SMART Motor™

Installation & Startup Guide

Class 6 SmartMotor Technology

MOOG ANIMATICS

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Moog Animatics Class 6 SmartMotor™ Installation & Startup Guide, Rev. 03 - PRELIMINARY, PN: SC80100006-001.

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Introduction

This chapter provides information on the purpose of the manual, safety information, and additional documents and resources.

Purpose

The Class 6 SmartMotor™ Installation & Startup Guide provides an overview of the Class 6 SmartMotor, along with information on unpacking, installation and start up. This guide is meant to be used in conjunction with the *SmartMotor Developer's Guide*, which describes the SmartMotor features, SMI software, programming, commands, and other topics related to SmartMotor application development.

The information in this guide is meant to be used by properly trained technical personnel only. Moog Animatics conducts classroom-style SmartMotor training several times per year, as well as product seminars and other training opportunities. For more information, please see the Moog Animatics website or contact your Moog Animatics representative.

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 potential 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 7.

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 *Moog Animatics Product Catalog*, 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*.

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://www.ul.com/global/eng/pages/solutions/standards/accessstandards/catalogofstandards/

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/enterprise/policies/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:

- *SmartMotor™ Developer's Guide*

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

- *SmartMotor™ Product Certificate of Conformance*

  http://www.animatics.com/download/Animatics_SmartMotor_Servida_Class_5_Declaration_of_Conformity_CE_Rev_1.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/support/download-center.html

- *Moog Animatics Product Catalog*

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

Additional Resources

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

- 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

EtherCAT is a common standard maintained by EtherCAT Technology Group (ETG):

- EtherCAT Technology Group website:
  http://www.ethercat.org

PROFINET is a common standard maintained by PROFIBUS & PROFINET International (PI):

- PROFIBUS & PROFINET International website:
  http://www.profinet.com

SmartMotor Overview

This chapter provides an overview of the design philosophy and functionality of the Moog Animatics SmartMotor. It also provides information on SmartMotor features and options, and where to find related documents and additional resources.

SmartMotor Introduction

The Moog Animatics SmartMotor™ servo is an industrial servo motor with motion controller integrated into a compact package. Its design is based on the following objectives:

1. Reduce development time
2. Lower machine-production cost
3. Simplify the machine, machine build and support

Class 6 M-Style SmartMotor

The SmartMotor is powerful and unique because of its ability to control an entire machine. The combination of programmability, networking, I/O and servo performance is unmatched. The SmartMotor brings savings and value to the machine builder by removing complex and costly elements in the machine design, such as PLCs, sensors, I/O blocks, cabinets, etc.

SmartMotor Features and Options

All SmartMotors offer the following features:

- Full floating-point math and trigonometric functions with 32-bit precision results
- Dual trajectory generators enabling relative and absolute position moves or velocity moves on top of gearing or camming
- Advanced gearing allowing preset traverse and take-up winding parameters including dwells and wrap counts
- Advanced camming including cubic spline interpolation and dynamic frequency and amplitude changes.
- Stand-alone, multi-axis linear interpolation with as many as 120 SmartMotors at a time
- Virtual-axis mastering into camming through gearing, which enables stand-alone, multi-axis coordinated motion
- Programmable and non-programmable protection features (both hardware and software)

A note about SmartMotor part numbers:

The SmartMotor uses a coded part number, which contains characters that describe the motor number, frame style and options. For details on decoding the SmartMotor part number, refer the *Moog Animatics Product Catalog* at this address:

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

and select the file: 14_Understanding Part Numbers.pdf.

Class 6 M-Style Motors

The Class 6 SmartMotor is available in an M-style configuration. All Class 6 M-style SmartMotors have:

- SmartMotor command access through RS-485 or USB
- Ports: Two industrial Ethernet (IE) ports for real-time daisy chain
- LEDs: Bi-colored LED indicators to show error codes, provide network status and communications activity
- Communications: RS-485, micro USB, and industrial Ethernet
- SMI software: Used for application development and debug
- Motor feedback: Supported
- Motor sample rate: 16 kHz
- Encoder: 4000 counts per revolution
- Position Capture Register from signal-ended, ground-referenced external input (non-differential)
- External Encoder input: Differential A-quad-B
- A or B channel input frequency up to 100 kHz

For a product-specific list of features, specifications, torque curves and more, see the corresponding SmartMotor datasheet for your motor. SmartMotor datasheets are available from the Products menu on the Moog Animatics website.

The following industrial (Fieldbus protocol) communications options are available on the Class 6 motors. (Availability varies by model number; see the *Moog Animatics Product Catalog* for details.)

- EtherCAT option
- PROFINET option

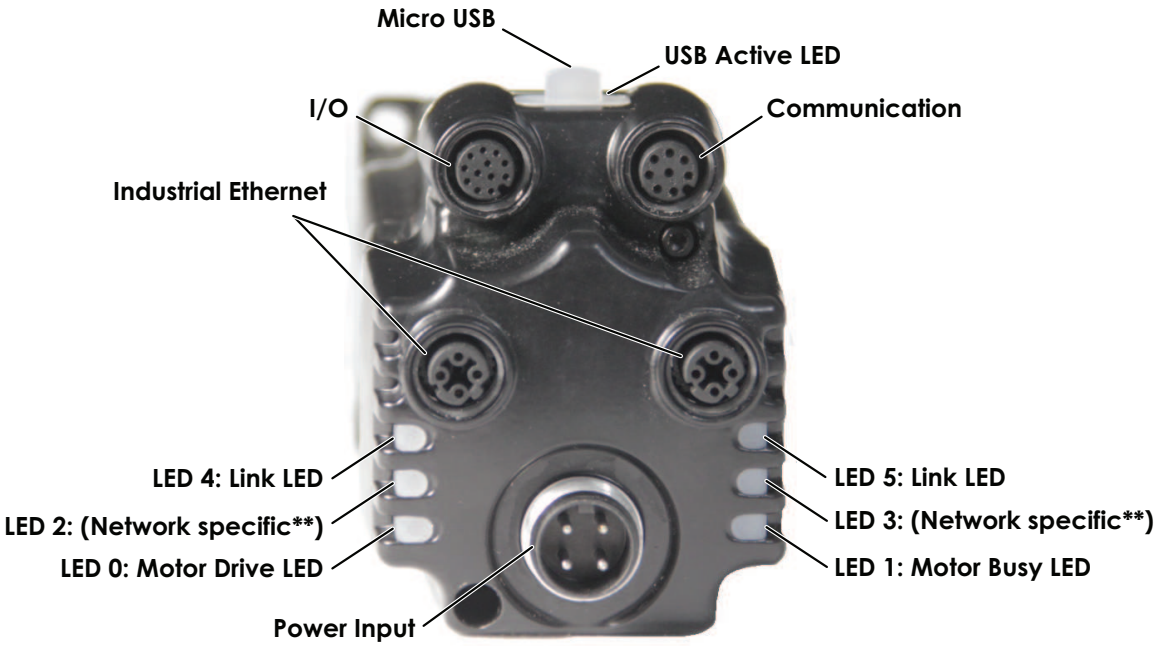
All firmware options include:

- Modbus Remote Terminal Unit (RTU) Slave (RS-485 COM 0)

The M-style motors are available in the following NEMA frame sizes:

- NEMA 23

The following figure shows the connector and LED location for the Class 6 M-style SmartMotor. For details on the motor connectors, see Connecting the System on page 30. For details on the LED functions, see Understanding the Status LEDs on page 37.



***Refer to the Status LED description in the corresponding SmartMotor fieldbus guide*

Class 6 M-Style SmartMotor Connectors and LEDs

CAUTION: When daisy-chaining SmartMotors for an EtherCAT network, you must connect the OUT port (right-hand port) of the upstream motor to the IN port (left-hand port) of the downstream motor.

Fieldbus Options

This section details the Fieldbus communications protocol options that are available on certain models of SmartMotors.

EtherCAT Fieldbus Protocol

NOTE: This fieldbus protocol is optionally available on Class 6 M-style motors.

The EtherCAT fieldbus protocol provides the following features:

- Command/Response Codes for SmartMotor commands
- CiA 402 Motion Modes: Profile Position (PP), Profile Velocity (PV), Torque (TQ), Cyclic Sync Position (CSP), Cyclic Sync Velocity (CSV), Cyclic Sync Torque (CST)
- Dynamic PDO mapping
- Configurable Sync Manager 2 and 3 assignment
- DC-Sync Subordinate Mode with SYNC0 and SYNC1
- DC-Sync Slave
- Selectable Homing modes (with or without index pulse)
- Selectable Interpolation modes (spline or linear)
- Touch Probe function allows the motor's position to be captured on a specific event

For the EtherCAT connector diagram and pinouts, see Connecting the System on page 30.

For more details on the EtherCAT protocol implementation, see the *SmartMotor EtherCAT Guide*.

PROFINET Fieldbus Protocol

NOTE: This fieldbus protocol is optionally available on Class 6 M-style motors.

The PROFINET fieldbus protocol provides the following features:

- Command/Response Codes for SmartMotor commands
- Use of on-board I/O through PROFINET, SmartMotor program, or RS-485 commands
- The Moog Animatics communications profile over PROFINET is intended to integrate well with a PLC that continuously transmits and receives cyclic data; the command and response codes achieve this through a handshaking mechanism
- Certain configuration data is held in nonvolatile storage in the SmartMotor; therefore, the motor data EEPROM must be correctly initialized before PROFINET operation

For the PROFINET connector diagram and pinouts, see Connecting the System on page 30.

For more details on the PROFINET protocol implementation, see the *Class 6 SmartMotor™ PROFINET Guide*.

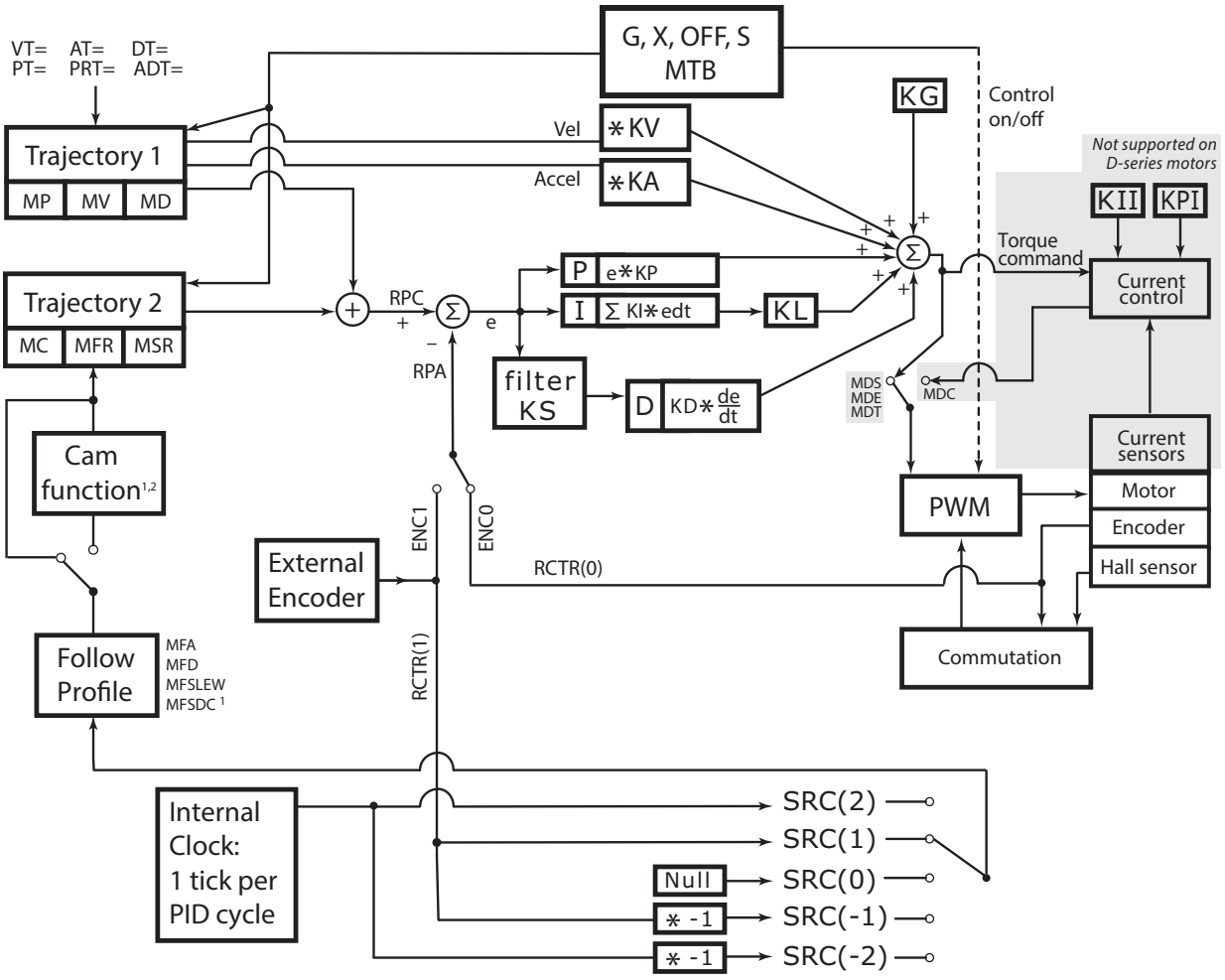
SmartMotor Theory of Operation

The Moog Animatics SmartMotor is an entire servo control system built inside of a servo motor. It includes a controller, an amplifier and an encoder. All that is required for it to operate is power and either an internal program or serial commands from outside (or both). To make the SmartMotor move, the program or serial host must set a mode of operation, state a target position with/or a maximum velocity at which to travel to that target, and a maximum acceleration. After these three parameters are set, and the two limit inputs are properly grounded or deactivated, a "Go" command starts the motion profile.

The core functional areas of the SmartMotor are:

- Motion Control Functions (see Motion Details in the *SmartMotor™ Developer's Guide*)
- System Control Functions (see Program Flow Details in the *SmartMotor™ Developer's Guide*, also see System Status in the *SmartMotor™ Developer's Guide*)
- Communication Functions (see Communication Details in the *SmartMotor™ Developer's Guide*)
- I/O Functions (see I/O Control in the *SmartMotor™ Developer's Guide*)

The following block diagram illustrates the relationship between the functional areas in the SmartMotor.



NOTES:

1. MFMUL and MFDIV commands do not have an effect on dwell time or distance. Dwell is strictly based on raw master encoder counts selected by the SRC( ) command specifying internal virtual or external master count source.
2. When feeding a Cam table with a gearing profile, changes to MFMUL and MFDIV will affect the time it takes to move through a Cam table but will *not* affect dwell time, as specified in the previous note.

SmartMotor Theory of Operation Diagram

Getting Started

This chapter provides information on getting started with your SmartMotor.

Unpacking and Verifying Your Shipment

Your Moog Animatics SmartMotor and accessories are carefully assembled, tested, inspected and packed at the factory.

When you receive your shipment, you should immediately do the following:

- Visually inspect all shipping containers for visible signs of shipping damage. If you see damage, please notify your carrier and then contact Moog Animatics to report the problem.
- Carefully unpack each component and verify the part number with your order. If there are any differences or missing items, please contact Moog Animatics so that the shipment can be corrected.
- As you are unpacking the shipment, please keep all boxes and packing materials. These may be needed for future storage or shipment of the equipment.

Installing the SMI Software

The SmartMotor Interface software (SMI software) provides a convenient user interface for programming the SmartMotor. Before you can use the SMI software, it must be installed on a Microsoft Windows PC.

The SMI software is distributed on CD-ROM and is also available as a download from the Moog Animatics website. To download the latest version of the SMI software, use the following address:

http://www.animatics.com

Then click the SMI Download button at the top of the page.

SMI Download Button

The installation package is downloaded to your system.

> **NOTE:** The SMI software requires Microsoft Windows XP or later.

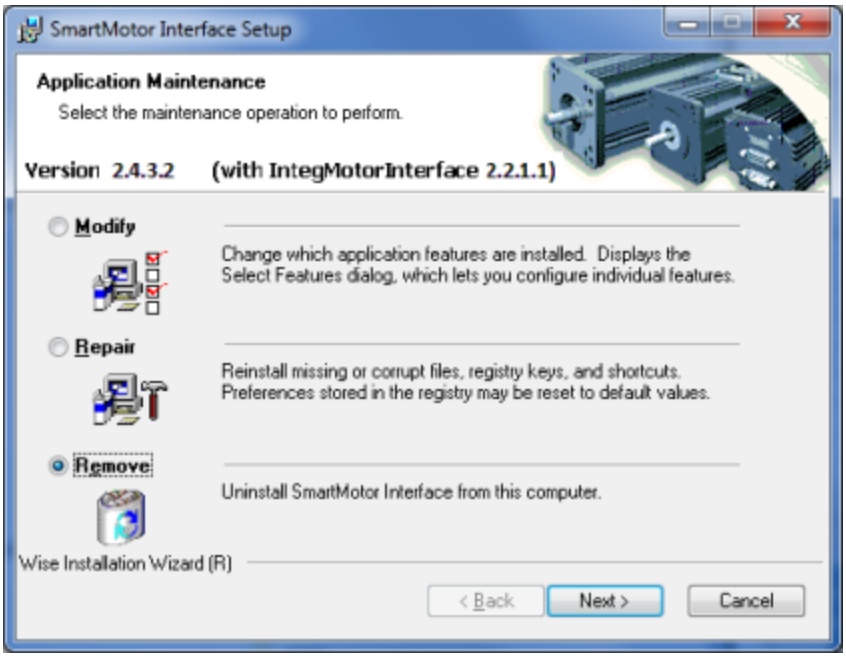
Installation Procedure

To install the SMI software:

1. Double-click the executable package (.MSI) file to begin the installation. In some versions of Microsoft Windows, you may receive a security warning message about running the file. You can ignore this message.

   If this is a new installation, go to the next step.

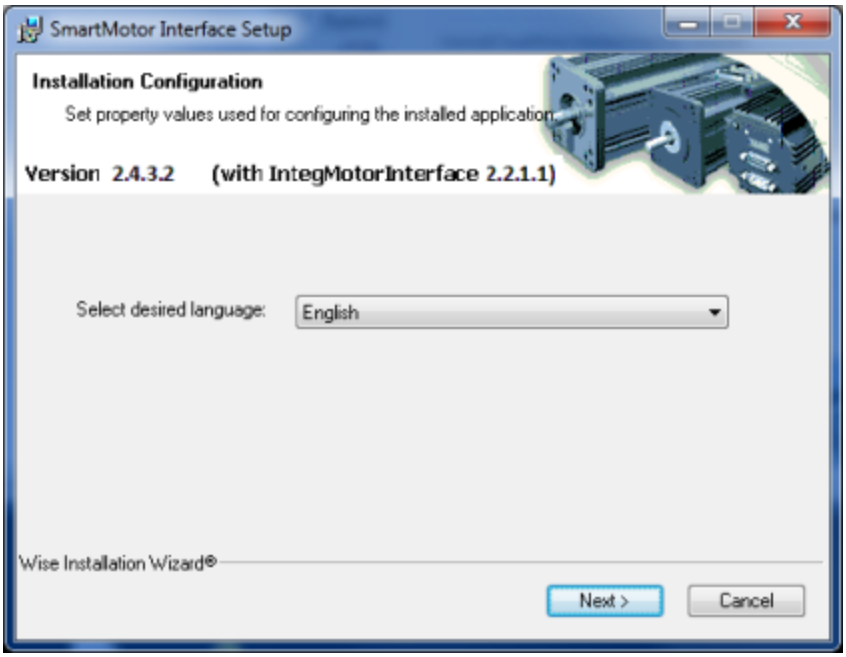
If this is an upgrade to a previous installation, you will see the following window. Select Remove, click Next and follow the instructions to remove the existing software from your PC.



After removing the existing software, restart the installation process.

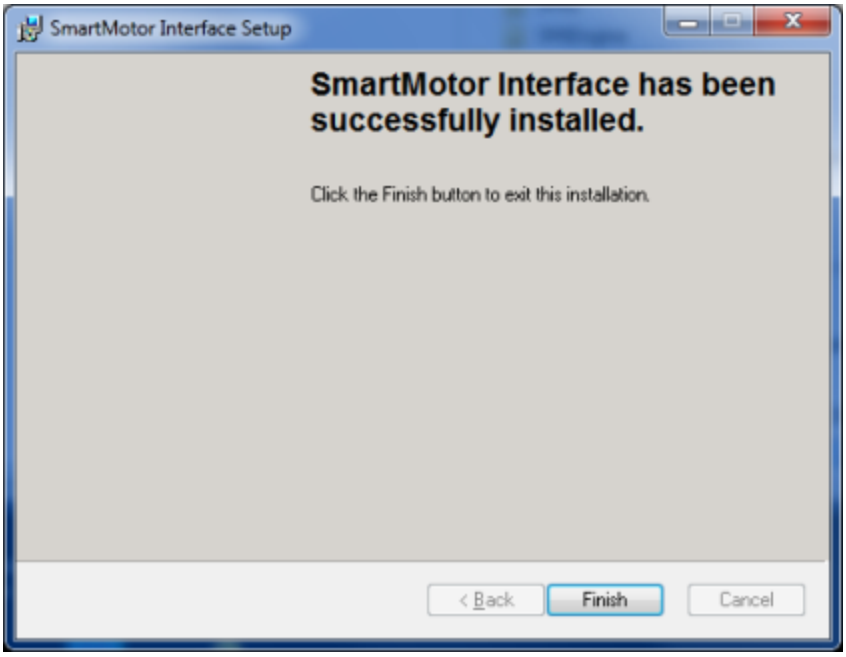
NOTE: All personal settings and user files will be retained.

2. Click Next to proceed. The Installation Configuration page opens.



3. Click Next to proceed. The SMI software installation wizard starts and the Welcome page opens.

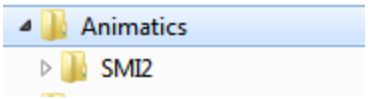
4. After you have finished reviewing the welcome information, click Next to proceed. Continue following the on-screen instructions to complete the SMI software installation.
5. When the installation has completed, the installation status message page opens, as shown in the following figure. Click Finish to complete the installation and close the installation wizard.



NOTE: After the software is installed, be sure to restart your computer before running the SMI software.

Installation Verification

To verify the installation, navigate to the C:\Programs folder. You should see the following directory structure:



Accessing the SMI Software Interface

The SmartMotor Interface software (SMI software) communicates with a single or series of SmartMotors from a Windows-based PC and gives you the capability to control and monitor the status of the motors. The SMI software also allows you to write programs and download them into the SmartMotor's long-term memory.

> **NOTE:** Every SmartMotor has an ASCII interpreter built in. Therefore, it is not necessary to use the SMI software to operate a SmartMotor.

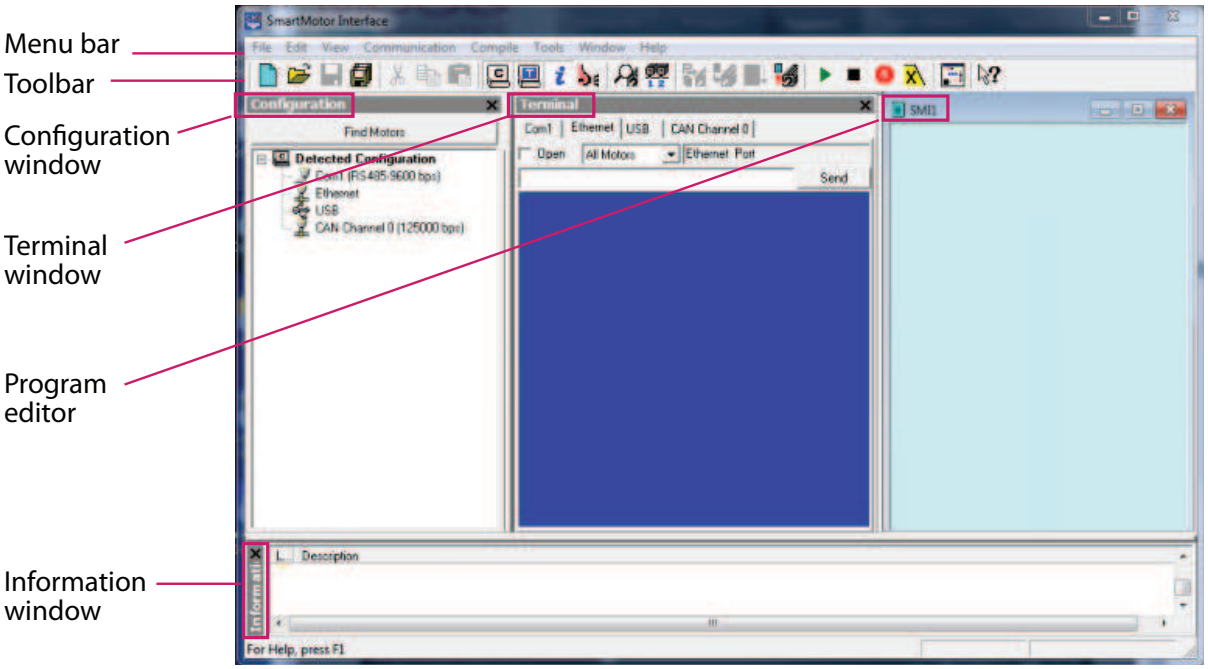
To open the SMI software, double-click the SmartMotor Interface shortcut on the Windows desktop.

SmartMotor Interface Shortcut

Optionally, to open the SMI software from the Microsoft Windows Start menu, select:

Start > All Programs > Animatics > SMI2 > SmartMotor Interface

The SMI software interface opens, as shown in the following figure.



SMI Software Interface

NOTE: In addition to the software information in this section, there is context-sensitive help available within the SMI software interface, which is accessed by pressing the F1 key or selecting Help from the SMI software main menu.

The following are the primary features in this interface:

- Menu Bar: All of the windows and functions of the SMI software can be accessed through the menu bar. Many of these are also accessible through the icons on the toolbar.
- Toolbar: The toolbar contains a collection of icons for accessing the primary features of the SMI software. Depending on the current state of the SMI software and the currently-active window, some toolbar buttons may be disabled.
- Configuration Window (far-left window): This window is used to display the current communication and detected motor configuration when no project is open, or the communication and motor configuration defined in an open project.
- Terminal Window (middle window): This window is used to communicate with SmartMotors (for example, issue single-line commands to one or all motors). The response (if any) is also shown in this window.
- Information Window (lower window): This window is used to display the results of user operations.
- Program Editor (far-right window): This window is used to manage, edit and print user programs. Most of the procedures for using the editor should seem familiar if you have used other Windows-based text editors.

For more details about these items, see SMI Software Features in the *SmartMotor™ Developer's Guide*.

Understanding the Power Requirements

This section describes the power requirements for Class 6 M-style SmartMotor power, CPU power, I/O power and Communications power.

Power Requirements

Requirement:

For Class 6 M-style SmartMotors: control power requires nominal 24 VDC (±20%), do not exceed 32 VDC; motor power requires from 24 VDC to 48 VDC, do not exceed 48 VDC.

CAUTION: Control power for M-style motors must be nominal 24 VDC (±20%). They are not rated for 48 volts.

Details: Large SmartMotors can draw high current. Therefore, heavy gauge wire is required to connect the large motors.

Voltages below 18 VDC could cause a brownout shutdown of the CPU, or what would appear as a power-off reset, under sudden load changes.

CAUTION: If power is reversed on any standard SmartMotors, immediate damage WILL occur and the SmartMotor will no longer operate.

When relying on torque/speed curves, pay close attention to the voltage on which they are based.

During hard, fast decelerations, a SmartMotor can pull up supply voltages to the point of damage if a shunt resistor pack is not used. Protective shunts are available from Moog Animatics.

Special care must be taken when near the upper voltage limit or in vertical applications that can back-drive the SmartMotor. Gravity-influenced applications can turn the SmartMotor into a generator and back-drive the power supply voltage above the safe limit for the SmartMotor. Many vertical applications require a shunt to protect the SmartMotor from damage. Protective shunts are available from Moog Animatics.

CAUTION: Many vertical applications and applications with hard, fast decelerations require shunts to protect the SmartMotor from damage. Note that shunts should always be placed between the motor input and any disconnect or E-stop relay to protect the motor when power is off or E-stop relay contacts are open.

CPU, I/O and Communications Power

CAUTION: The maximum allowed supply voltage is 32 VDC. Voltages greater than the maximum value will damage the equipment.

CPU Power Requirements

Requirement: Nominal 24 VDC (±20%) must be supplied. Do not exceed 32 VDC.

Details: Power is supplied from the "control" power input (pin 1) on the 4-pin power input connector.

I/O Power Requirements

Requirement: Nominal 24 VDC (±20%) must be supplied. Do not exceed 32 VDC.

Details: Power is supplied from the "control" power input (pin 1) on the 4-pin power input connector.

> **NOTE:** This I/O is not isolated from the CPU's power supply and the motor drive.

24 VDC Control/IO output power is provided on pin 11 and supports a maximum of 2 amps. That pin is directly connected to Pin 1 of the power input connector. Refer to Motor Connectors and Pinouts on page 31.

Specifications:

> **NOTE:** All specifications assume nominal 24 VDC (±20%) Control power. The maximum allowed supply voltage is 32 VDC. Voltages greater than the maximum value will damage the motor.

Input Pins Electrical Specification:

- Input Voltage Low Level Threshold: 3.6 Volts maximum
- Input Voltage High Level Threshold: 5.0 Volts minimum
- Input Hysteresis Voltage: 1.0 Volts minimum

Output Pins Electrical Specification:

- Output Loading:
  - Nominal load: 250 mA each output
  - Maximum load: not to exceed 500 mA combined
- Output voltage: 23 Volts maximum load

Communications Power Requirements

Requirement: Nominal 24 VDC (±20%) must be supplied. Do not exceed 32 VDC.

Details: Power is supplied from the "control" power input (pin 1) on the 4-pin power input connector.

> **NOTE:** The RS-485 signal is not isolated from the CPU's power supply or the motor drive.

Drive Enable Power

The Drive Enable input must be connected and activated with 24V. For the input location, see Motor Connectors and Pinouts on page 31.

Connecting the System

The following sections show system connections and cable diagrams for typical installations.

Minimum Requirements

At minimum, you will need the following items:

1. A Class 6 M-style SmartMotor
2. A computer running Microsoft Windows and the SMI software
3. A DC power supply and power cable for the SmartMotor
4. A data cable to connect from the computer to the SmartMotor using one of the following:
   - Serial port (or serial adapter)
   - USB port
   - Ethernet port

   Refer to the following sections for more details.

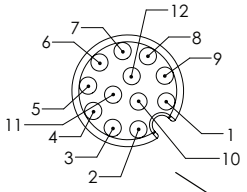
Motor Connectors and Pinouts

The following figure provides an overview of the connectors and pinouts available on the Class 6 SmartMotors. Additional connector specifications are available in Class 6 M-Style Connector Pinouts on page 56.

I/Os

PIN	FUNCTION	INPUT OR OUTPUT	POSSIBLE (SELECTABLE) FUNCTIONS	DESCRIPTION
1	IN0	INPUT, DIGITAL OR ANALOG	GENERAL PURPOSE	GENERAL PURPOSE
2	IN1	INPUT, DIGITAL OR ANALOG	GENERAL PURPOSE	GENERAL PURPOSE
3	IN2/POSLIMIT	INPUT, DIGITAL OR ANALOG	POSITIVE LIMIT OR GENERAL PURPOSE	POSITIVE LIMIT
4	IN3/NEGLIMIT	INPUT, DIGITAL OR ANALOG	NEGATIVE LIMIT OR GENERAL PURPOSE	NEGATIVE LIMIT
5	IN4	INPUT, DIGITAL OR ANALOG	GENERAL PURPOSE, OR EXTERNAL ENCODER INDEX CAPTURE	GENERAL PURPOSE
6	IN5	INPUT, DIGITAL OR ANALOG	GENERAL PURPOSE, OR INTERNAL ENCODER INDEX CAPTURE	GENERAL PURPOSE
7	IN6	INPUT, DIGITAL OR ANALOG	GENERAL PURPOSE, G COMMAND, OR HOMING INPUT	GENERAL PURPOSE
8	IN7-DRVEN	INPUT, DIGITAL	DRIVE ENABLE	DRIVE ENABLE
9	OUT8/BRAKE	OUTPUT, DIGITAL	BRAKE OUTPUT OR GENERAL-PURPOSE OUTPUT	BRAKE OUTPUT
10	OUT9-NOFAULT	OUTPUT, DIGITAL	NOT FAULT	NOT FAULT
11	24 VDC OUT*	N/A	N/A	CONTROL/IO POWER
12	GND	N/A	N/A	MOTOR COMMON GROUND

*NOTE: 2 AMPS MAX.



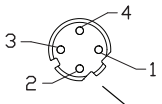
INDUSTRIAL ETHERNET OPTION:

EtherCAT*

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

PROFINET

PIN	FUNCTION
1	+TD
2	+RD
3	-TD
4	-RD

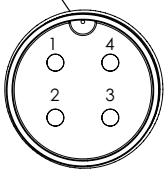


COMMUNICATION

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

POWER INPUT

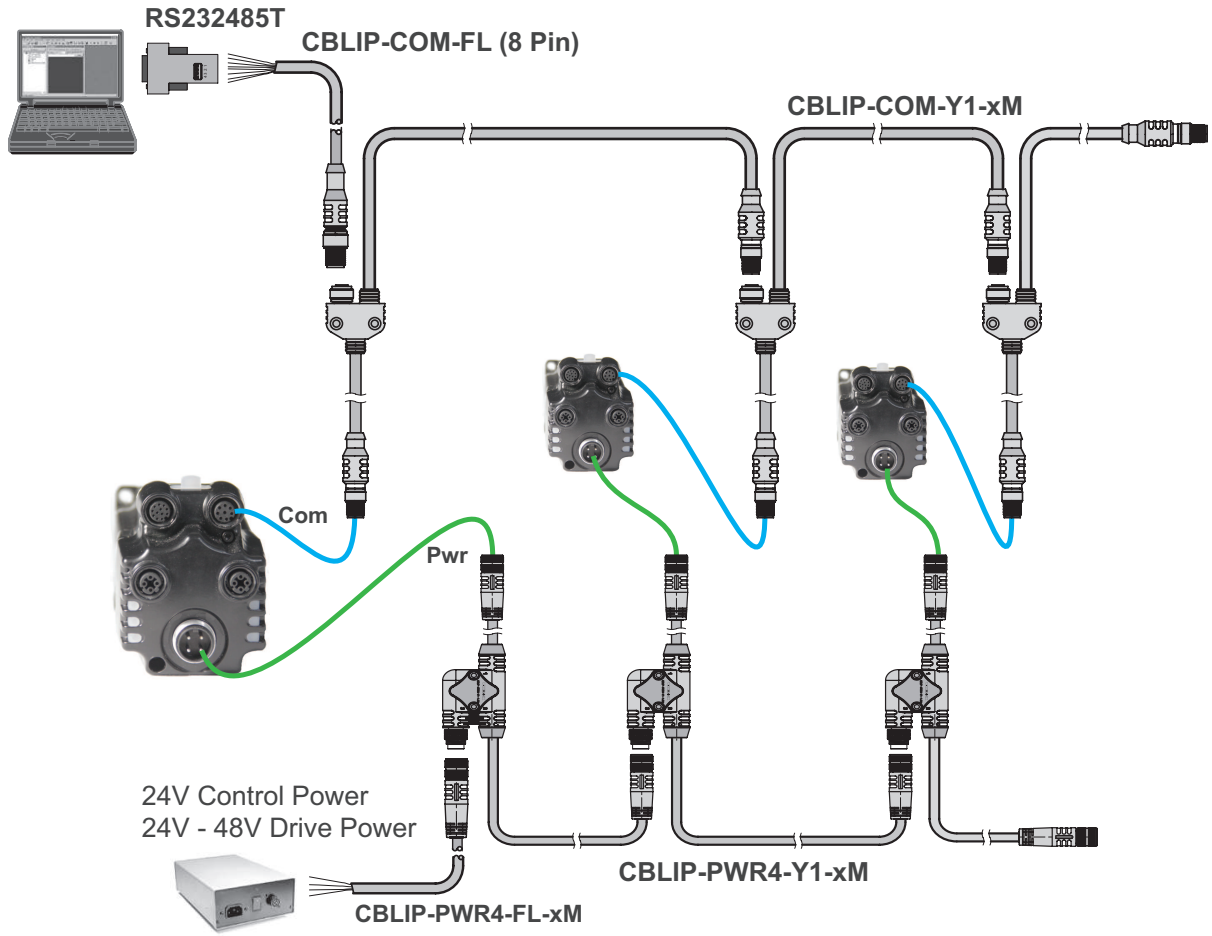
PIN	FUNCTION	DESCRIPTION
1	24 VDC	Control/IO Power
2	EARTH	Chassis Ground
3	GND	Motor's common ground
4	48 VDC	Motor Power



**The Input/Output applies to these networks. Refer to the following CAUTIONS.*
***For LED Status information, refer to the corresponding SmartMotor fieldbus guide.*

CAUTION: When daisy-chaining SmartMotors for an EtherCAT network, you must connect the Output port (right-hand port) of the upstream motor to the Input port (left-hand port) of the downstream motor. For more details, see Industrial Ethernet Cable Diagram on page 34.

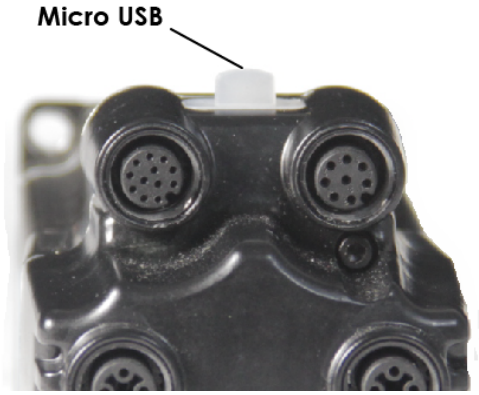
Power and RS-485 Com Multidrop



NOTE: RS-485 serial communications uses a voltage differential signal that requires proper termination with a 120 ohm resistor across pins 2 and 3 at both ends of the network cable. This follows RS-485 standards for biasing to ensure reliable performance. The termination can be created by adding the resistor to CBLIP-COM-FL Flying Lead cables or to off-the-shelf connectors.

USB Connector and Cable

As shown in following figure, there is a micro USB (micro-B) connector located under a protective cover on top of the motor. An LED indicator is also provided, which shows the status/activity for that connector.



Micro USB Connector (Located Under Protective Cover)

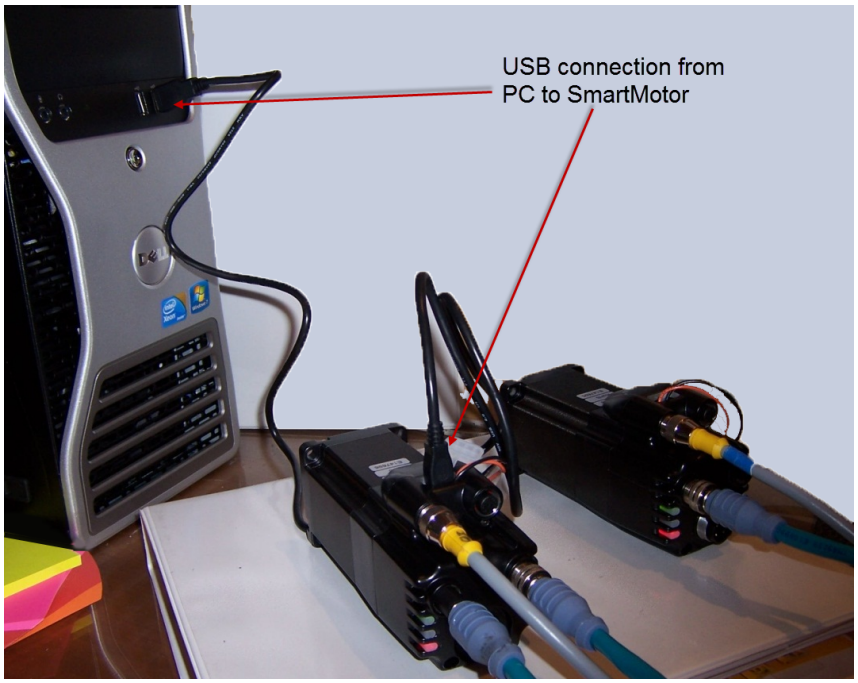
NOTE: To keep dust and debris out of the port, always replace the protective cover when the micro USB connector is not in use.

A micro-B USB cable is a standard type of USB cable that can be obtained from most computer or electronics supply stores. Typically, this cable is referred to as a "micro USB" cable.

Micro USB Cable

NOTE: Be aware that some micro USB cables have a thicker plastic molding that may interfere with the motor housing.

The following figure shows the SmartMotor connected to a PC through the USB ports on both devices.



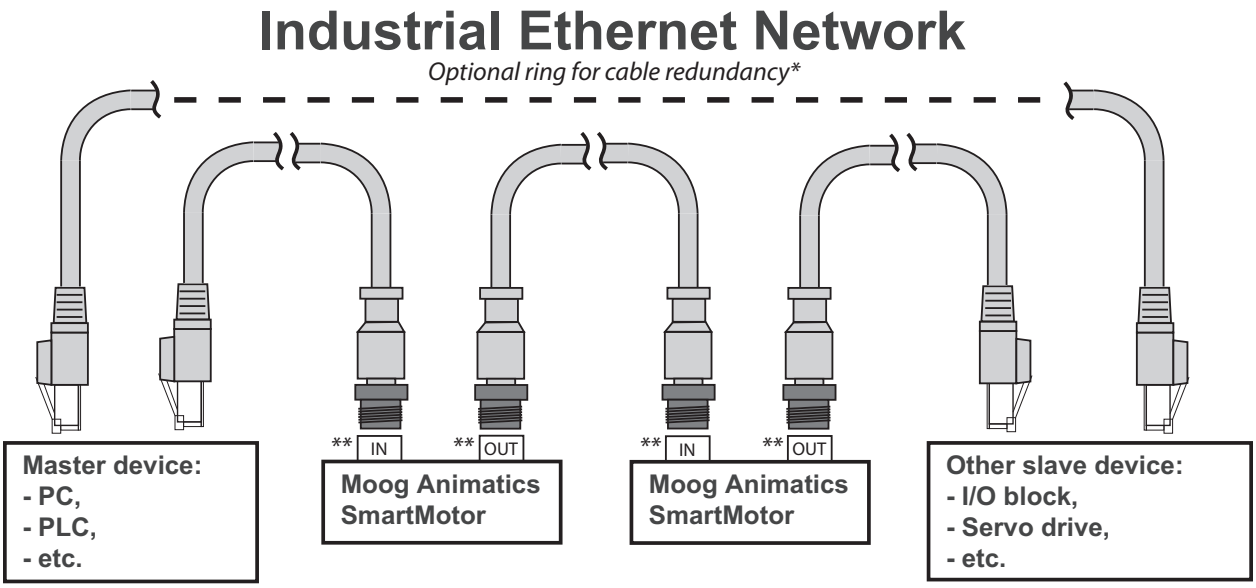
USB Connection from PC to SmartMotor

Industrial Ethernet Cable Diagram

Most industrial Ethernet (IE) networks support line, tree or star device-connection topology. Requirements for specific configurations depend on the capabilities of the master device, the slave devices, and use of other networking equipment. For more details, refer to the corresponding SmartMotor fieldbus manual.

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

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



*Ring configuration requires a master device with two ports

**The Input/Output applies only to EtherCAT networks. Refer to the following CAUTION.

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

CAUTION: When daisy-chaining SmartMotors for an EtherCAT network, you must connect the OUT port (right-hand port) of the upstream motor to the IN port (left-hand port) of the downstream motor.

Maximum Cable Length

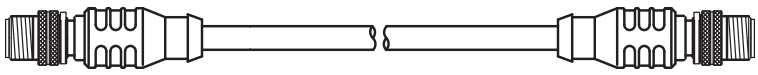
For transmission speeds of 100 Megabits/second on shielded Ethernet Cat 5 cable, most industrial Ethernet networks allow cable lengths up to 100 meters between network nodes. For more details, refer to the corresponding SmartMotor fieldbus manual.

Moog Animatics Industrial Ethernet Cables

The following industrial Ethernet cables are available from Moog Animatics.

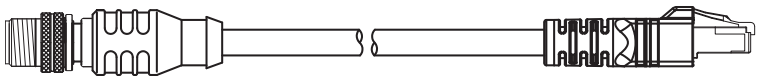
M-style to M-style Ethernet Cable

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

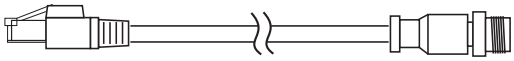
This cable has an M12 male threaded connector at one end, and an RJ45 male connector at the opposite end. It is available in 1, 3, 5 and 10 meter lengths. For the standard cable, use part number CBLIP-ETH-MR-xM, where "x" denotes the cable length. A right-angle version is also available; use part number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



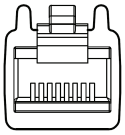
Ethernet Cable Schematic

The following figure provides details for creating a custom industrial Ethernet shielded cable.

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



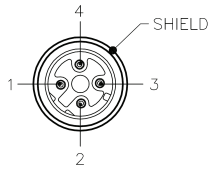
RJ45 Connector
(EtherCAT master end of cable)



12345678

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 RJ45 connector	

Industrial Ethernet Connector
(Motor end of cable)



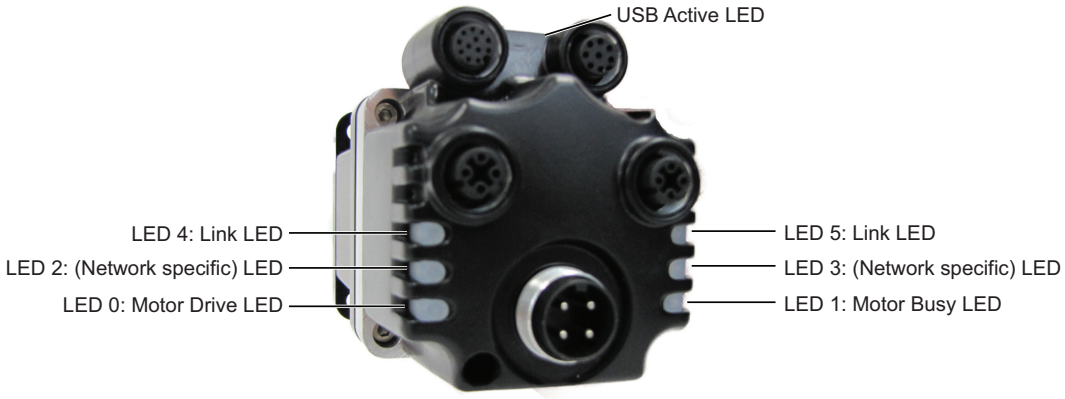
PIN	DESCRIPTION
1	+TX
2	+RX
3	-TX
4	-RX
Shield tied to motor housing	

Understanding the Status LEDs

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

Status LEDs

The following figure and tables describe the functionality of the Status LEDs on the SmartMotor. Refer to the corresponding SmartMotor fieldbus guide for the functions of the network-specific LEDs.



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

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 2: (Network specific) LED
Refer to the corresponding SmartMotor fieldbus guide

LED 4: Link LED
Refer to the corresponding SmartMotor fieldbus guide

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 3: (Network specific) LED
Refer to the corresponding SmartMotor fieldbus guide

LED 5: Link LED
Refer to the corresponding SmartMotor fieldbus guide

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

LED 1 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

Detecting and Communicating with the SmartMotors

This section describes how to detect and address the Class 6 SmartMotors over the serial network.

This procedure assumes that:

- The SmartMotor is connected to the computer. For details, see Connecting the System on page 30.
- The SmartMotor is connected to a power source. For details, see Understanding the Power Requirements on page 28 and Connecting the System on page 30.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 23.

Understanding the Detection and Configuration Options

There are several ways to use the SMI software to find and address the Class 6 SmartMotors that are connected to your PC:

> **NOTE:** This feature requires connection to the serial port, configured as RS-485. USB also has a "detect" option. There is no support for EtherCAT or PROFINET detection.

- Use the Find Motors button (RS-485 only)—this method is recommended for first-time communications or when you don't know the port used to connect the motors. For details, see Using the Find Motors Button on page 38.
- Use the Detect Motors feature (RS-485 and USB only)—this method can be used if you know the communications port used to connect your motors and if your motors may be pre-addressed. For details, see Using the Detect Motors Feature on page 41.
- Configure and communicate with PROFINET or EtherCAT—this method allows you to configure the motor to work in an industrial Ethernet (PROFINET or EtherCAT) network. For details, see the corresponding fieldbus protocol guide.

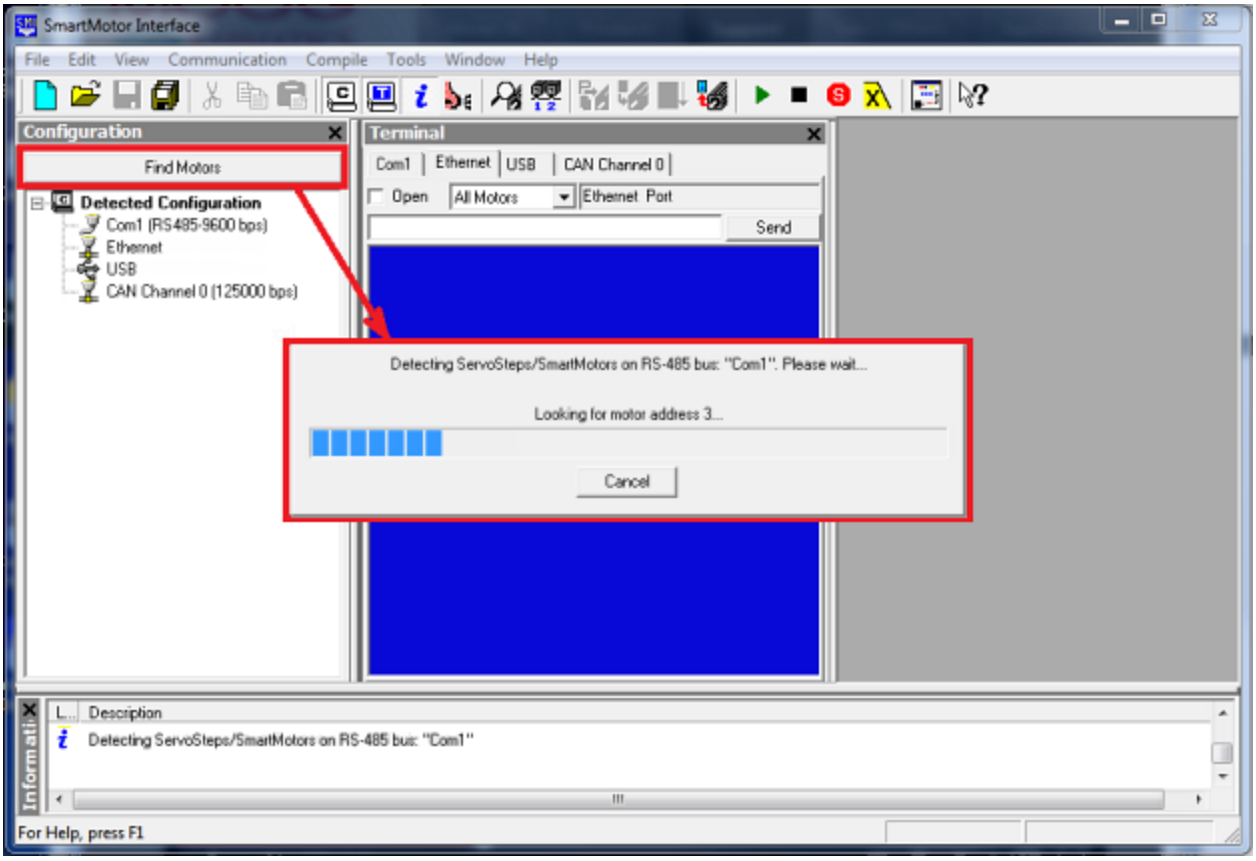
Several of these methods are described in the following sections.

Using the Find Motors Button

> **NOTE:** This method works only for RS-485 connections.

The easiest way to locate any connected SmartMotor is to use the Find Motors button (see the following figure). This method searches the RS-485 port(s) on the PC for connected motors.

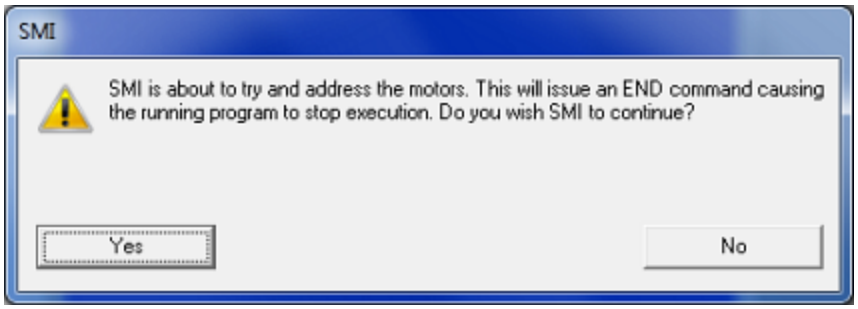
To begin searching for motors on the RS-485 port(s) on the PC, in the Configuration window of the SMI software interface, click Find Motors. The SMI software begins searching for all SmartMotors connected to the PC.



Find Motors Detecting SmartMotors on the RS-485 Chain

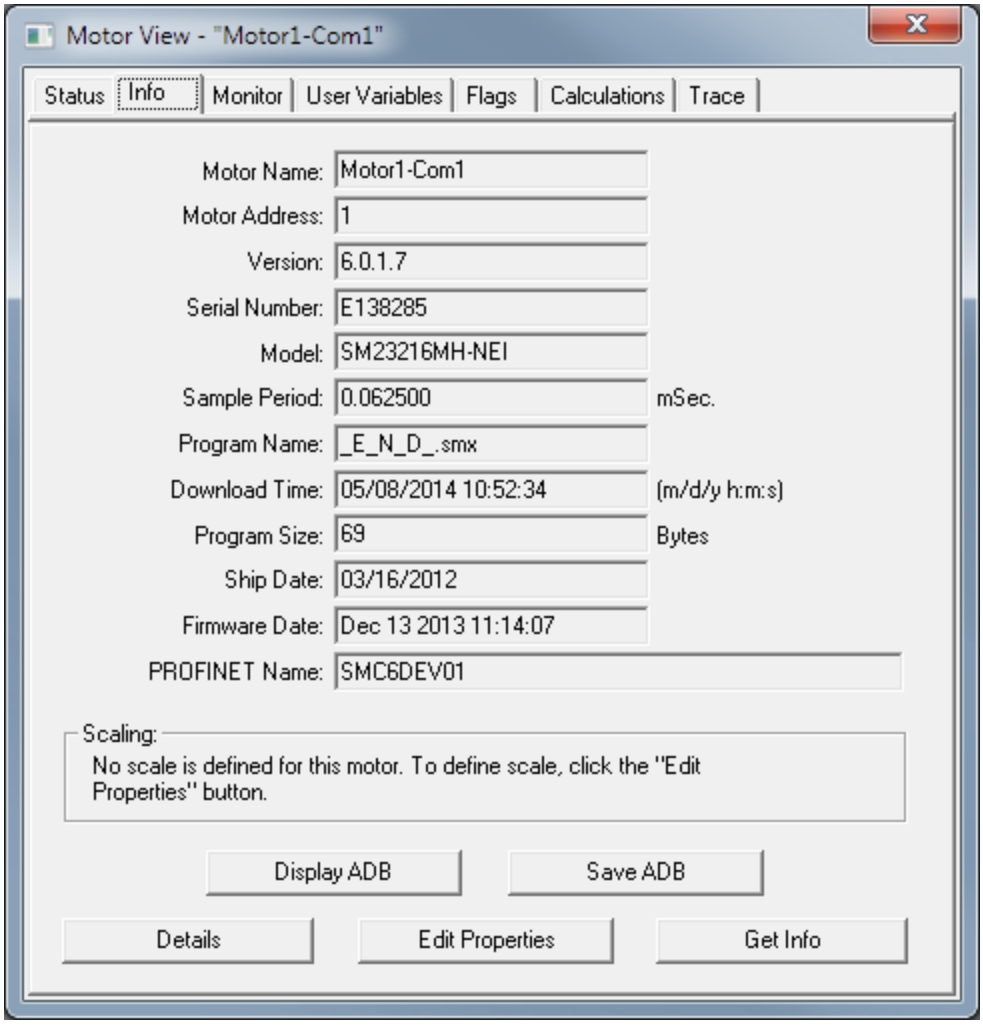
After the motors are detected, the SMI software will address them if needed. The following steps are only used when the SMI software finds motors that do not have addresses.

To address the motors, click Yes when you see the following prompt.



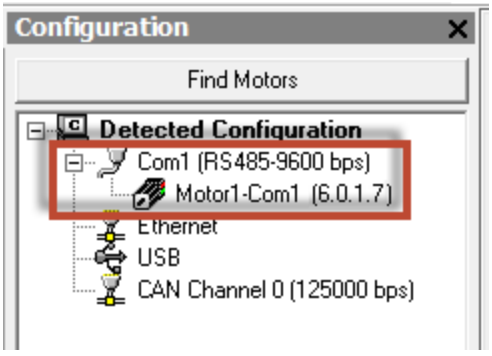
Address the Motors Prompt

A progress bar displays a "Getting motor information" message while the SMI software addresses the motors. During this process, the SMI software is collecting the following information on each motor. The information is the same as that shown in the Motor View window, which can be accessed by selecting the **Tools > Motor View > Info** tab:



Motor View Information

After the process has completed, the SMI software shows the found motors in the Configuration window under the corresponding communications port. Each motor is represented by a motor icon; the motor's address and firmware version are shown next to the motor icon.



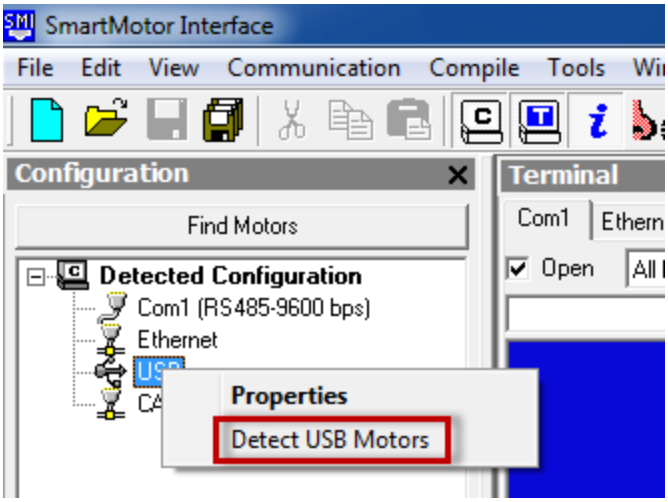
Configuration Window Showing Found/Addressed SmartMotor

Using the Detect Motors Feature

NOTE: This method works only for RS-485 and USB connections.

This method is similar to the Find Motors method, but it searches only the specified communications port for connected SmartMotors. This is also the recommended method for detecting M-style motors after they have been pre-addressed and daisy-chained to the communications port.

To use the Detect Motors feature, in the Configuration window of the SMI software, right-click the desired communications port and select Detect Motors from the menu.

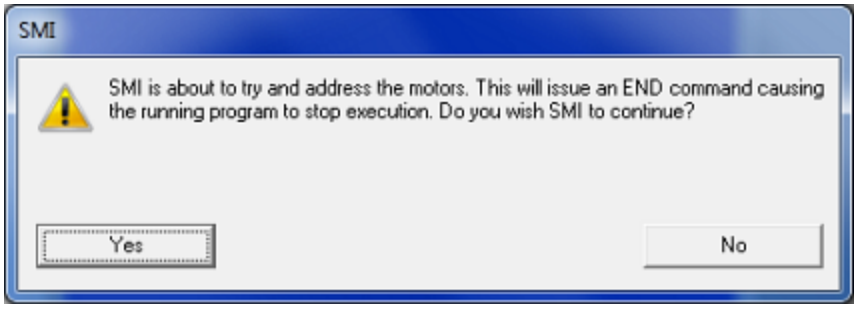


Selecting the Detect Motors Feature

The SMI software begins searching for all SmartMotors connected to the specified communications port. A progress bar is shown while the SMI software searches for the motors.

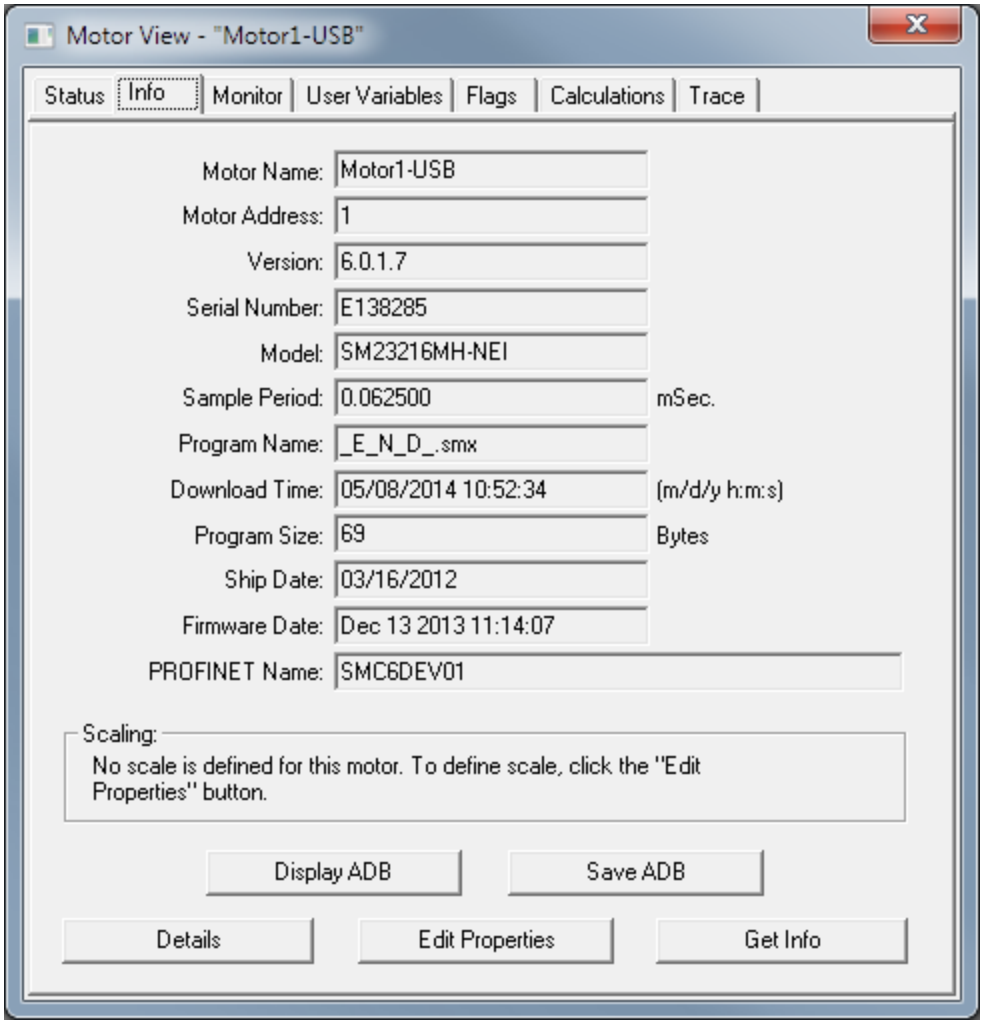
After the motors are detected, the SMI software will address them if needed. The following steps are only used when the SMI software finds motors that do not have addresses.

To address the motors, click Yes when you see the following prompt.



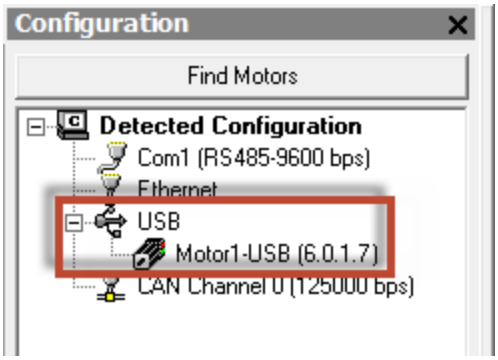
Address the Motors Prompt

A progress bar displays a "Getting motor information" message while the SMI software addresses the motors. During this process, the SMI software is collecting the following information on each motor. The information is the same as that shown in the Motor View window, which can be accessed by selecting the **Tools > Motor View > Info** tab:



Motor View Information

After the process has completed, the SMI software shows the found motors in the Configuration window under the corresponding communications port. Each motor is represented by a motor icon; the motor's address and firmware version are shown next to the motor icon.



Configuration Window Showing Found/Addressed SmartMotor

Checking and Clearing the Status Bits

> **NOTE:** In addition to the software information in this section, there is context-sensitive help available within the SMI software interface, which is accessed by pressing the F1 key or selecting Help from the SMI software main menu.

The Motor View window is used to view and monitor various motor parameters. It is used in conjunction with the Terminal window to clear any active overtravel limits.

This procedure assumes that:

- The SmartMotor is connected to the computer. For details, see Connecting the System on page 30.
- The SmartMotor is connected to a power source. For details, see Understanding the Power Requirements on page 28 and Connecting the System on page 30.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 23.
- The SmartMotor has been detected and addressed. For details, see Detecting and Communicating with the SmartMotors on page 38.

Polling the Motor

To view the current state of the status bits, you must poll the motor.

1. Double-click the motor icon to open the Motor View window (see the following figure).
2. Click the Poll button to begin polling data from the motor.

Motor View with Active Overtravel Limits

A SmartMotor with no program and no I/O connections will boot up with active overtravel limits (see the red status bits numbered 10 through 15 in the previous figure).

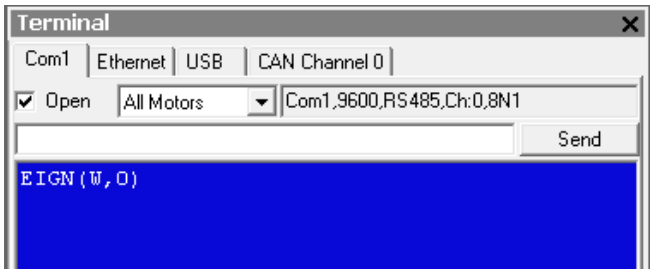
The EIGN() command is used to clear these status bits as described in the next section. EIGN stands for: Enable Inputs as General Use. In the case of EIGN(W,0), the W means a "word" or 16 bits of I/O; the 0 means first word or local I/O. There are only seven local I/O on the D-style motors. Therefore, EIGN(W,0) sets all seven I/O to general-use inputs.

Clearing the Overtravel Limits and Fault Bits

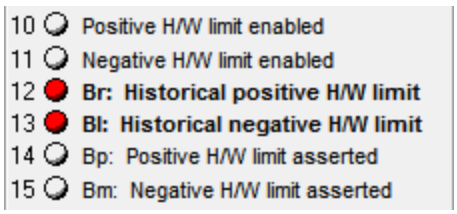
To disable (clear) the overtravel limits, enter EIGN(2) and EIGN(3) in the SMI software Terminal window. This sets I/O 2 (positive overtravel limit) and I/O 3 (negative overtravel limit) as general inputs/outputs instead of being used as travel limits. To set all status bits in Word 0 as general inputs/outputs, enter EIGN(W,0).

> **NOTE:** You can either type the command in the white text box or type the command directly in the blue area of the terminal screen and then click Send or press Enter.

The active and asserted bits are cleared, as shown in the following figures.

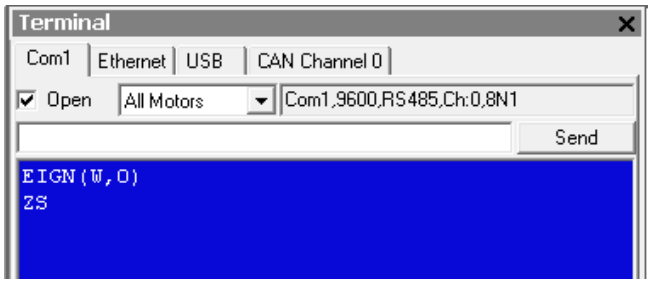


EIGN Command Entered

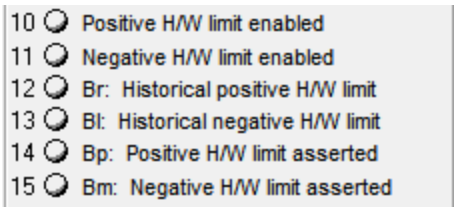


Active and Asserted Bits Cleared

To clear the historical fault bits, enter ZS. All remaining fault bits are cleared, as shown in the following figures.



ZS Command Entered



Remaining Bits Cleared

Moving the SmartMotor

> **NOTE:** In addition to the software information in this section, there is context-sensitive help available within the SMI software interface, which is accessed by pressing the F1 key or selecting Help from the SMI software main menu.

The SMI software contains a Torque mode that is used to test the motor response and ensure the drive is operating properly.

This procedure assumes that:

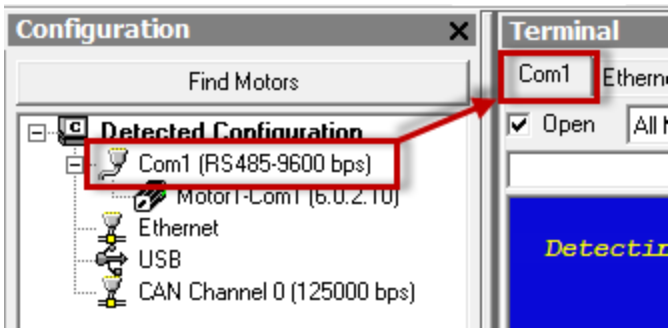
- The SmartMotor is connected to the computer. For details, see Connecting the System on page 30.
- The SmartMotor is connected to a power source. For details, see Understanding the Power Requirements on page 28 and Connecting the System on page 30.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 23.
- The SmartMotor has been detected and addressed. For details, see Detecting and Communicating with the SmartMotors on page 38.
- The Drive Enable input must be connected and activated with 24V. For the input location, see Motor Connectors and Pinouts on page 31.
- The overtravel limits and fault bits have been cleared. For details, see Checking and Clearing the Status Bits on page 43.

Making the Motor Move

WARNING: The larger SmartMotors can shake, move quickly and exert great force. Therefore, proper motor restraints must be used, and safety precautions must be considered in the workcell design (see Other Safety Considerations on page 6).

To make the SmartMotor move:

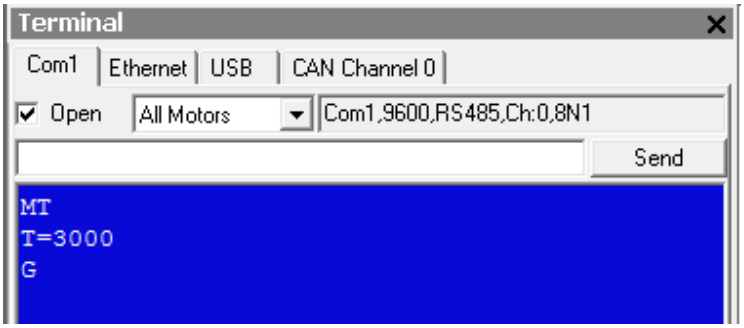
1. In the Terminal window, select the tab that matches the communications channel to which your motors are connected. To do this, look at the Configuration window, find the channel where the motors are listed and click that tab name in the Terminal window.



Tab Selected that Matches the Communications Channel

NOTE: If you do not have the correct tab selected, the commands you enter will not go to the motors and there will be no response.

2. Enter the following commands in the Terminal window:



You should immediately see the motor shaft moving in the positive direction (clockwise, when looking at the end of the motor shaft). If the motor does not respond to the commands, see Troubleshooting on page 54 for troubleshooting tips.

NOTE: Macros (shortcut keys) can be used to simplify entry of frequently-used commands. For details, see Macros in the *SmartMotor™ Developer's Guide*.

3. After you have observed the motor shaft turning, enter the X command to decelerate the motor to a stop.

Setting and Reporting Torque

The following commands are related to the previous motion procedure. For more details on these commands, see the *SmartMotor™ Command Reference Guide*.

MT (Mode Torque)

MT sets the mode of operation to torque mode. In this mode, the SmartMotor shaft applies a torque independent of position. For more details, see Torque Mode in the *SmartMotor™ Developer's Guide*.

T=formula (Set Target Torque)

T can be set to any value from -32767 to +32767, which represents -99.99% to +99.99% PWM (pulse-width modulation) commanded.

RTRQ (Report Actual Torque)

Enter RTRQ at the Terminal window to report the commanded torque from the trajectory generator.

Note that RTRQ typically reports a value that's one less than the T value. In the previous example, T=3000, but RTRQ reports 2999. This is due to zero being counted as the least amount of torque commanded. TRQ is *always* % PWM commanded to the motor at any time and in any mode of operation. It can be used to transfer across modes without a ripple or bump in force applied to the load.

TS (Set Torque Slope)

The TS command defines how fast the processor applies a change in torque. For an example of the TS command, see the Chart View Example in the *SmartMotor™ Developer's Guide*.

Torque slope can range from -1 to 2147483647 (default). At a value of 65536, the processor changes torque by a value of 1 for each PID sample. The default sample rate is 16000; you can view the current sample rate with the RSAMP command.

> **NOTE:** If you're moving from a Class 5 to a Class 6 SmartMotor, the faster Class 6 sample rate means the torque slope operates twice as fast in real-world time.

Checking the Motor Position

There are several ways to check the motor position:

- Report the position using commands from the Terminal window
- View the position in the Motor View tool

These two methods are described in the following sections. You can also view the position in the Monitor or Chart View software tools. For details, see SMI Software Features in the *SmartMotor™ Developer's Guide*.

This procedure assumes that:

- The SmartMotor is connected to the computer. For details, see Connecting the System on page 30.
- The SmartMotor is connected to a power source. For details, see Understanding the Power Requirements on page 28 and Connecting the System on page 30.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 23.
- The SmartMotor has been detected and addressed.
- The overtravel limits and fault bits have been cleared. For details, see Checking and Clearing the Status Bits on page 43.

Viewing the Motor Position with a Report Command

To report the motor position, in the Terminal window, issue the RPA (Report Position Actual) command:

```
RPA
```

The terminal responds with the current position of the motor:

```
RPA       3593657
```

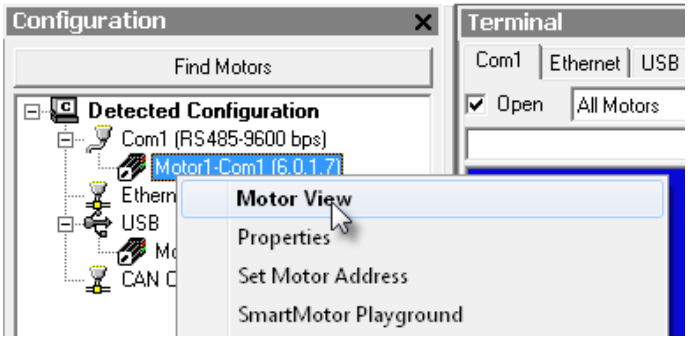
> **NOTE:** The position is reported on the same line as the command; there is no line feed or carriage return for "report" commands.

The RPA command reports the actual motor position at the time the command was issued. Therefore, it is just a "snapshot"—if the motor is moving, the reported position is not dynamically updated.

Viewing the Motor Position with the Motor View Tool

The Motor View tool provides another way to view the motor position. The advantage of using this tool is that the position is dynamically updated when the motor is moving.

To open the Motor View tool, from the SMI software Configuration window, right-click the motor you want to view and select Motor View from the menu.



Opening the Motor View Tool

After the Motor View window opens, click the Poll button to begin polling (getting information from) the motor. After polling begins, the motor position is shown in the Position box.

Motor View Tool Showing the Motor Position

Other Class 6 Changes

In addition, please note the following items:

Features not Available in Class 6

The following Class 5 SmartMotor features have not yet been implemented in the Class 6 SmartMotors:

- Combitronic communications
- CAN communications
- CANopen protocol
- DeviceNet protocol
- I²C communications
- Synchronized motion

EOBK(exp) Command Limitations

The EOBK(exp) command configures the specified SmartMotor output to control an external brake. However, only output 8 works for the M-style SmartMotor. Therefore, the valid EOBK (exp) values are:

- EOBK(8) to enable
- EOBK(-1) to disable

Status Bit for Ethernet in Status Word 2

The intent of this bit is to inform the user that one or more errors has occurred through the Ethernet interface. To determine the specific error that has occurred, consult the RETH command. For details, see the *Class 6 SmartMotor™ EtherCAT Guide*.

I/O Control Details

The SmartMotor fieldbus guides describe the details of accessing I/O for each communication protocol. The *SmartMotor™ Developer's Guide* describes I/O control details for RS-485 communications.

In a local program or serial command, the OR, OS and OUT commands are the same as Class 5. For details, see the *SmartMotor™ Developer's Guide*.

For the Class 6 M-style SmartMotor, it is important to note which are inputs, which are outputs, and which have special functions. For those details, refer to the following table.

Logical I/O Number	Input or Output	Possible (Selectable) Functions	Default Operation
0	Input only, digital or analog	General purpose	General purpose
1	Input only, digital or analog	General purpose	General purpose
2	Input only, digital or analog	Positive limit, or general purpose	Positive limit
3	Input only, digital or analog	Negative limit, or general purpose	Negative limit
4	Input only, digital or analog	General purpose, or index capture for external encoder	General purpose
5	Input only, digital or analog	General purpose, or index capture for internal encoder	General purpose
6	Input only, digital or analog	General purpose, G command, or homing input	General purpose
7	Input only, digital	Drive enable	Drive enable
8	Output only, digital	Brake output or general-purpose output	Brake output
9	Output only, digital	Not fault	Not fault

I/O Control Examples

To make output 8 a general-purpose output:

```
EOBK(-1)      'Disables brake output from any I/O pin
OR(8)         'Clears output (0 volts)
OS(8)         'Sets output (24 volts)
EOBK(8)       'Restores output 8 to brake function
```

To read inputs:

```
x=IN(W,0,15) 'Reads inputs 0,1,2,3 as bitfield stored into variable x
EIGN(2)      'Disables positive limit, makes a general-purpose input
EIGN(3)      'Disables negative limit, makes a general-purpose input
EILP         'Re-enables positive limit
RIN(3)       'Reads input 3
```

Scale Factor Calculation – Sample Rates

The sample rate for Class 6 SmartMotors is fixed at 16,000 Hz (16 kHz).

New Commands for Class 6

The following commands were added for the Class 6 SmartMotor:

> **NOTE:** These commands are *not* available for the Class 5 SmartMotor.

IDENT=, RIDENT, x=IDENT: Set the IDENT value which is useful for user programs to detect which axis they are. Report, use in expression, or assign the value of IDENT to a user variable.

IPCTL(action,"string"): Sets IP address, Mask, or Gateway:
action= 0, set IP address; 1, set Mask; 2, set Gateway;
"string": formatted as an IP address and entered as a string;
e.g., IPCTL(0,"192.168.0.10") sets IP address to 192.168.0.10

PRINT0: Explicitly outputs to the COM0 serial port.

PRINT8: Explicitly outputs to the USB port.

RSP5: Reports network interface card firmware version.

RUSB(arg), x=USB(arg): Report the value of the specified USB status word (specified by arg) or assign it to a variable.

RUSB, x=USB: Report the value of USB status word 0 or assign it to a variable.

SNAME("string"): Sets a unique PROFINET station name. See the *Class 6 SmartMotor™ PROFINET Guide*.

For details on these commands, see the *SmartMotor™ Developer's Guide*.

The following industrial Ethernet (IE) commands were added for the Class 6 SmartMotor:

> **NOTE:** These commands are *not* available for the Class 5 SmartMotor.

RETH(arg), x=ETH(arg): Assign result to a variable or report errors and certain status information for the EtherCAT or PROFINET bus. See the corresponding fieldbus manual for arg values.

ETHCTL(action,value): Controls network features. See the corresponding fieldbus manual for details.

For details on these commands, see the *Class 6 SmartMotor™ EtherCAT Guide* or the *Class 6 SmartMotor™ PROFINET Guide*.

Commands That Have Changed

The following commands have been modified for the Class 6 SmartMotor:

PRINT: Follows the value of STDOUT, which is 8 (USB port) by default. Note that this behavior is slightly different than the Class 5 version.

STDOUT=8: (Default) Sets internal report commands to the USB port.

For details on these commands, see the *SmartMotor™ Developer's Guide*.

Commands Not Currently Supported

The following commands are *not* currently supported in the Class 6 SmartMotor:

CAN related: CADDR=, CANCTL, CBAUD=, RCADDR, RCAN, RCBAUD

Sync motion commands (require Combitronic): ADTS, ATS, DTS, GS, PRTS, PRTSS, PTS, PTSS, RPTSD, RPTST, TSWAIT, VTS

Commands associated with the second serial port or other hardware that is not available in the M-style motors: BAUD(1)=, CCHN on channel 1, ECHO1, ECHO_OFF1, OCHN on channel 1, PRINT1, RBAUD(1), RGETCHR1, RLEN1, ROC, ROF, SILENT1, SLEEP1, TALK1, WAKE1,

Other: ENCCTL, MDT, PID

For Further Information...

For further information on SMI software features, SmartMotor programming details, communication details, motion details, a complete command reference and more, see the *SmartMotor™ Developer's Guide*.

Troubleshooting

The following table provides troubleshooting information for solving common problems. For additional support resources, see the Moog Animatics Support page at:

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

Issue	Cause	Solution
Communication and Control Issues		
Motor control power light does not illuminate.	Control power is off, disconnected or incorrectly wired.	Check that control power is connected to the proper pins and turned on. For connection details, see Connecting the System on page 30.
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.
	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.	Motor does not have its address set in the user program. NOTE: Serial addresses are lost when motor power is off or reset.	Use the SADDR or ADDR= 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.

Issue	Cause	Solution
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 a default firmware version closest to the motor's firmware version. In the SMI software, view the motor's firmware version by right-clicking the motor and selecting Properties.

Class 6 M-Style Connector Pinouts

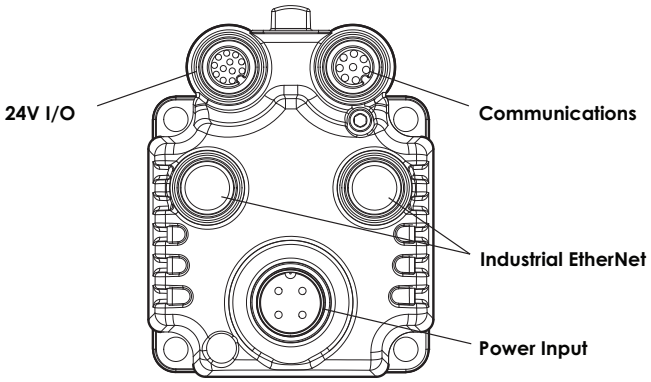
The following table shows the pinouts for the connectors on the Class 6 M-style SmartMotors.

PIN	Main Power	Specifications:	Notes:	P1
1	Control Power In	+24V (±20%), 32V Max	Also supplies I/O	M16 4-Pin Male
2	Chassis			
3	Control, Com, I/O and Amplifier Ground	Common Ground	Unisolated	
4	Amplifier Power In	+24V Min, 48V Max	Powers Amplifier Only	

PIN	Communications Connector	Specifications:	Notes:	P2
1	Control, Com, I/O and Amp Ground	Common Ground	Unisolated	M12 8-Pin Female End View
2	RS-485 B, Com ch. 0	115.2 KBaud Max		
3	RS-485 A, Com ch. 0	115.2 KBaud Max		
4	Encoder A+ Input/Output	1.5 MHz Max as Encoder or Step Input	Configurable as Encoder Output	
5	Encoder B- Input/Output	1.5 MHz Max as Encoder or Direction Input	Configurable as Encoder Output	
6	Encoder A- Input/Output	1.5 MHz Max as Encoder or Step Input	Configurable as Encoder Output	
7	+5V Out	250 mA Max		
8	Encoder B+ Input/Output	1.5 MHz Max as Encoder or Direction Input	Configurable as Encoder Output	

PIN	24V I/O Connector	Specifications:	Notes:	P3
1	IN0 GP Input, Digital or Analog	T.B.D.	**For Inputs**:	M12 12-Pin Female End View
2	IN1 GP Input, Digital or Analog	T.B.D.	Low Lvl Thld: 3.6V Max	
3	IN2/Pos Limit or GP, Digital or Analog	T.B.D.	High Lvl Thld: 5.0V Min	
4	IN3/Neg Limit or GP, Digital or Analog	T.B.D.	Inp. Hysteresis: 1.0V Min	
5	IN4 GP or Ext. Enc. Index Capture	T.B.D.	Anlg Inp Scale: 24V FS ±1%	
6	IN5 GP or Int. Enc. Index Capture	T.B.D.		
7	IN6 GP, G Cmnd or Homing Input	T.B.D.		
8	IN7-DRVEN, Digital	T.B.D.		
9	OUT8, Digital - Brake or GP Output	250 mAmps Max	**For Outputs:** Do not exceed	
10	OUT9, NOFAULT, Digital Output	250 mAmps Max	500 mAmps combined	
11	+24 VDC Out	12.5V Min, 23V Max Load		
12	Ground Common	Common Ground	Unisolated	

PIN	Industrial EtherNet Connectors		Specifications:	Notes:	P4
	EtherCAT / PROFINET		10/100BASE-T	Input (L), Output (R)	M12 4-Pin
1	+TX	+TD	EtherCAT=100BASE-TX		
2	+RX	+RD			
3	-TX	-TD			
4	-RX	-RD			



CAUTION: Exceeding 32 VDC into control power on any of the +24V pins may cause immediate damage to the internal electronics.
Exceeding a sustained voltage of 48V to pin 4 of the P1 Power Input may cause immediate damage to the internal electronics.
Exceeding these voltage limits will void the warranty.

PN: SC80100006-001
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