext_Get
  - SM6_Attribute_Ext_Load
  - SM6_Attribute_Ext_Value
  - SM6_Clear_Flags
  - SM6_Disable
  - SM6_Drive
  - SM6_Enable
  - SM6_Get_Attribute
  - SM6_Move_Position_Ext
  - SM6_Move_Torque
  - SM6_Move_Velocity_Ext
  - SM6_Set_Acceleration
  - SM6_Set_Attribute
  - SM6_Set_Deceleration
  - SM6_Set_Mode
  - SM6_Set_Position
  - SM6_Set_Variable_u
  - SM6_Set_Velocity
  - SM6_Stop_Hard
  - SM6_Stop_Soft
- Data Types
  - User-Defined
    - SM6_AttrToGet
    - SM6_Axis
    - SM6_Control
    - SM6_Response_Error
    - SM6_Status

Controller Organizer - Imported AOI Files

SmartMotor AOI Example

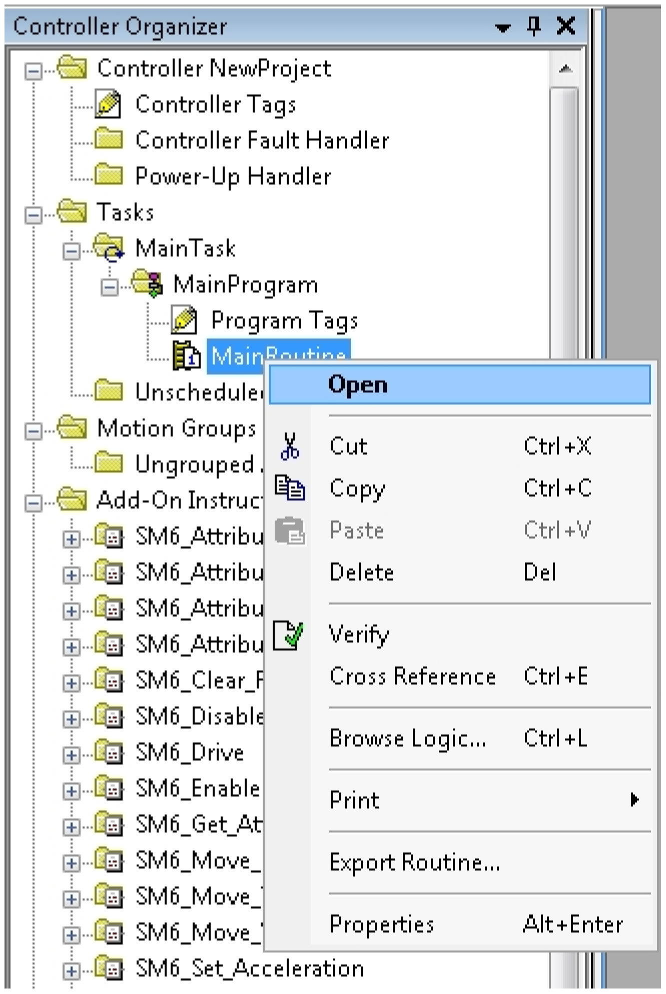
This section provides an example of using the SmartMotor Add-On Instructions (AOIs) in a ladder logic program.

The AOI distribution has three example projects in the sub-folder: ...\SM6_Support_Files\SM6_Examples.

- NewProject.ACD: The program created through the following procedure.
- Example_2Motor.ACD: A program that moves two motors back and forth, first one motor moves then the other.
- Example_2Motor_Parallel.ACD: A Program that moves two motors back and forth simultaneously.

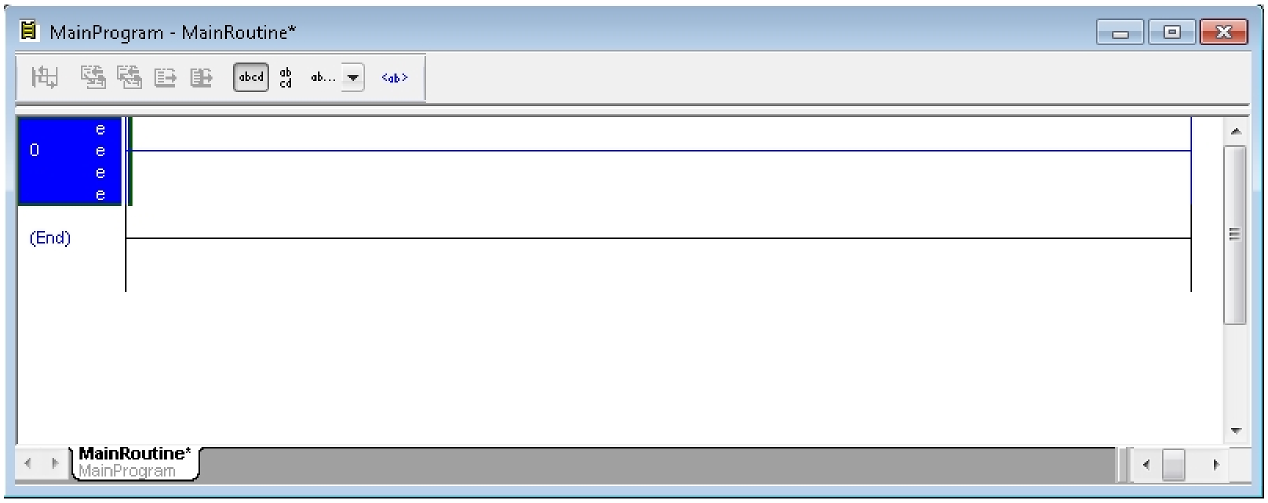
To create the program:

1. In the Controller Organizer, right-click the Main Task > MainRoutine folder and select Open.



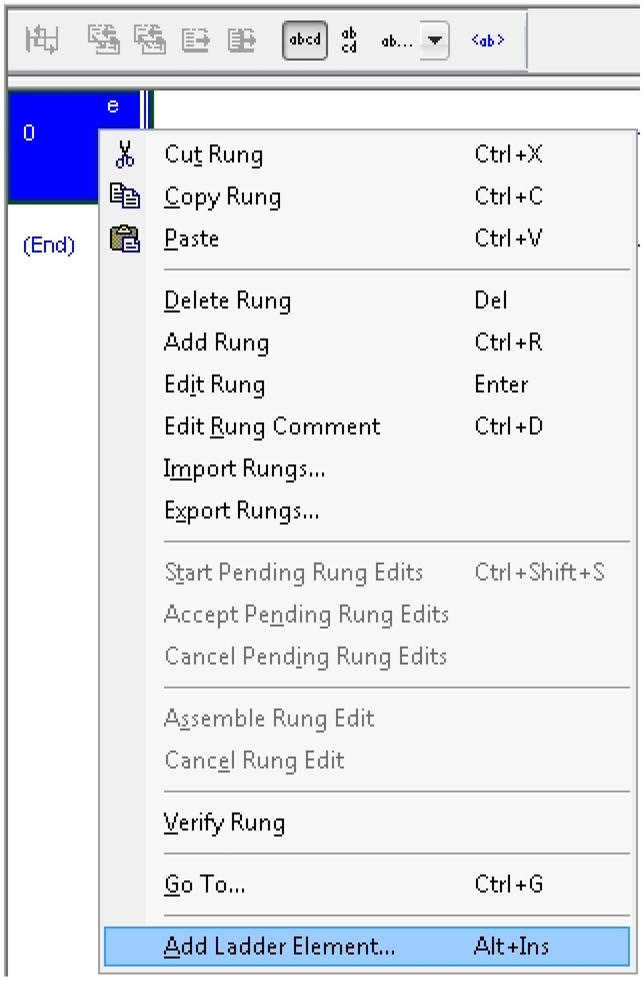
Open the Main Program Routine

An empty MainProgram - MainRoutine ladder logic form opens.



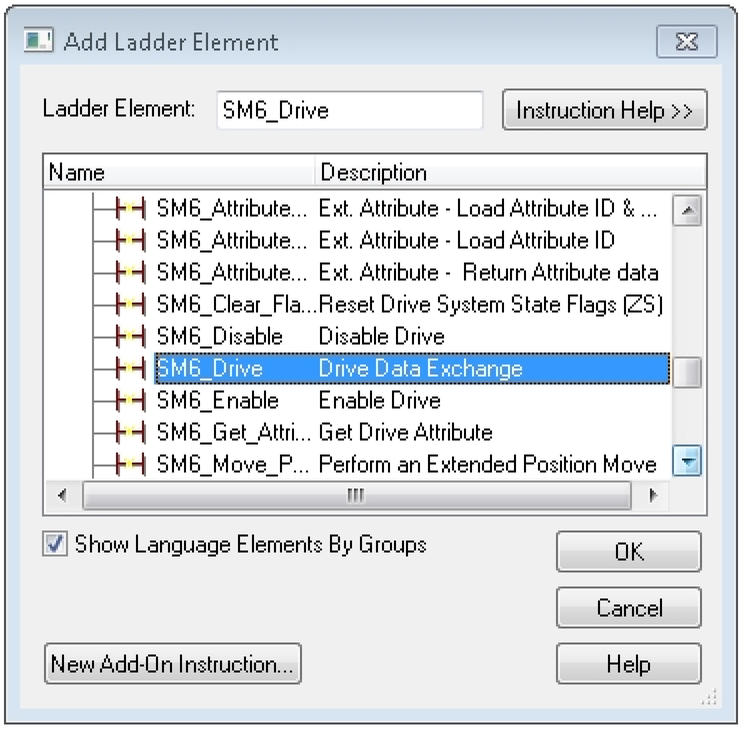
MainRoutine Ladder Logic Form

2. Right-click on Rung 0 and select Add Ladder Element.



The Add Ladder Element opens.

3. From the list of Ladder Elements, select SM6_Drive and then click OK.



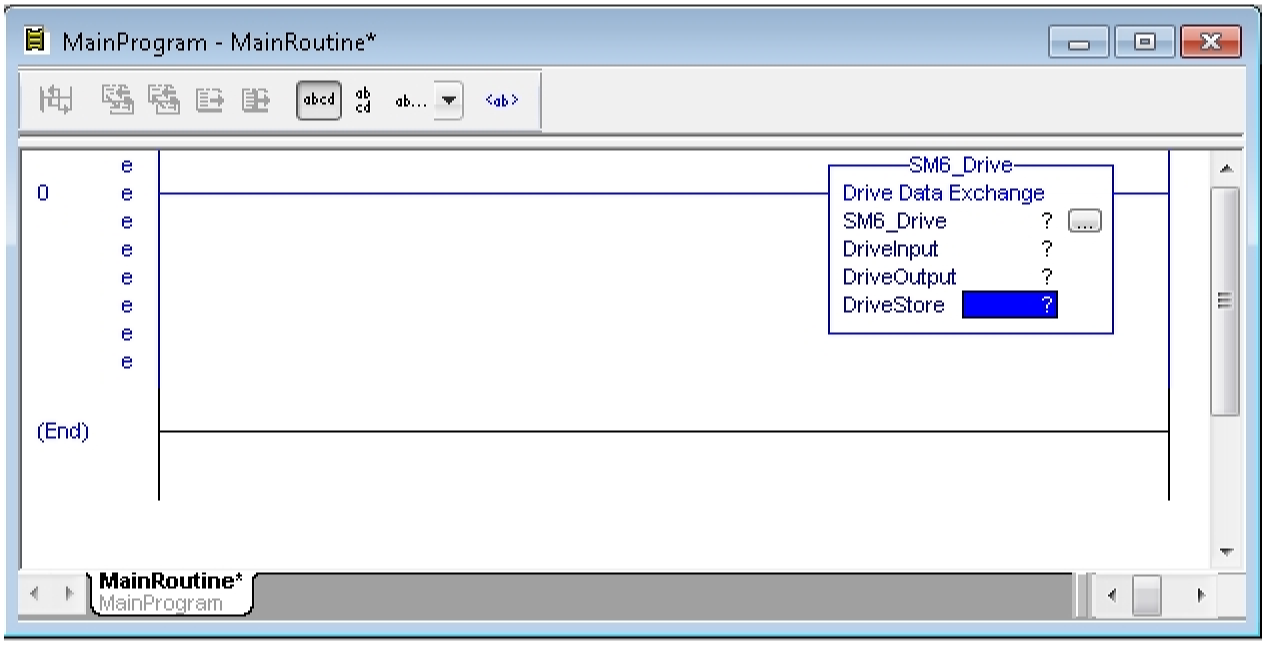
Ladder Element: SM6_Drive

Name	Description
SM6_Attribute...	Ext. Attribute - Load Attribute ID & ...
SM6_Attribute...	Ext. Attribute - Load Attribute ID
SM6_Attribute...	Ext. Attribute - Return Attribute data
SM6_Clear_Fla...	Reset Drive System State Flags (ZS)
SM6_Disable	Disable Drive
SM6_Drive	Drive Data Exchange
SM6_Enable	Enable Drive
SM6_Get_Attri...	Get Drive Attribute
SM6_Move_P...	Perform an Extended Position Move

☑ Show Language Elements By Groups

Add Ladder Element

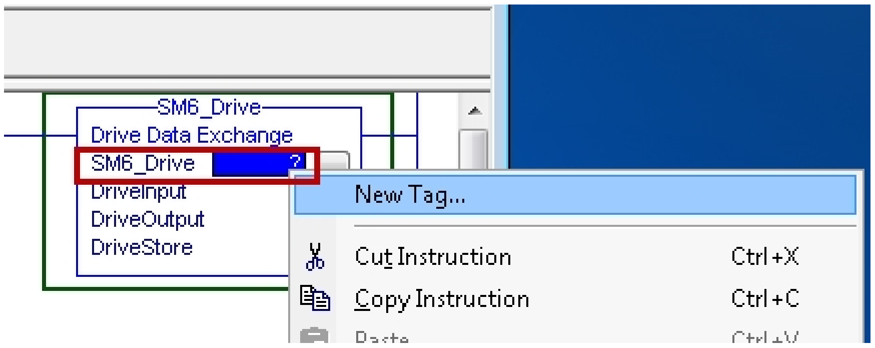
The MainProgram - MainRoutine form opens.



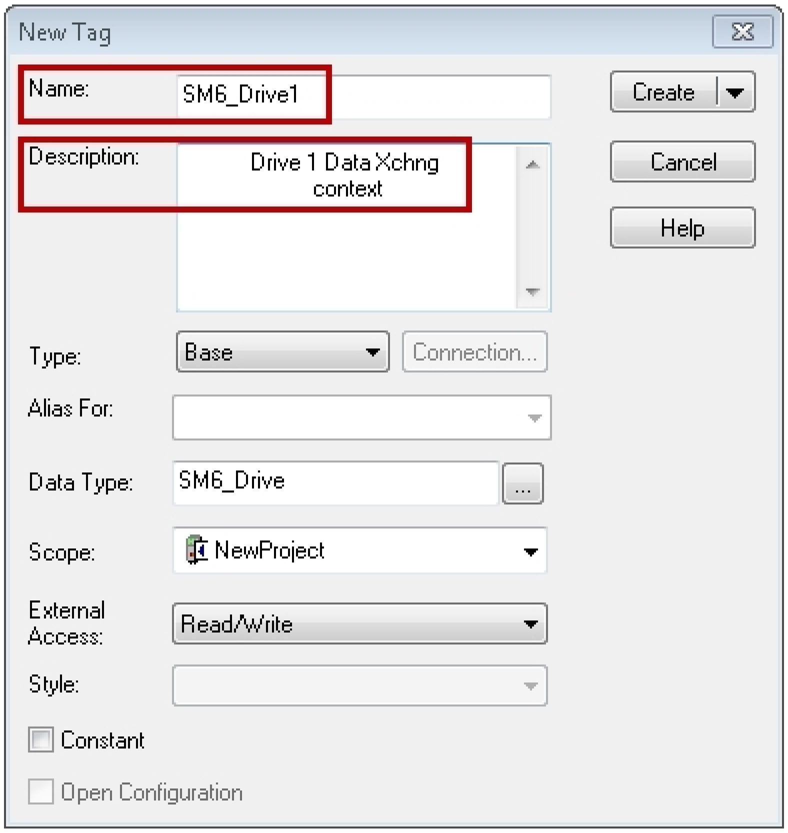
SM6_Drive
Drive Data Exchange
SM6_Drive ?
DriveInput ?
DriveOutput ?
DriveStore ?

MainRoutine Ladder Logic Form

4. In SM6_Drive block SM6-Drive parameter value field, right-click on the "?" and select New Tag.



Fill in the Name and Description boxes of the New tag and click Create.


New Tag

Name: SM6_Drive1

Description: Drive 1 Data Xchng context

Type: Base

Alias For:

Data Type: SM6_Drive

Scope: NewProject

External Access: Read/Write

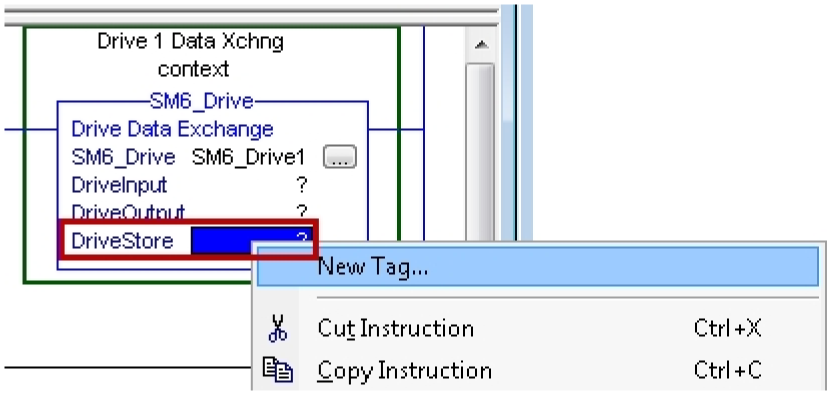
Style:

Constant

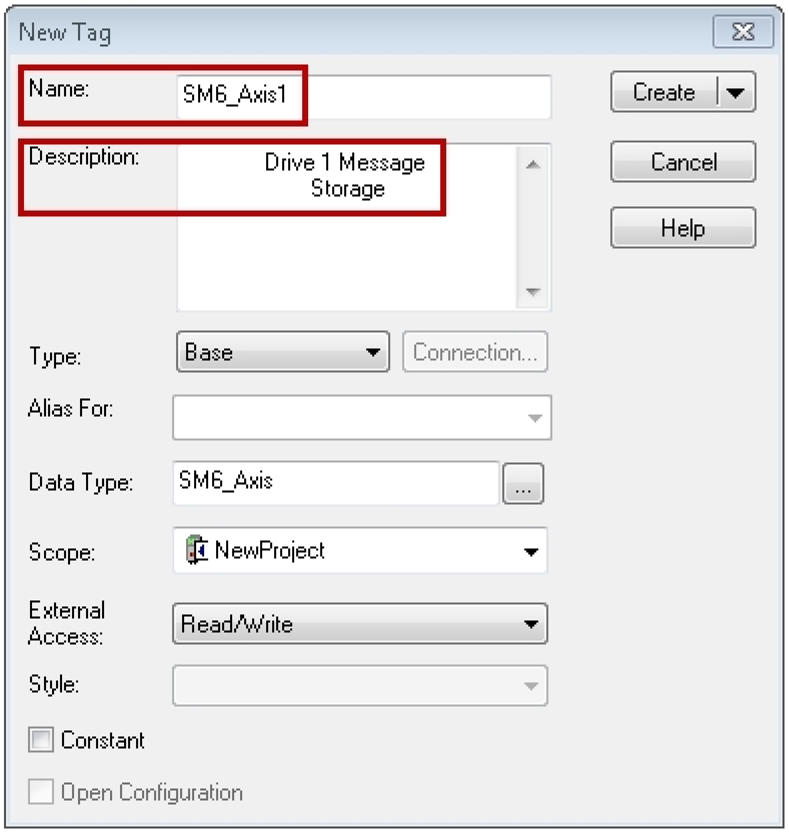
Open Configuration

New Tag - Name and Description Boxes

5. In SM6_Drive block SM6-DriveStore parameter value field, right-click on the "?" and select New Tag.



Fill in the Name and Description boxes of the New tag and click Create.


New Tag

Name: SM6_Axis1

Description: Drive 1 Message Storage

Type: Base

Alias For:

Data Type: SM6_Axis

Scope: NewProject

External Access: Read/Write

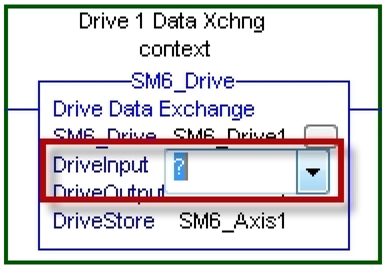
Style:

Constant

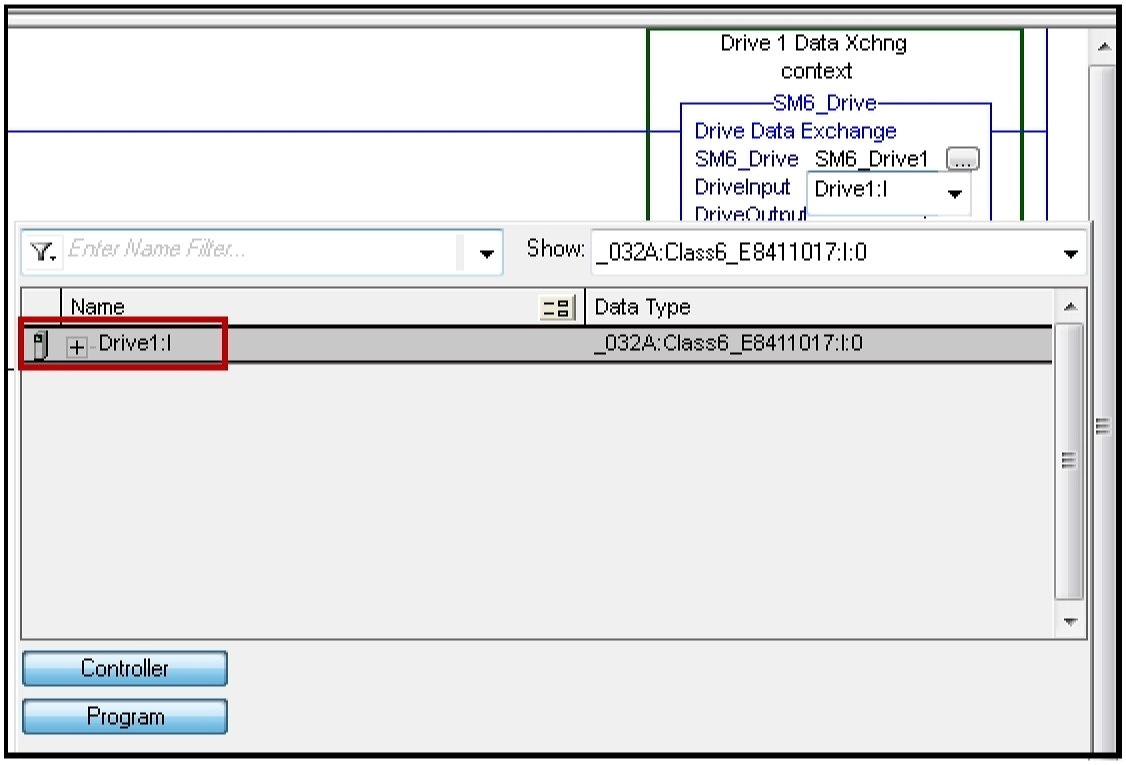
Open Configuration

New Tag - Name and Description Boxes

6. In the SM6_Drive block, DriveInput parameter, double-click the "?" in the value field and then click the arrow.

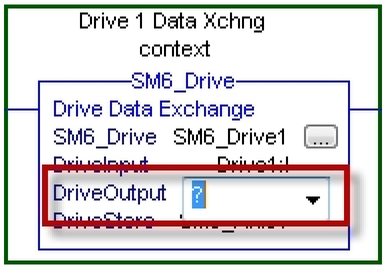


In the tag list, double-click Drive1:I to select the Input Connection variable.



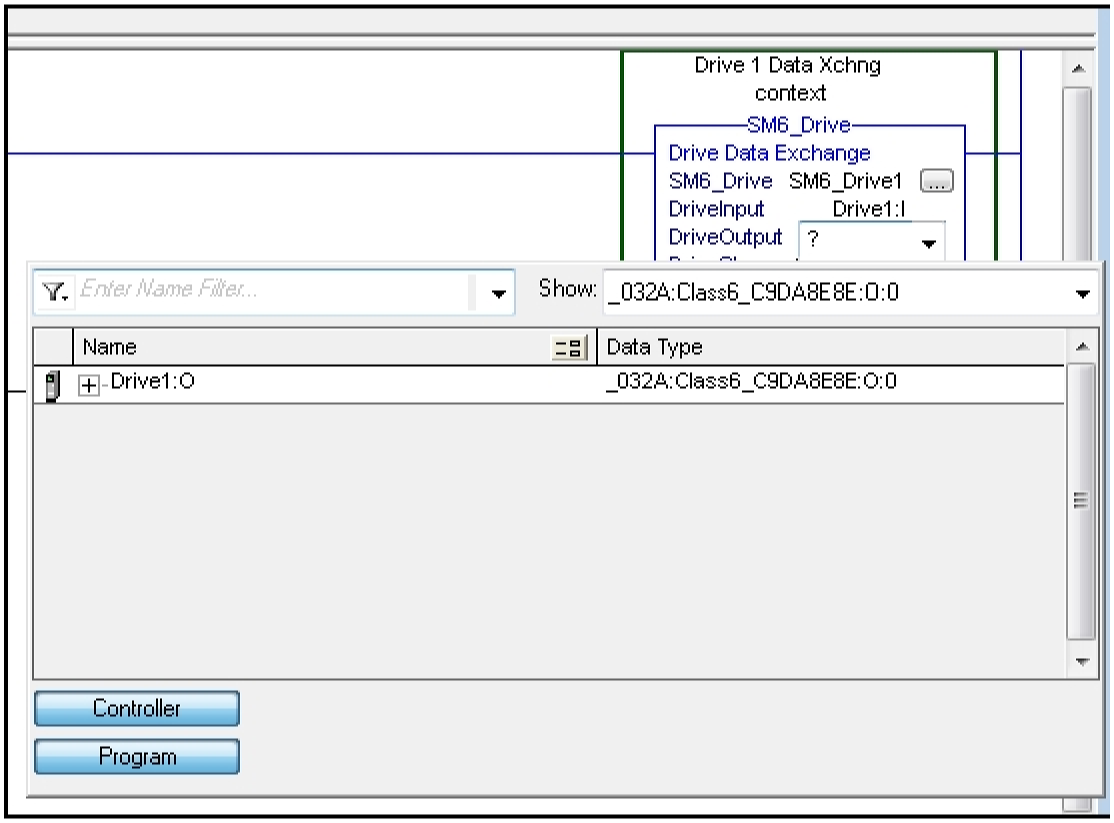
Drive 1:I Input Connection Variable

7. In the SM6_Drive block, DriveOutput parameter, double-click "?" and click the arrow.



Drive 1 Data Xchng
context
SM6_Drive
Drive Data Exchange
SM6_Drive SM6_Drive1
DriveInput Drive1:I
DriveOutput ?

In the tag list, double-click Drive1:O to select the Output Connection variable.



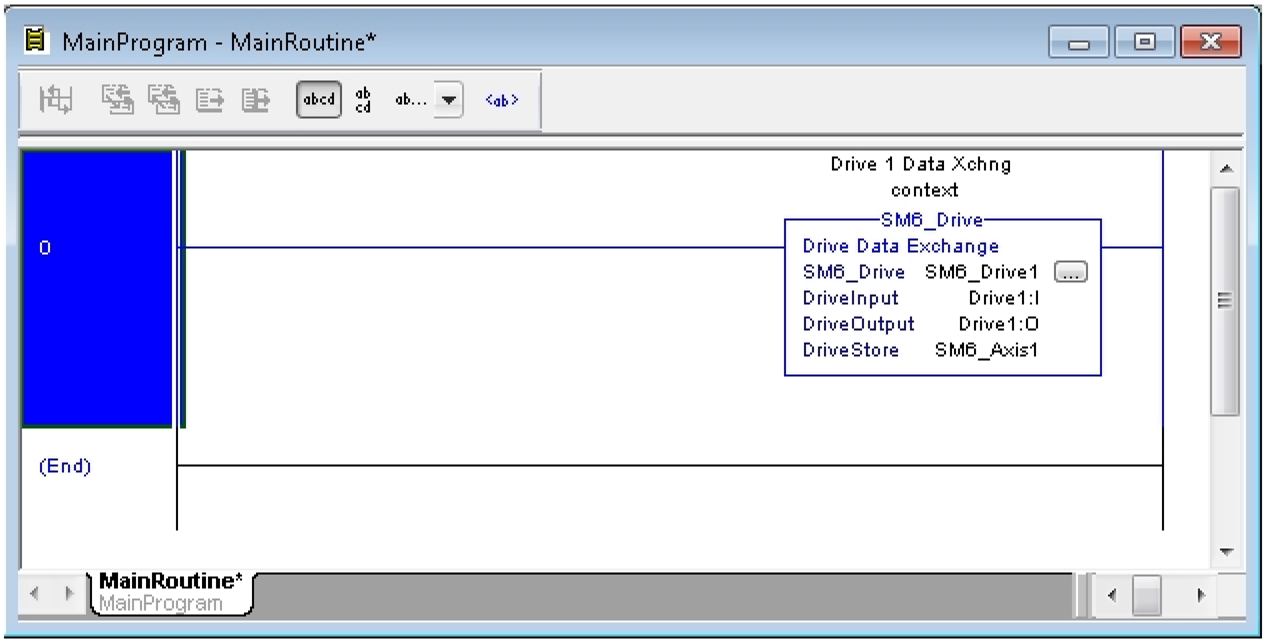
Drive 1 Data Xchng
context
SM6_Drive
Drive Data Exchange
SM6_Drive SM6_Drive1
DriveInput Drive1:I
DriveOutput ?

Enter Name Filter...
Show: _032A:Class6_C9DA8E8E:O:0

Name	Data Type
Drive1:O	_032A:Class6_C9DA8E8E:O:0

Drive 1:O Output Connection Variable

The MainRoutine should look as follows:



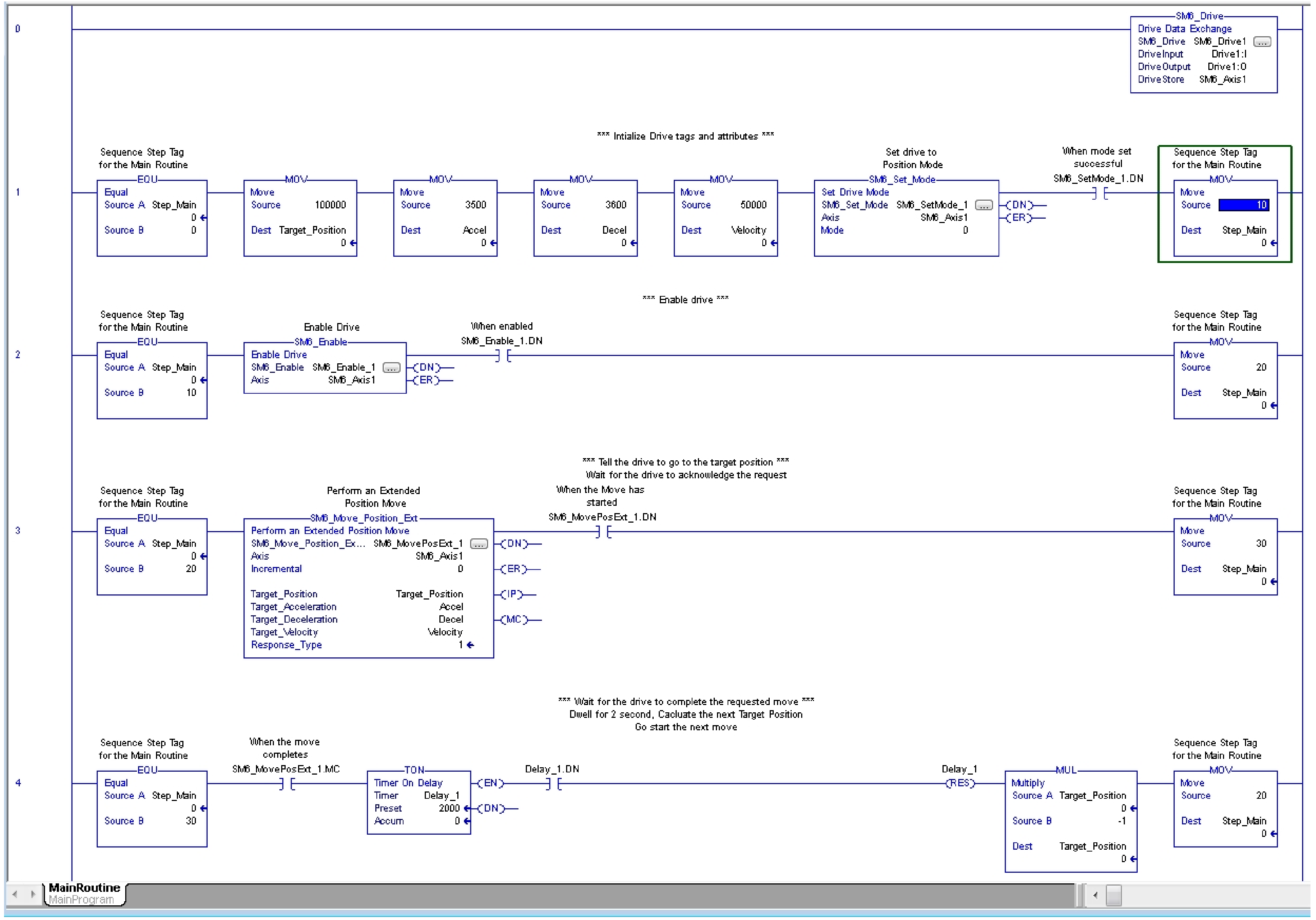
Drive 1 Data Xchng
context

SM6_Drive
Drive Data Exchange
SM6_Drive SM6_Drive1
DriveInput Drive1:I
DriveOutput Drive1:O
DriveStore SM6_Axis1

Completed MainRoutine

The following figure shows a complete program using the AOIs to move a drive back and forth between positions 100000 and -100000.

NOTE: The project for this program can be imported from the AOI support files (...\SM6_Support_Files\SM6_Examples\NewProject.ACD).



```
0
SM6_Drive
Drive Data Exchange
SM6_Drive      SM6_Drive1
DriveInput     Drive1:I
DriveOutput    Drive1:O
DriveStore     SM6_Axis1

*** Intialize Drive tags and attributes ***
1
Sequence Step Tag for the Main Routine
EQU  Equal  Source A Step_Main 0  Source B 0
MOV  Move  Source 100000  Dest Target_Position 0
MOV  Move  Source 3500  Dest Accel 0
MOV  Move  Source 3600  Dest Decel 0
MOV  Move  Source 50000  Dest Velocity 0
Set drive to Position Mode
SM6_Set_Mode  Set Drive Mode  SM6_Set_Mode SM6_SetMode_1  Axis SM6_Axis1  Mode 0   (DN) (ER)
When mode set successful
SM6_SetMode_1.DN
Sequence Step Tag for the Main Routine
MOV  Move  Source 10  Dest Step_Main 0

*** Enable drive ***
2
Sequence Step Tag for the Main Routine
EQU  Equal  Source A Step_Main 0  Source B 10
Enable Drive
SM6_Enable  Enable Drive  SM6_Enable SM6_Enable_1  Axis SM6_Axis1   (DN) (ER)
When enabled
SM6_Enable_1.DN
Sequence Step Tag for the Main Routine
MOV  Move  Source 20  Dest Step_Main 0

*** Tell the drive to go to the target position ***
Wait for the drive to acknowledge the request
3
Sequence Step Tag for the Main Routine
EQU  Equal  Source A Step_Main 0  Source B 20
Perform an Extended Position Move
SM6_Move_Position_Ext  Perform an Extended Position Move
SM6_Move_Position_Ex...   SM6_MovePosExt_1
Axis                      SM6_Axis1
Incremental               0
Target_Position           Target_Position
Target_Acceleration       Accel
Target_Deceleration       Decel
Target_Velocity           Velocity
Response_Type             1
(DN) (ER) (IP) (MC)
When the Move has started
SM6_MovePosExt_1.DN
Sequence Step Tag for the Main Routine
MOV  Move  Source 30  Dest Step_Main 0

*** Wait for the drive to complete the requested move ***
Dwell for 2 second, Cacluate the next Target Position
Go start the next move
4
Sequence Step Tag for the Main Routine
EQU  Equal  Source A Step_Main 0  Source B 30
When the move completes
SM6_MovePosExt_1.MC
TON  Timer On Delay  Timer Delay_1  Preset 2000  Accum 0   (EN) (DN)
Delay_1.DN
Delay_1
(RES)
MUL  Multiply  Source A Target_Position 0  Source B -1  Dest Target_Position 0
Sequence Step Tag for the Main Routine
MOV  Move  Source 20  Dest Step_Main 0

MainRoutine
MainProgram
```

Troubleshooting

The following table provides troubleshooting information for solving SmartMotor problems that may be encountered when using CANopen. For additional support resources, see the Moog Animatics Support page at:

http://www.animatics.com/support.html

Issue	**Cause**	**Solution**
EtherNet/IP Communication Issues		
Master device does not recognize motor.	Motor not powered.	Check Drive Status LED. If LED is not lit, check wiring.
	Disconnected or miswired connector, or broken wiring between motors.	Check that connector is correctly wired and connected to motor. For details, see Connections, Wiring and Status LEDs on page 24.
	Wrong node ID (address)	Set address and then reboot motor. For details, see Network Settings and Status Commands on page 36.
	Wrong firmware	Please consult Moog Animatics for the proper software version.
	Network flooded with traffic.	Reduce the network to just the SmartMotor and try a simple move command without interference from other devices.
Solid red error LED.	A warning or bus off condition has occurred.	A blinking red LED may indicate occasional issues from any of the causes listed above; a solid red LED indicates that these issues have occurred frequently, which causes the motor to stop communicating (bus off condition). In this case, the SmartMotor must be reset after fixing the cause of the problem.
Communication and Control Issues		
Motor control power light does not illuminate.	Motor is equipped with the DE option.	To energize control power, apply 24-48 VDC to pin 15 and ground to pin 14.
	Motor has routed drive power through drive-enable pins.	Ensure cabling is correct and drive power is not being delivered through the 15-pin connector.
Motor does not communicate with SMI.	Transmit, receive, or ground pins are not connected correctly.	Ensure that transmit, receive and ground are all connected properly to the host PC.
	Motor program is stuck in a continuous loop or is disabling communications.	To prevent the program from running on power up, use the Communications Lockup Wizard located on the SMI software Communications menu.
Motor disconnects from SMI sporadically.	COM port buffer settings are too high.	Adjust the COM port buffer settings to their lowest values.

Issue	Cause	Solution
	Poor connection on serial cable.	Check the serial cable connections and/or replace it.
	Power supply unit (PSU) brownout.	PSU may be too high-precision and/or undersized for the application, which causes it to brown-out during motion. Make moves less aggressive, increase PSU size, or change to a linear unregulated power supply.
Motor stops communicating after power reset, requires re-detection.	DHCP server not working or motor does not have fixed IP address set.	For dynamic addressing, check that DHCP is working and that SmartMotor is set to default address (0.0.0.0). For fixed address, use the IPCTL command within the program to set the motor address.
Red PWR SERVO light illuminated.	Critical fault.	To discover the source of the fault, use the Motor View tool located on the SMI software Tools menu.
Common Faults		
Bus voltage fault.	Bus voltage is either too high or too low for operation.	Check servo bus voltage. If motor uses the DE power option, ensure that both drive and control power are connected.
Overcurrent occurred.	Motor intermittently drew more than its rated level of current. Does not cease motion	Consider making motion less abrupt with softer tuning parameters or acceleration profiles.
Excessive temperature fault.	Motor has exceeded temperature limit of 85°C. Motor will remain unresponsive until it cools down below 80°C.	Motor may be undersized or ambient temperature is too high. Consider adding heat sinks or forced air cooling to the system.
Excessive position error.	The motor's commanded position and actual position differ by more than the user-supplied error limit.	Increase error limit, decrease load, or make movement less aggressive.
Historical positive/negative hardware limit faults.	A limit switch was tripped in the past.	Clear errors with the ZS command.
	Motor does not have limit switches attached.	Configure the motor to be used without limit switches by setting their inputs as general use.
Programming and SMI Issues		
Several commands not recognized during compiling.	Compiler default firmware version set incorrectly.	Use the "Compiler default firmware version option" in the SMI software Compile menu to select the default firmware version closest to the motor firmware version. In the SMI software, view the motor firmware version by right-clicking the motor and selecting Properties.

Reference Documents

This section lists the documents that were referenced for this guide.

ODVA Specifications

The following ODVA specifications were referenced for this guide:

- THE CIP NETWORKS LIBRARY, Volume 1: Common Industrial Protocol (CIP™), Edition 3.16, April 2014.
- THE CIP NETWORKS LIBRARY, Volume 2: EtherNet/IP Adaptation of CIP, Edition 1.17, April 2014.

These volumes comprise The EtherNet/IP™ Specification, which must be purchased using the order form on the ODVA.org website at:

https://secure.odva.org/forms/spec-vendor-id-order-form.htm

ODVA Libraries

The following ODVA libraries were referenced for introductory topics:

- The CIP Technology Library
- The EtherNet/IP Library

These ODVA libraries can be accessed directly on the ODVA.org website at:

http://www.odva.org/Publication-Download

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Rev. C