



Installation & Startup Guide

Class 5 SmartMotor
Technology with

COMBITRONIC™



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Moog Animatics Class 5 SmartMotor™ Installation & Startup Guide, Rev. A, PN: SC80100000-002.

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Introduction

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

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Purpose

The Class 5 SmartMotor™ Installation & Startup Guide provides an overview of the Class 5 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.

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. Combitronic is a protocol that operates over a standard CAN interface. It may coexist with either CANopen or DeviceNet protocols. 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 additional details, see the *SmartMotor™ Developer's Guide*.

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 9.

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>

If you do not have internet access, a static version of the worksheet items can be found in the Appendix of the *SmartMotor™ Developer's Guide*.

- *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>

SmartMotor Overview

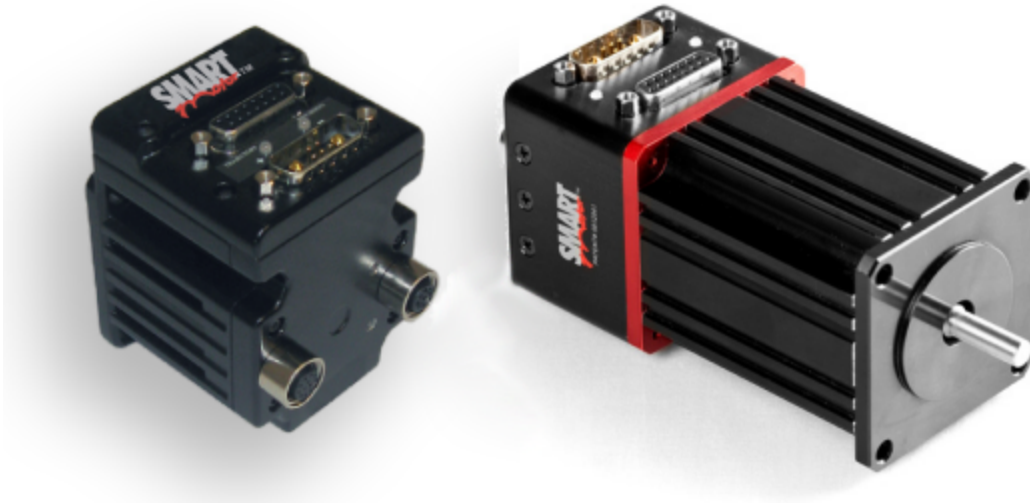
This chapter provides an overview of the design philosophy and functionality of the Moog Animatics SmartMotor. It also provides information on SmartMotor features and options, and where to find related documents and additional resources.

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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



D-Style Cast and Extruded SmartMotors

NOTE: Information in this guide applies to both the cast and extruded motors.



M-Style SmartMotors

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

The Class 5 SmartMotor is available in D-style and M-style configurations. 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)

The following sections describe the similarities and differences between the D-style and M-style configurations.

In addition to this information, there is Product Foldout available on the Moog Animatics website, which illustrates the standard and optional features of the D-style and M-style motors. To access the foldout, use the following address:

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

and select the Product Info Center tab.

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.

D-Style Motors

All D-style SmartMotors have:

- A primary RS-232 communications port
- A secondary RS-485 communications port
- Seven channels of 5 VDC TTL non-isolated I/O

- Ten optional channels of expanded 24 VDC isolated I/O
- A dedicated, single-ended encoder output

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

- CANopen option
- PROFIBUS option
- DeviceNet option

For more details, see Fieldbus Options on page 20.

All firmware options include:

- Modbus Remote Terminal Unit (RTU) Slave (RS-485 COM 1)
- DMX Slave (RS-485 COM 1)

In addition, a hardware DE power option is available, which allows the controller and drive amplifier to be powered from separate power sources. For more details, see DE Power Option (D-Style Motors) on page 23.

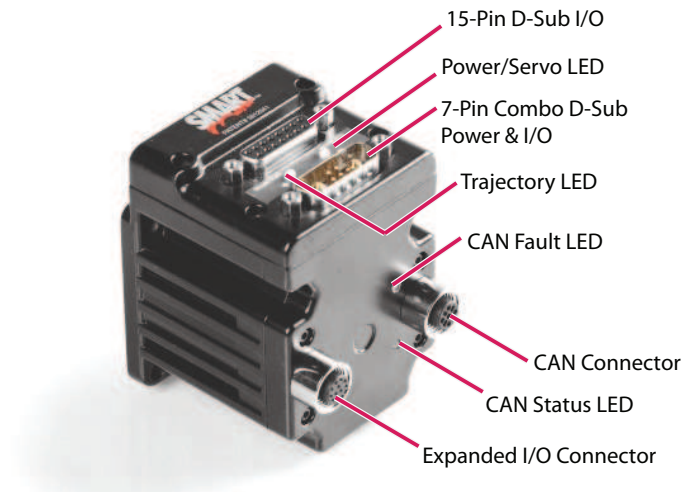


CAUTION: For D-style SmartMotors, pins 14 and 15 of the 15-pin D-sub port are intended for use with DE series motors for control power only. Attempts to power a non-DE motor through those pins as main servo drive power could result in immediate damage to the electronics and will void the warranty.

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

- NEMA 17
- NEMA 23
- NEMA 34

The following figure shows the connector and LED locations for the D-style motors. For details on the D-style motor connectors, see D-Style Motors: Connectors and Pinouts on page 37. For details on the LED functions, see Understanding the Status LEDs on page 47.



D-Style Motor Connectors and LEDs

M-Style Motors

All M-style SmartMotors have:

- A primary RS-485 communications port
- Eleven channels of general purpose 24 VDC isolated I/O
- A dedicated Drive-Enable Input and NOT-FAULT Output
- A dedicated differential $\pm 5V$ encoder bus

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

- CANopen option
- DeviceNet option

NOTE: The PROFIBUS fieldbus protocol is not available on the M-style motors.

All firmware options include:

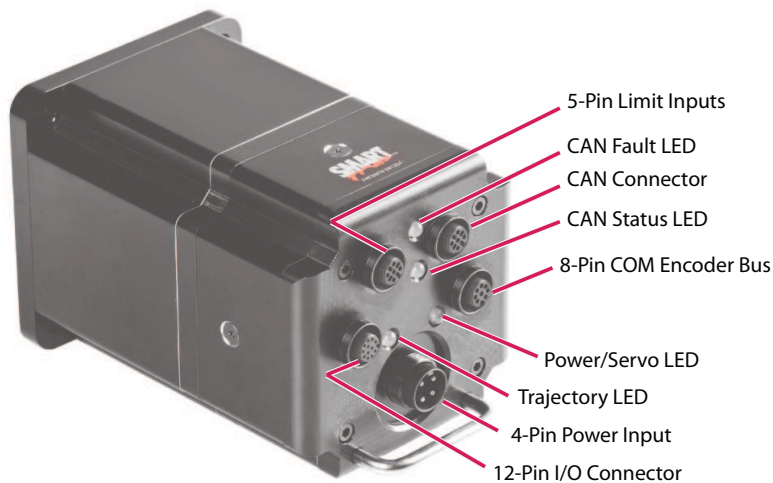
- Modbus Remote Terminal Unit (RTU) Slave (RS-485 COM 0)
- DMX Slave (RS-485 COM 0)

In addition, a hardware DE power option is available, which allows the controller and drive amplifier to be powered from separate power sources. For more details on the Fieldbus and DE options, see Fieldbus Options on page 20 and DE Power Option (D-Style Motors) on page 23.

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

- NEMA 23
- NEMA 34

The following figure shows the connector and LED location for the M-style motors. For details on the M-style motor connectors, see M-Style Motors: Connectors and Pinouts on page 44. For details on the LED functions, see Understanding the Status LEDs on page 47.



M-Style Motor Connectors and LEDs

Fieldbus Options

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

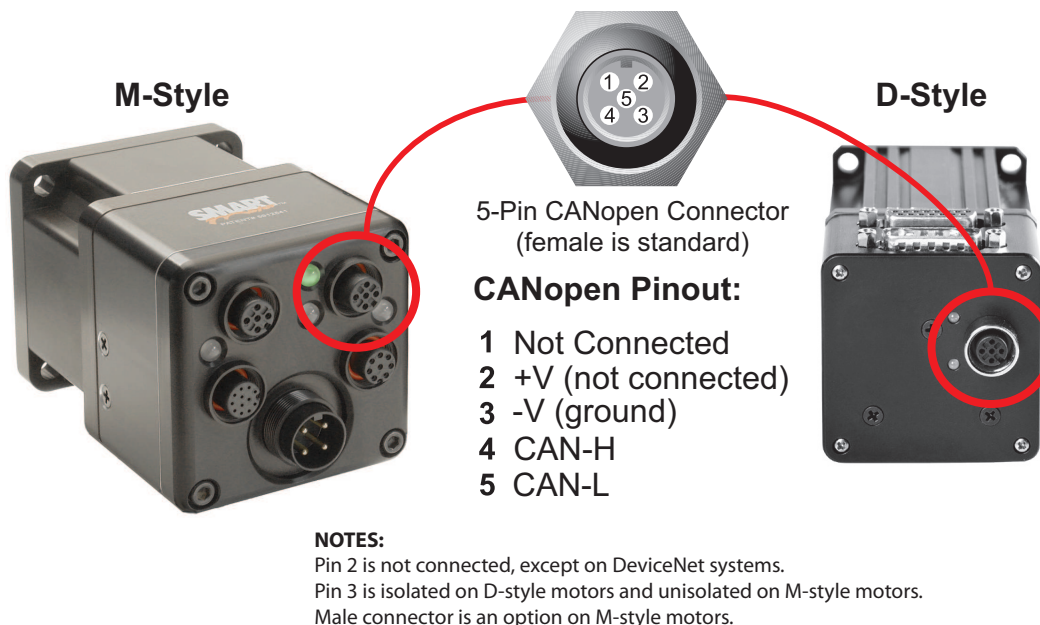
CANopen Fieldbus Protocol

NOTE: This protocol is available on D-style and M-style motors.

The CANopen fieldbus protocol provides the following features:

- All basic Motion commands available through the CiA V4.02 specification
- Ability to read/write all SmartMotor variables
- Use of on-board I/O through CANopen gateway, SmartMotor program or serial commands
- Ability to run 1000 SmartMotor subroutines through CANopen
- Online diagnostics of the SmartMotor through SMI software and serial connection
- Up to 127 nodes
- 250 microsecond interrupt-driven subroutine
- Baud rates of 20 Kbps, 50 Kbps, 125 Kbps (default), 250 Kbps, 500 Kbps and 1 Mbps

The following figure shows the location of the CANopen port and the corresponding pinouts.



CANopen Connector Location and Pinouts

For more connector/pinout details, see Connecting the System on page 36

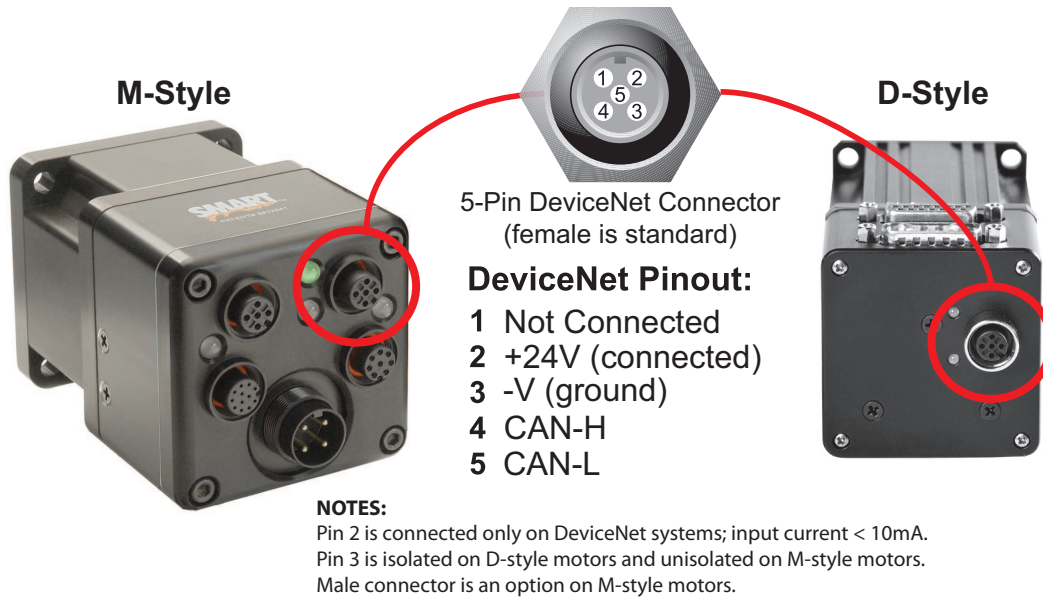
DeviceNet Fieldbus Protocol

NOTE: This protocol is available on D-style and M-style motors.

The DeviceNet Fieldbus protocol provides the following features:

- Polled I/O and Explicit Messages from your PLC to control all SmartMotor operation
- Read/write control over all Open DeviceNet Vendor Association (ODVA) position-controller parameters
- Use of on-board I/O through DeviceNet, SmartMotor program or serial commands
- Ability to run 1000 SmartMotor subroutines through DeviceNet and read/write four 32-bit user variables
- Online diagnostics of the SmartMotors through SMI software and serial connection
- Up to 64 DeviceNet nodes
- 250 microsecond interrupt-driven subroutine
- Baud rates of 125 Kbps, 250 Kbps and 500 Kbps (the default is 125 Kbps)

The following figure shows the location of the DeviceNet port and the corresponding pinouts.



DeviceNet Connector Location and Pinouts

For more connector/pinout details, see Connecting the System on page 36

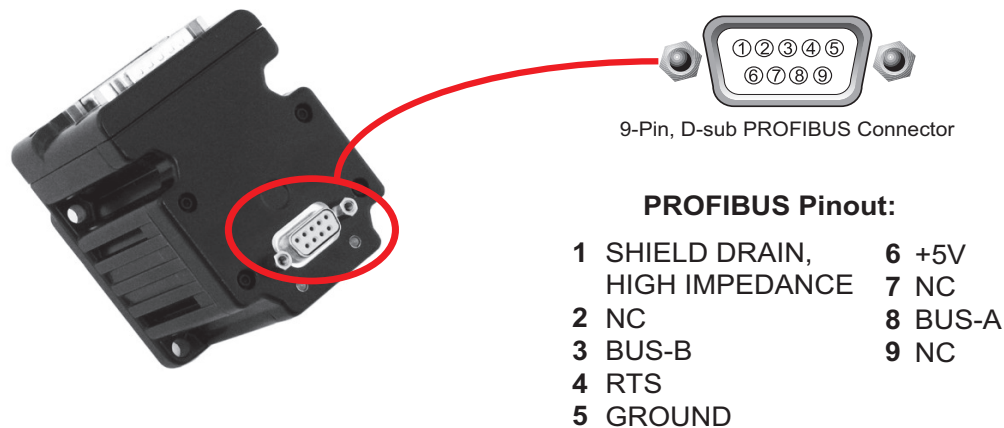
PROFIBUS Fieldbus Protocol

NOTE: The PROFIBUS fieldbus protocol is not available on the M-style motors.

The PROFIBUS fieldbus protocol provides the following features:

- Command/Response Codes for all Class 5 SmartMotor commands
- Use of on-board I/O through PROFIBUS, SmartMotor program, or RS-232 commands
- Ability to run 1000 SmartMotor subroutines through PROFIBUS
- Ability to read/write all SmartMotor variables
- Online diagnostics of the SmartMotors through SMI software and RS-232 connection
- Up to 127 PROFIBUS nodes
- 250 microsecond interrupt-driven subroutine
- Baud rates of 9.6 Kbps, 19.2 Kbps, 31.25 Kbps, 45.45 Kbps, 93.75 Kbps, 187.5 Kbps, 500 Kbps, 1.5 Mbps, 3 Mbps, 6 Mbps and 12 Mbps (the default is 1.5 Mbps)

The following figure shows the location of the PROFIBUS port on the D-style motor and the corresponding pinouts.



PROFIBUS Connector Location and Pinouts on D-Style Motor

DE Power Option (D-Style Motors)

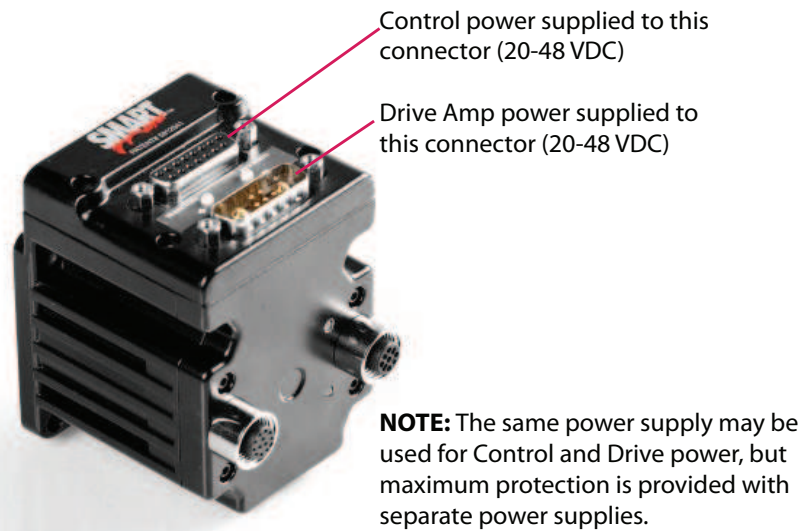
The D-style SmartMotor's hardware DE power option allows the controller and drive amplifier to be powered from separate DC power supplies (see the following figure). For a schematic diagram, see D-Style Motors: DE Power Option Schematic on page 41.

This hardware option provides the following advantages:

- Controller can be powered from a standard 24-48 VDC power supply
- Position will not be lost if drive power is lost
- No need to re-home
- Load surges will not cause a power surge on the controller
- Standard battery options are made simpler

NOTE: All M-style and IP-sealed SmartMotors are designed to *always* have separate drive and control power. Therefore, no DE designation is available for these SmartMotors.

The following figure shows the connectors used for the DE power option.



D-Style SmartMotor Showing DE Power Option

As noted in the previous figure, although you can supply the control and drive power from one power supply, you will only get the full benefits and maximum protection by using separate power supplies.

IP65 and IP67 M-Style Motors

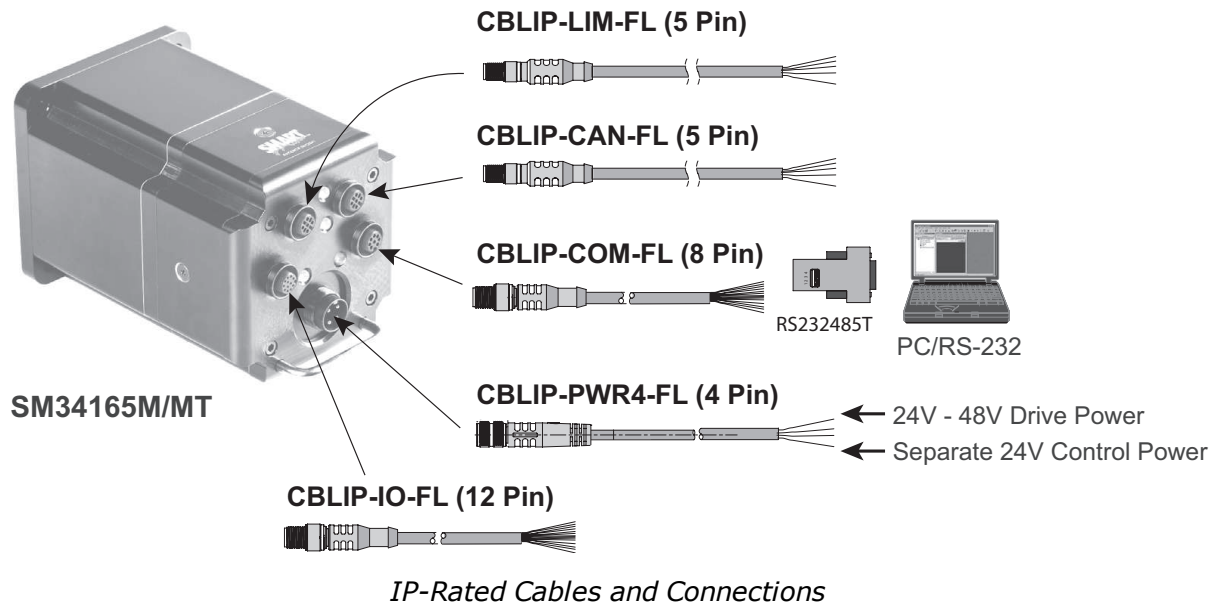
Certain models of M-style SmartMotors are available in IP-rated versions (see the *Moog Animatics Product Catalog* for details). The standard IP rating is IP65, which protects the motor from dust particles and splashing water. Additionally, certain motors can be ordered with the higher IP67 rating. Contact Moog Animatics for details.

IP ratings are in accordance with the code defined in international standard IEC 60529. Instead of the vague descriptions of "waterproof", "water-resistant" or "dustproof", the IP-rating system provides a uniform, quantifiable set of standards to which each product is rigorously tested. The IP code refers to the degree of protection for the electrical enclosures on a machine against liquid, solid objects and particulates. The first number following "IP" refers to the level of protection of the hazardous parts and electrical enclosures against solid objects and particulates, and the second digit indicates the level of water resistance. The higher the first digit rating in the IP system, the smaller the foreign object that it is protected against.

SmartMotors with the IP65 rating are both completely dust tight and protected from ingress of liquid that may occur from any angle, rendering no harmful effects on the electrical enclosure. SmartMotors with the IP67 rating can be submersed in water or other non-hazardous liquids to a depth of one meter for a maximum time of 30 minutes. Therefore, conditions with high levels of humidity and condensation are no longer a problem. The IP-rated models provide the perfect integrated servo for food and beverage manufacturing and packaging, rugged outdoor conditions, as well as any wet environment.

Note that there are special IP-rated cables, which are available from Moog Animatics, that are designed for use with the IP-rated SmartMotors. The following figure shows the cables, part numbers and corresponding connections.

NOTE: LED operation is the same as standard (non-IP rated) SmartMotors.



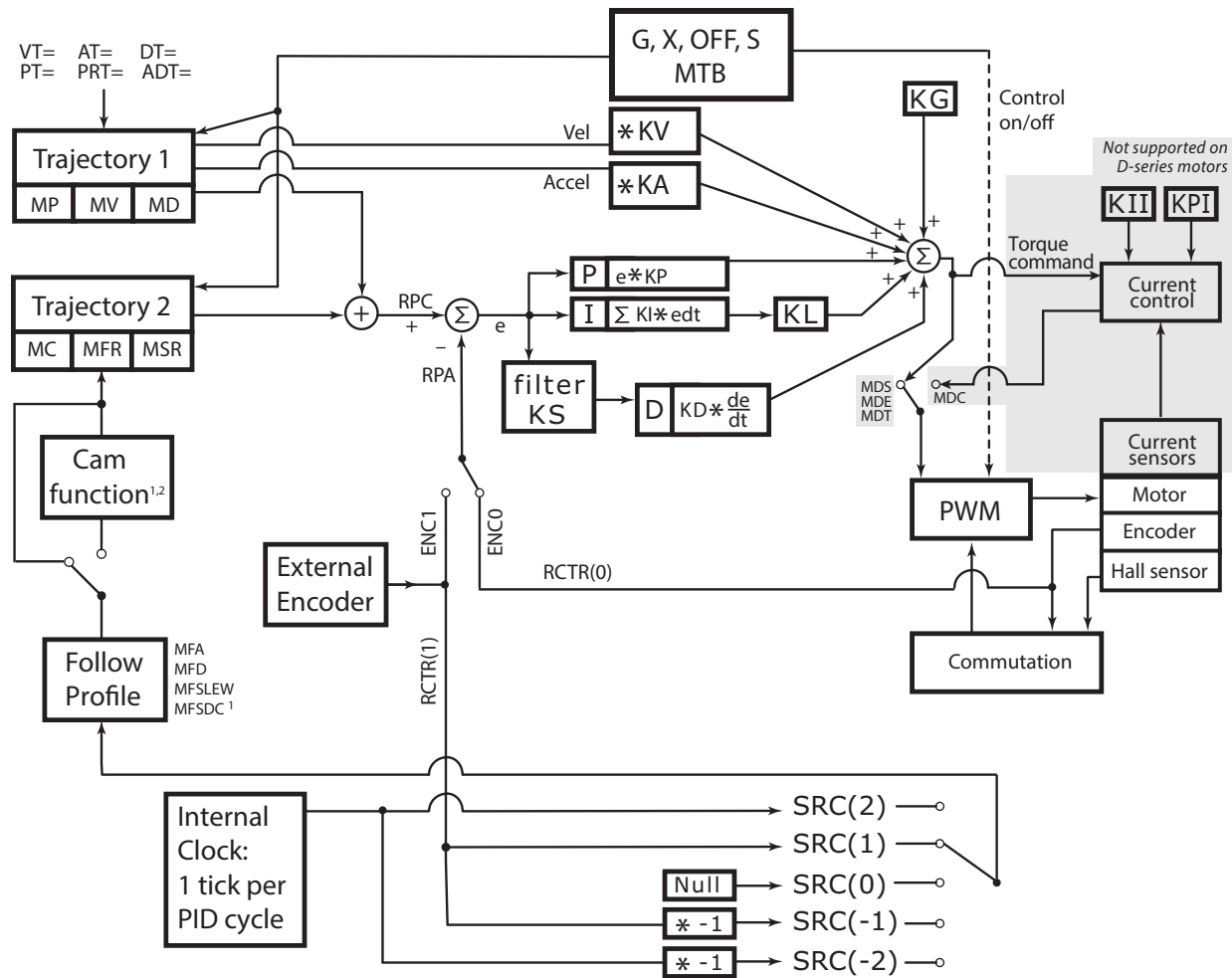
SmartMotor Theory of Operation

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.



SmartMotor Theory of Operation Diagram

Getting Started

This chapter provides information on getting started with your SmartMotor.

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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.

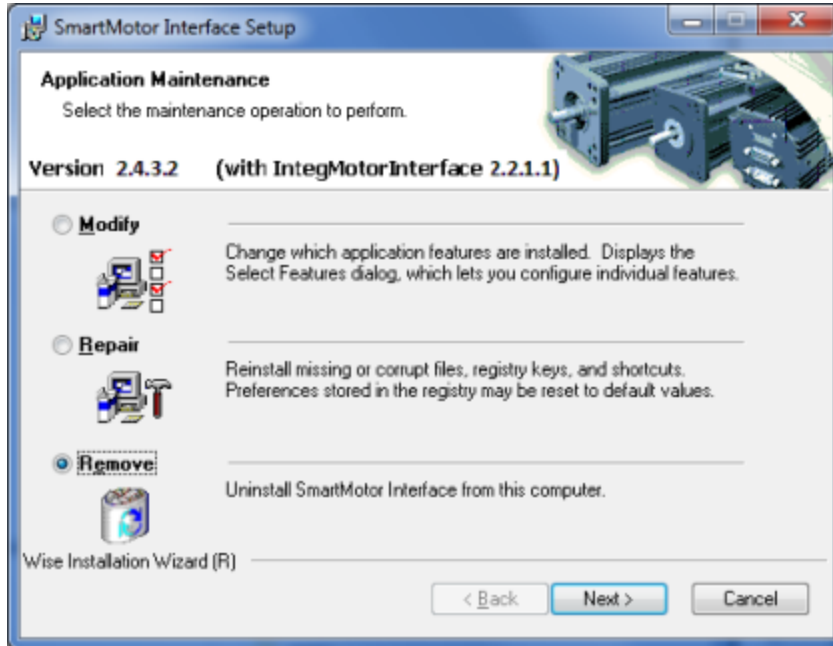
Installation Procedure

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.

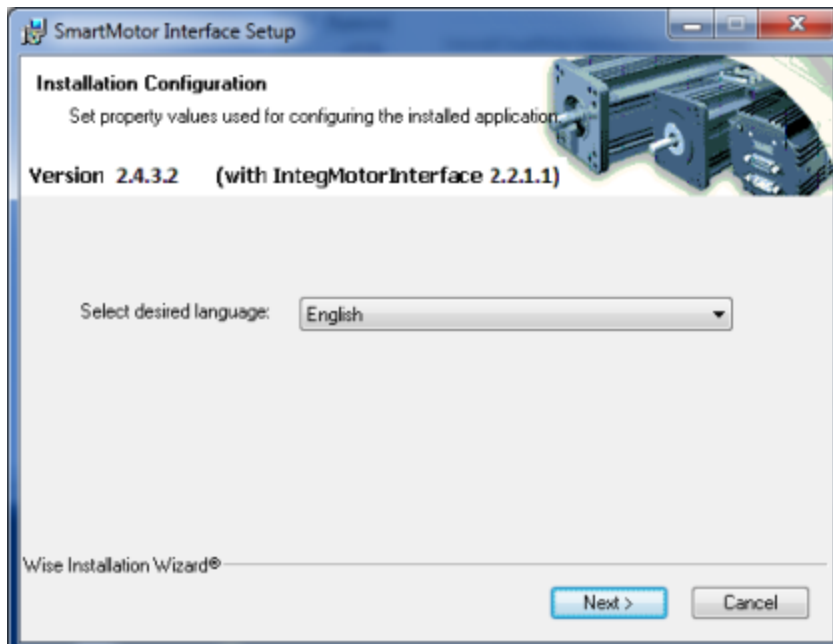
If this is an upgrade to a previous installation, you will see the following window. Select Remove, click Next and follow the instructions to remove the existing software from your PC.



After removing the existing software, restart the installation process.

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

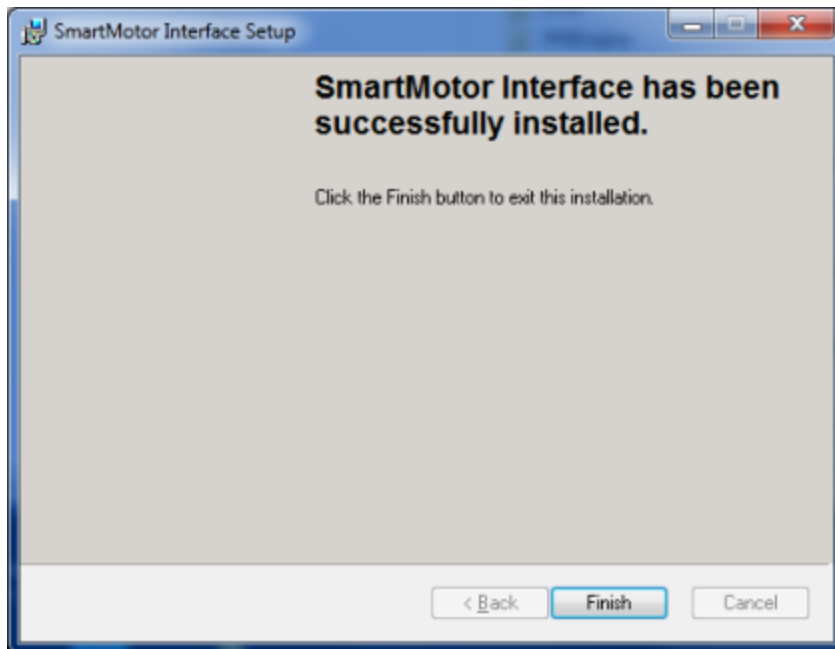
2. Click Next to proceed. The Installation Configuration page opens.



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



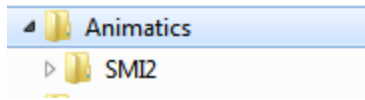
- After you have finished reviewing the welcome information, click Next to proceed. Continue following the on-screen instructions to complete the SMI software installation.
- When the installation has completed, the installation status message page opens, as shown in the following figure. Click Finish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

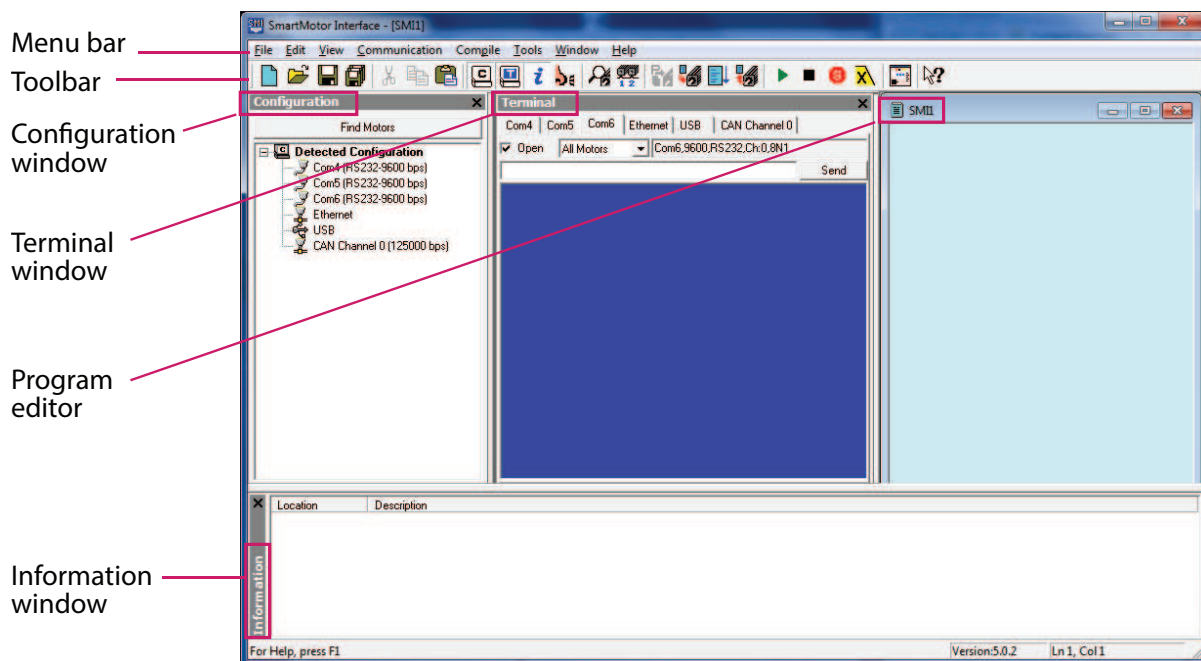


SmartMotor Interface Shortcut

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 SmartMotor power, CPU power, I/O power and Communications power.

SmartMotor Power Requirements

Requirement: The power range for D-style SmartMotors is from 24 VDC to 48 VDC; do not exceed 48 VDC. For the D-style AD1 option, do not exceed 24 VDC.

For M-style SmartMotors: control power requires 24 VDC, do not exceed 24 VDC; motor power requires from 24 VDC to 48 VDC, do not exceed 48 VDC.



CAUTION: Control power for M-style motors must be 24 volts. They are not rated for 48 volts.

Details: Some of the larger SmartMotors can draw high current. Therefore, heavy gauge wire is required to connect the large motors. As a result, Add-A-Motor cables are only recommended for series 17 and 23 motor frames.

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.

D-Style CPU, I/O and Communications Power

CPU Power Requirements

Requirement: Maximum of 5 VDC on any I/O pin or 5 VDC pin.

Details: D-style SmartMotors have an internal 5 VDC power supply to run the internal CPU. This supply can be easily damaged if an external voltage source of a higher voltage potential is applied. Therefore, do not exceed 5 VDC on any TTL-level I/O pin or 5 VDC pin.

I/O Power Requirements

Requirement: Maximum sink amperage = 12 mA; Maximum source amperage = 4 mA.

Details: Each on-board 5-volt I/O pin has a minimum amount of protection consisting of a 100 ohm current-limit resistor and a 5.6 VDC Zener diode. Each I/O pin also has a 5 kohm pull-up resistor. When assigned as outputs, they act as a push-pull amplifier that drives hard to either the positive or negative 5 VDC rail. This means they are not open-collector I/O pins. Each I/O pin can sink up to 12 mA and source up to 4 mA. Exceeding this could result in damage to the I/O port.

The AD1 option on the D-series motor provides isolated 24-Volt I/O. The user must supply the 24 volts at the appropriate pin on the round 12-pin connector.



CAUTION: For Class 5 D-style AD1 option motors, at no time should the voltage to any input exceed the level on the I/O power input (Pin 11). Doing so could cause immediate damage to the expanded I/O hardware.

Communications Power Requirements

Requirement: Proper serial ground signal referencing and shielding techniques are required; do not use the cable shield for the RS-232 ground reference.

Details: The D-style SmartMotor has a two-wire RS-232 port. This port meets IEEE standards with full +/-12 VDC potential on the transmit line. Proper serial ground signal referencing and shielding techniques must be used. Under no circumstances should the shield of a cable be used for the RS-232 ground reference. This could result in noise or corrupt data as well as ground loops that could damage the serial port chip set.

M-Style CPU, I/O and Communications Power

CPU Power Requirements

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

Details: The CPU **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 ($\pm 20\%$) must be supplied. Do not exceed 32 VDC.

Details: The I/O **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.

Communications Power Requirements

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

Details: The RS-485 signal **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.

M-Style Drive Enable Power

The Drive Enable input on the M-series motor must be connected and activated with 24V. For the input location, see M-Style Motors: Connectors and Pinouts on page 44.

Connecting the System

The following sections show system connections and cable diagrams for typical D-style and M-style motor installations.

For D-style motors:

- D-Style Motors: Connectors and Pinouts on page 37
- D-Style Motors: Demo or Development System on page 37
- D-Style Motors: RS-232 Through USB on page 38
- D-Style Motors: RS-232 with Protective Shunt on page 40
- D-Style Motors: RS-232 Multidrop with Add-A-Motor Cables on page 41
- D-Style Motors: RS-232 Multidrop with Custom X-Y-Z Cable on page 41
- D-Style Motors: DE Power Option Schematic on page 41

For M-style motors:

- M-Style Motors: Connectors and Pinouts on page 44
- M-Style Motors: Power, RS-485 Com and CAN Multidrop on page 44
- M-Style Motors: RS-232 to RS-485 Multidrop on page 45
- M-Style Motors: CANopen or DeviceNet Multidrop on page 46

As you can see, many configurations are possible.

- If you are using one of these typical configurations and Moog Animatics-supplied cables, simply follow the connection information in this section.
- If you are using your own cables or a non-typical configuration, review the cable diagrams and also see the detailed connector and pinout descriptions in D-Style Motors: Connectors and Pinouts on page 37 and M-Style Motors: Connectors and Pinouts on page 44.

Additionally, see the Moog Animatics website for other cabling options:

<http://www.animatics.com/supports/knowledge-base/connectivity-map.html>

Advanced communication information is available in Communication Details in the *SmartMotor™ Developer's Guide*.

Minimum Requirements

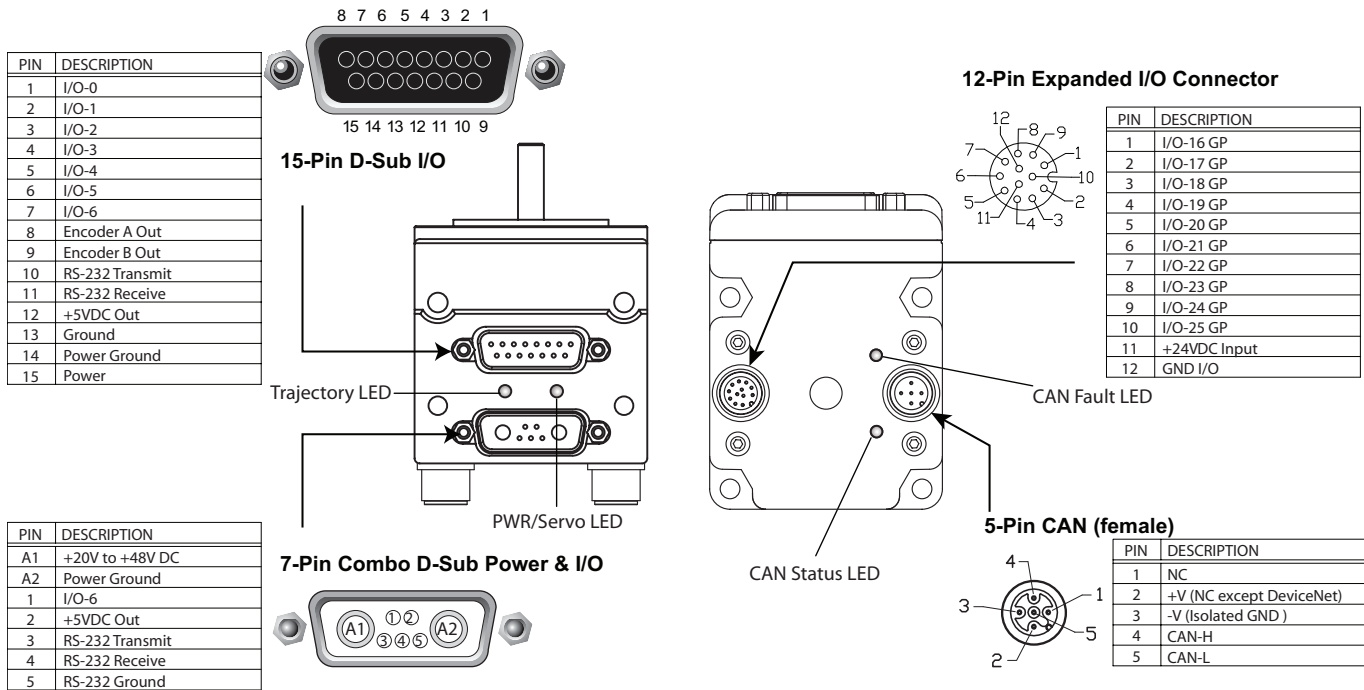
At minimum, you will need the following items:

1. A Class 5 D-style or 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 the SmartMotor to the computer's serial port or serial adapter

NOTE: First time users of the SM1700 through SM3400 series motors should purchase the Moog Animatics SMDEVPACK-D. It includes the CBLSM1-3M data and power cable, the SMI software, the manual and a connector kit.

D-Style Motors: Connectors and Pinouts

The following figure provides a brief overview of the connectors and pinouts available on the D-style SmartMotors. Additional connector specifications are available in Class 5 D-Style Connector Pinouts on page 66.



NOTE: The DE power option is recommended. For details, see D-Style Motors: DE Power Option Schematic on page 41.

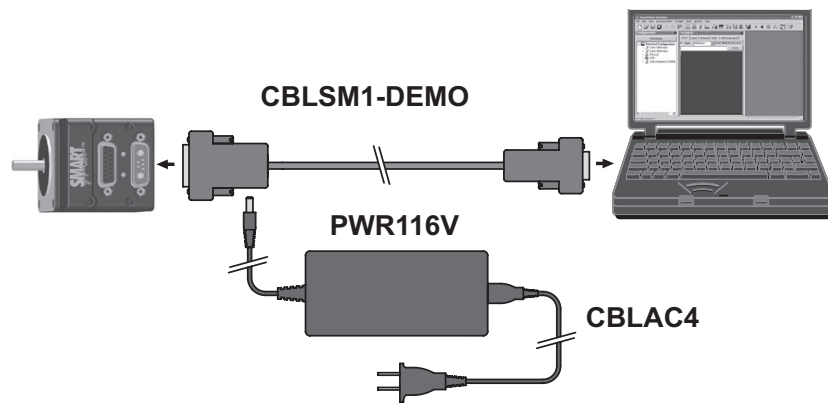


CAUTION: For Class 5 D-style AD1 option motors, at no time should the voltage to any input exceed the level on the I/O power input (Pin 11). Doing so could cause immediate damage to the expanded I/O hardware.

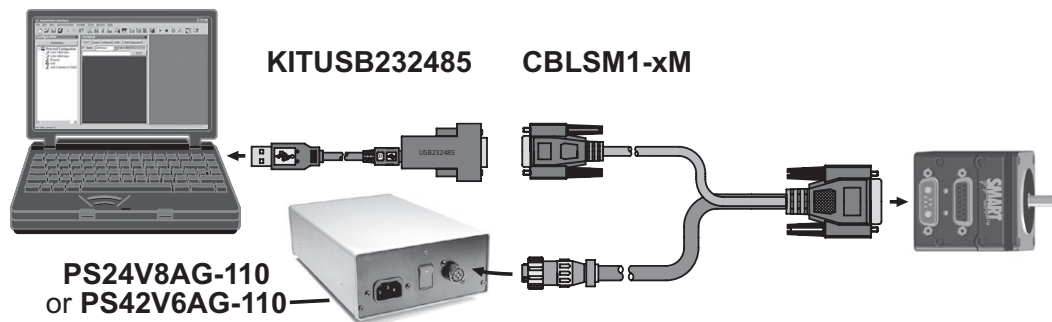
D-Style Motors: Demo or Development System



CAUTION: This configuration is designed for development, training or demo purposes only. It is not intended for use in an industrial (manufacturing) environment.



D-Style Motors: RS-232 Through USB



Adding a USB Adapter

Moog Animatics sells a USB to Serial adapter (PN KITUSB232485), which is used on PCs that don't have a built-in serial port. The adapter allows you to connect from an available USB port to the serial interface on the SmartMotor. The adapter simply connects between the USB port and the serial cable.

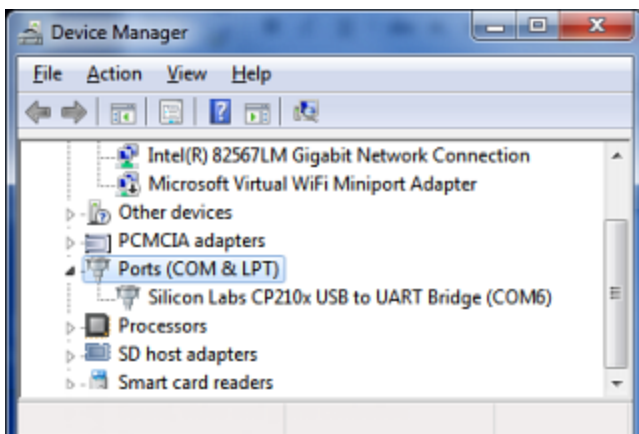
When the adapter is used, it is recommended that you use the Microsoft Windows Device Manager's Port Settings tab to change the port's communications buffers to minimum. This allows the operating system to immediately notify the SMI software when data is being received from a SmartMotor. Otherwise, you may experience intermittent interruptions in communications.

To change the USB port settings:

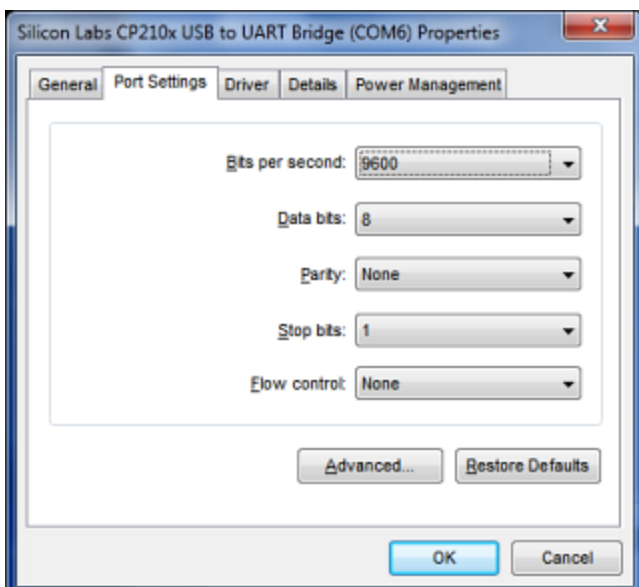
1. From the Windows Desktop, open the Device Manager by selecting:

Start > Control Panel > Device Manager

2. Scroll through the list of devices and locate Ports (COM & LPT), as shown in the next figure.

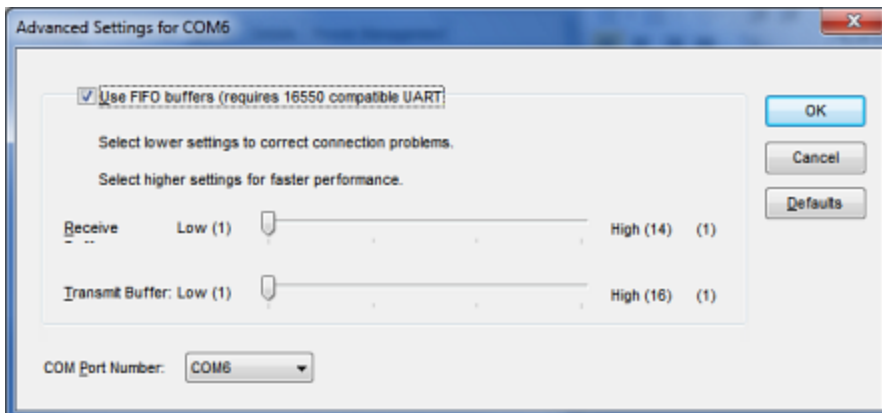


3. Double-click the COM port to open the settings window. For example, in the previous figure, you would double-click the COM6 port.



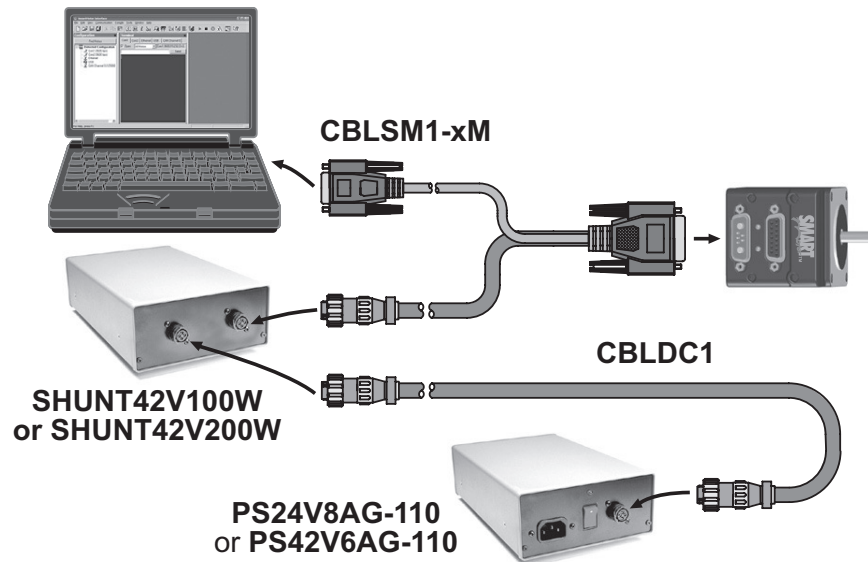
4. Click Advanced to open the Advanced Settings window for the COM port.

5. Move the Receive and Transmit Buffer sliders to Low (1), which is the minimum setting, as shown in the following figure.

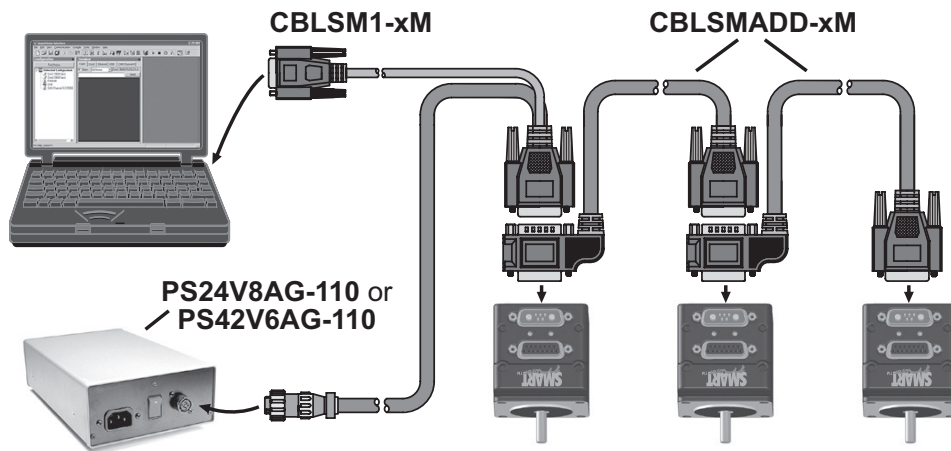


6. Click OK to save the new settings.

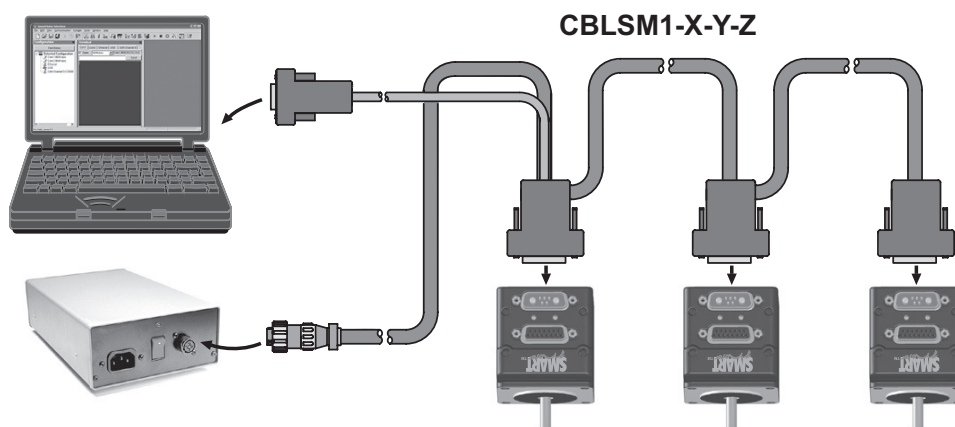
D-Style Motors: RS-232 with Protective Shunt



D-Style Motors: RS-232 Multidrop with Add-A-Motor Cables

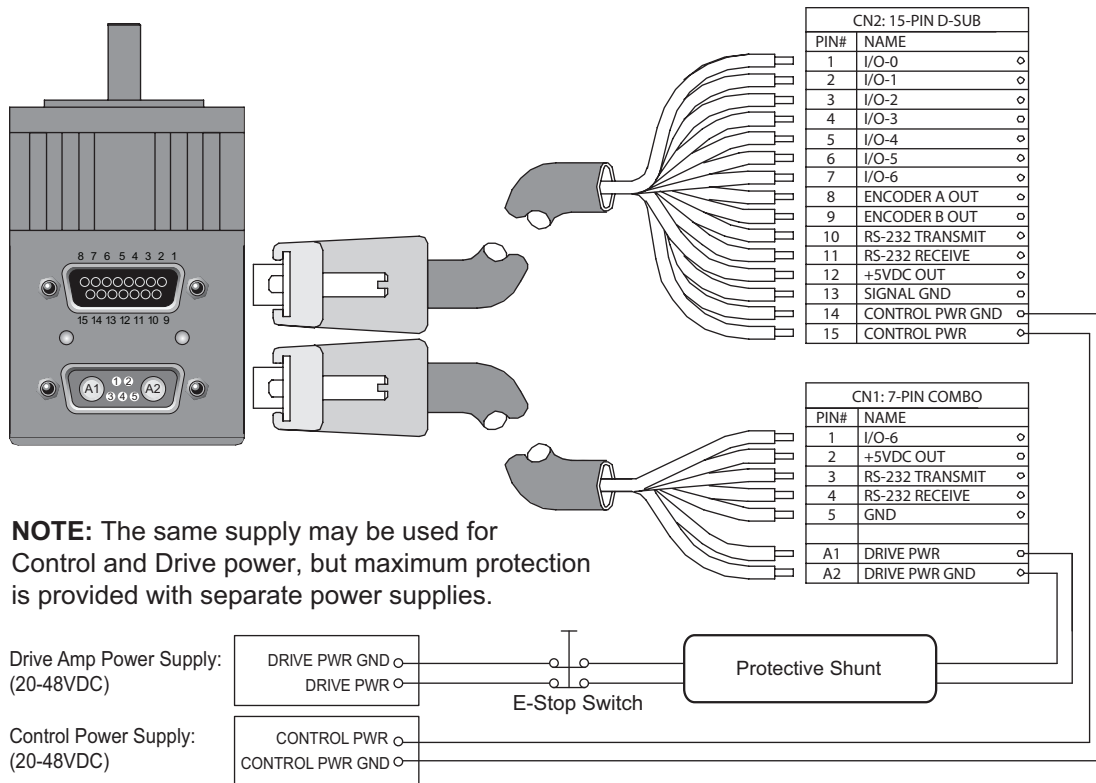


D-Style Motors: RS-232 Multidrop with Custom X-Y-Z Cable



D-Style Motors: DE Power Option Schematic

The DE power option allows the controller and drive-amplifier to be powered from separate DC power supplies (see the following figure).



NOTE: All M-style and IP-sealed SmartMotors are designed to *always* have separate drive and control power. Therefore, no DE designation is available for these SmartMotors.

D-Style Motors: CDS Option Schematic

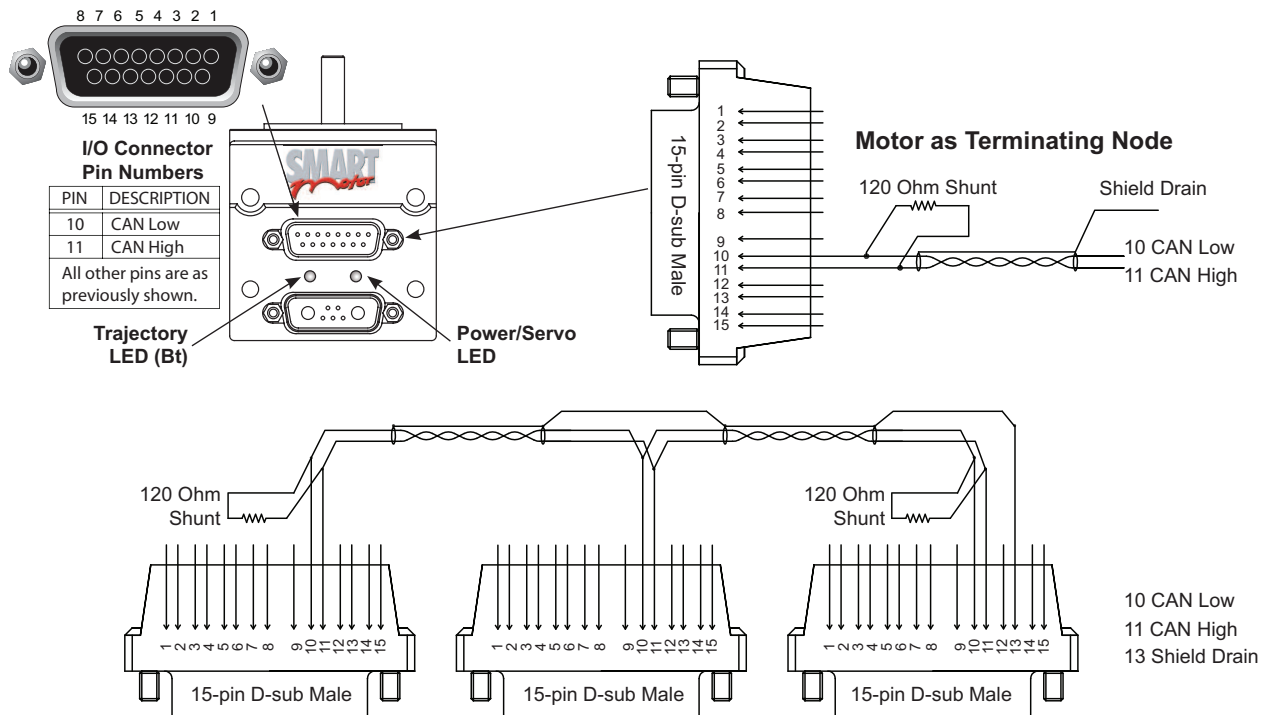
This section provides a schematic for wiring a D-style SmartMotor equipped with the CDS CAN connection option. This option can be used for Combitronic communications. For details on Combitronic communications, see Combitronic Communications in the *SmartMotor™ Developer's Guide*. The option also allows the integrated brake option to be used with CAN, which is useful for many vertical-axis applications.

NOTE: The CDS Option is available only on specially equipped D-style SmartMotors. Contact Moog Animatics for details.

A special version of the D-style SmartMotor with the CDS CAN connector option allows simple CAN bus network wiring through the DA-15 connector (15-pin D-sub I/O connector shown in the following figure). This is an advantage when the M-style CAN connector is not desired. The D-style motor with the CDS CAN connection option can be used as the terminating node. To enable this, a 120 ohm shunt must be placed across pins 10 and 11. For details, see the following figure.

NOTE: Terminating resistors must always be used at both ends of a CAN bus network.

D-Style Motors: CDS Option Schematic

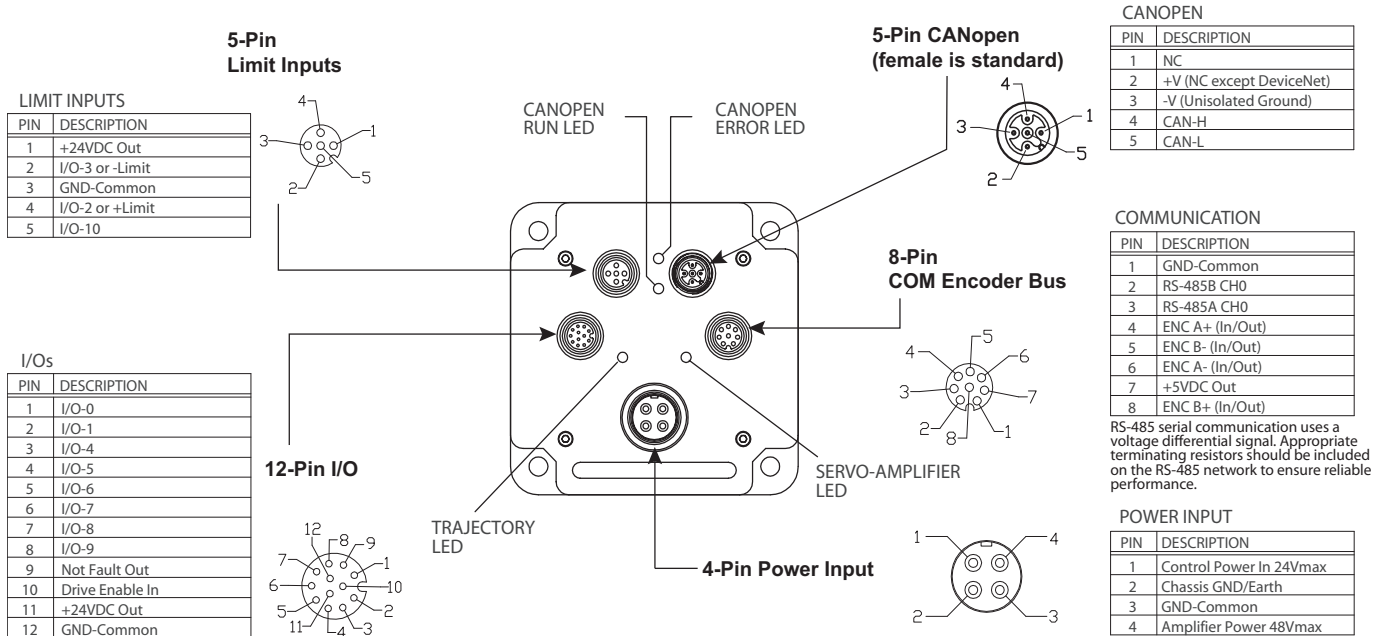


NOTES: A terminating resistor is required at each end of the bus.
 Bus must be multi-drop as shown, *not* a star network.
 24V CAN bus power connection is *not* required at the motor.

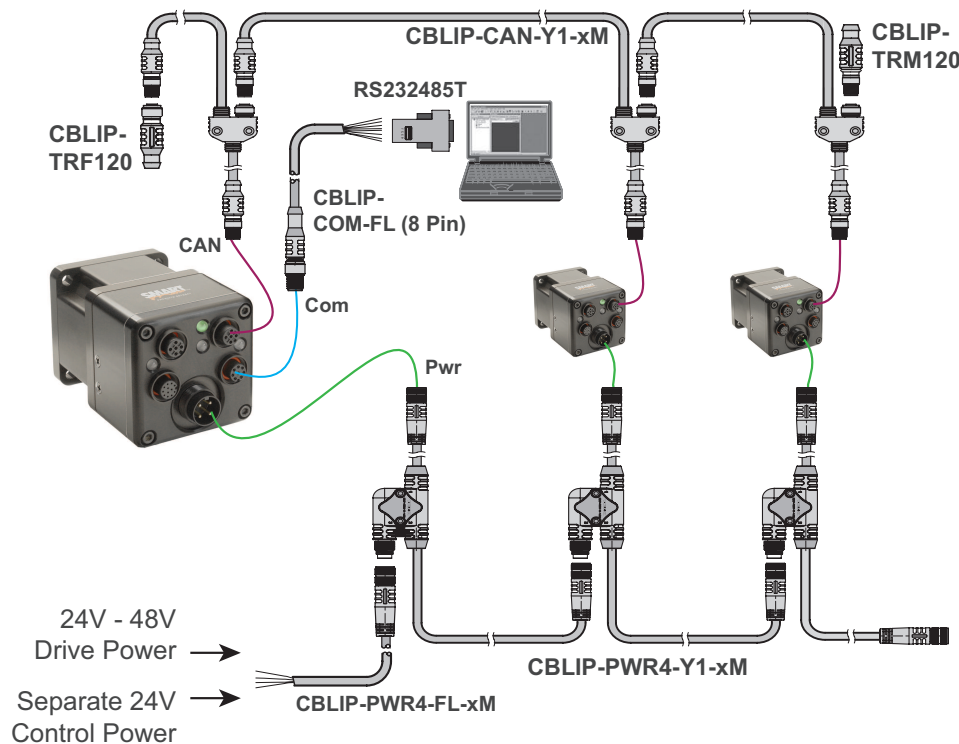
Schematic for CDS Option, D-Style SmartMotor Used as Terminating Node

M-Style Motors: Connectors and Pinouts

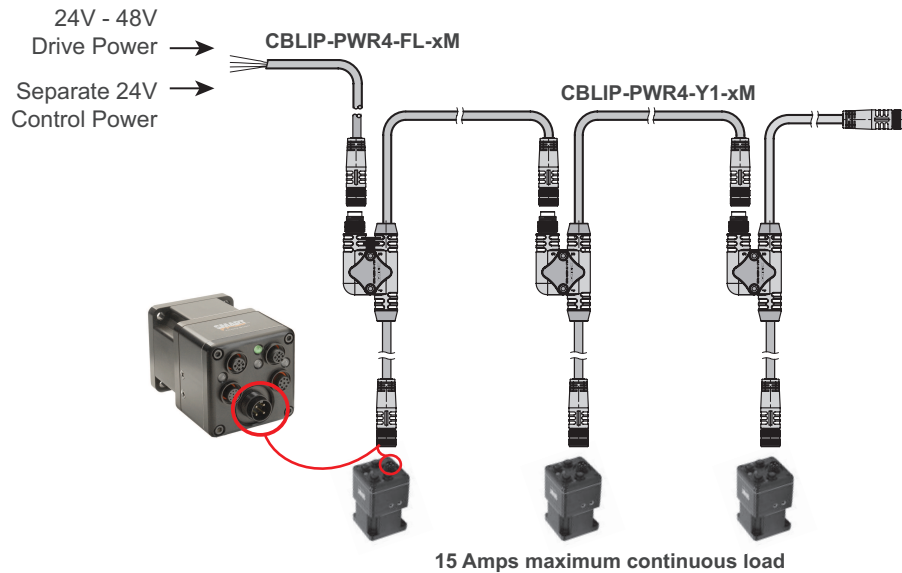
The following figure provides a brief overview of the connectors and pinouts available on the M-style SmartMotors. Additional connector specifications are available in Class 5 M-Style Connector Pinouts on page 67.



M-Style Motors: Power, RS-485 Com and CAN Multidrop

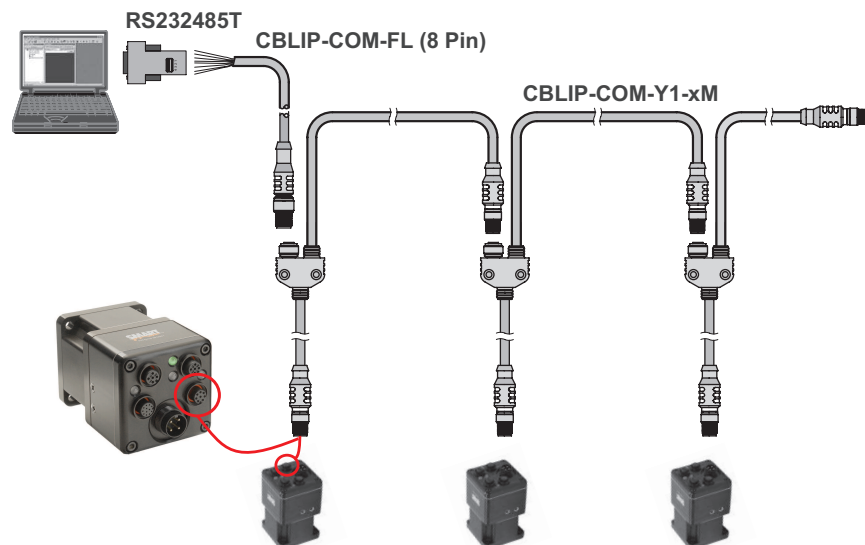


M-Style Motors: Power Multidrop



This power-connection method would be combined with a communications-connection method. For example, see the diagrams in the following two sections.

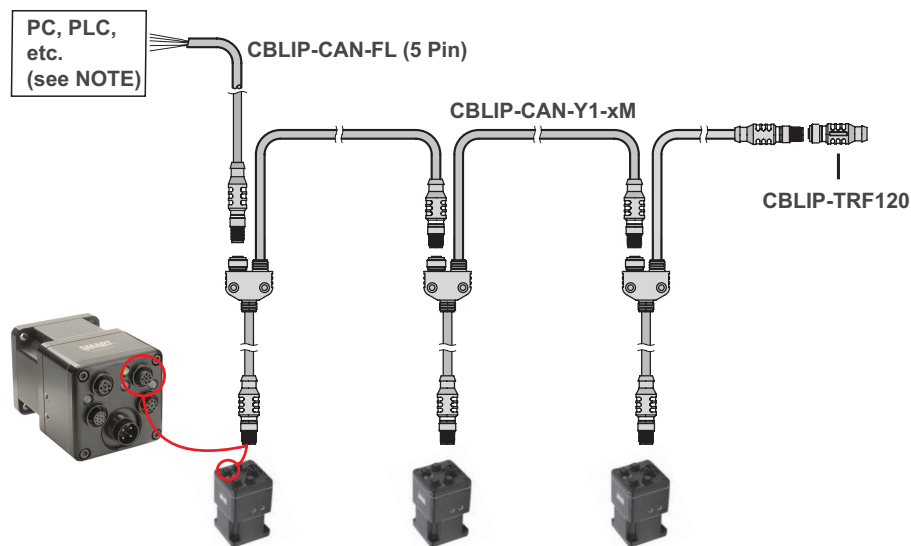
M-Style Motors: RS-232 to RS-485 Multidrop



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.

This communications-connection method would be combined with a power-connection method. For example, see M-Style Motors: Power, RS-485 Com and CAN Multidrop on page 44.

M-Style Motors: CANopen or DeviceNet Multidrop

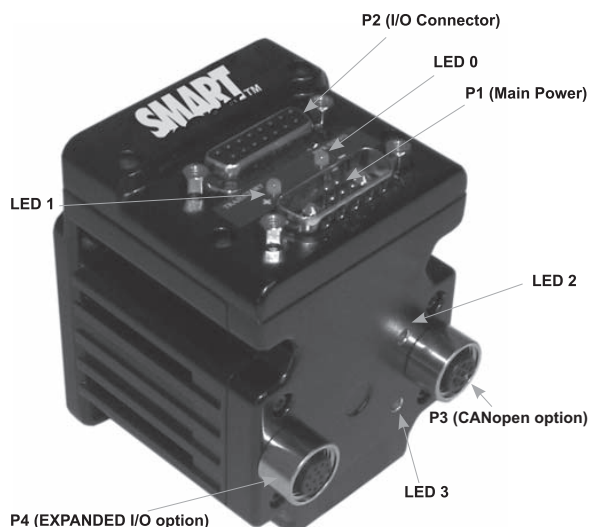
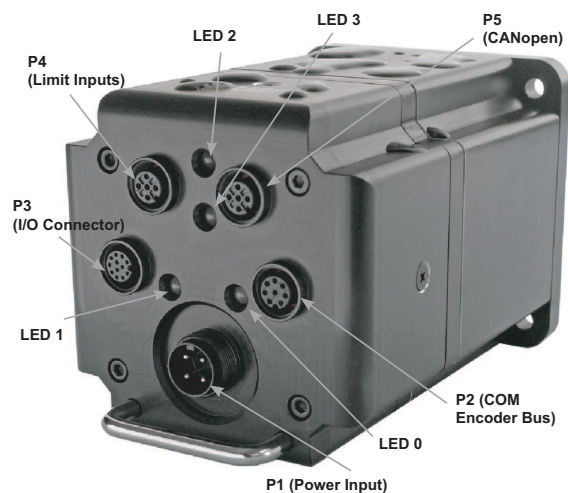


NOTE: The bus requires a termination resistor at each end. If the master device (PC, PLC, etc.) does not include one, then an external termination resistor must be supplied.

This communications-connection method would be combined with a power-connection method. For example, see M-Style Motors: Power, RS-485 Com and CAN Multidrop on page 44.

Understanding the Status LEDs

The Status LEDs provide the same functionality for the D-style and M-style (including IP-sealed) SmartMotors.



LED 0: Drive Status Indicator	
Off	No power
Solid green	Drive on
Flashing green	Drive off
Flashing red	Watchdog fault
Solid red	Major fault
Alt. red/green	In boot load; needs firmware
LED 1: Trajectory Status Indicator	
Off	Not busy
Solid green	Drive on, trajectory in progress

LED 2: CAN Bus Network Fault (Red LED)	
Off	No error
Single Flash	At least one error exceeded limit
Double Flash	Heartbeat or guard error
Solid	Busy off state
LED 3: CAN Bus Network Status (Green LED)	
Blinking	Pre-operational state (during boot-up)
Solid	Normal operation
Single	Device is in stopped state

LED Status on Power-up:

- With no program and the travel limit inputs are low:
LED 0 will be solid red indicating the motor is in a fault state due to travel limit fault.
LED 1 will be off.
- With no program and the travel limit inputs are high:
LED 0 will be solid red for 500 milliseconds and then begin flashing green.
LED 1 will be off.
- With a program that disables only travel limits and nothing else:
LED 0 will be solid red for 500 milliseconds and then begin flashing green.
LED 1 will be off.

NOTE: D-style motors with the CDS CAN connector option use LED 1 to indicate a CAN error. Because this LED also indicates the trajectory status, it will alternate red/green colors if a CAN error occurs while a trajectory is in progress.

D-Style Motor CDS Option LED 1 CAN Error Indication:

Condition	Indication
Bt = 0, CAN bus OK	Trajectory LED = Off
Bt = 1, CAN bus OK	Trajectory LED = Green
Bt = 0, CAN bus fault	Trajectory LED = Flashing red
Bt = 1, CAN bus fault	Trajectory LED = Alternating red/green

Bt refers to Busy Trajectory status bit. When the motor is actively pursuing a trajectory, that bit will be set to 1.

Detecting and Addressing the SmartMotors

This section describes how to detect and address the motors over the serial network. For details on other communications methods, see Communication Details 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 36.
- The SmartMotor is connected to a power source. (M-style motors require separate control and drive power.) For details, see Understanding the Power Requirements on page 33 and Connecting the System on page 36.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 29.

Understanding the Detection and Addressing Options

There are three different ways to use the SMI software to find and address the D-style SmartMotors that are connected to your PC:

- Use the Find Motors button—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 50.
- Use the Detect Motors feature—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 52.
- Use the Address Motors feature—this method can be used if you know the communications port used to connect your motors. This method *always* re-addresses the motors; therefore, if you have pre-addressed motors connected, their addresses may be changed. For details, see Using the Address Motors Feature on page 54.

These methods are described in the following sections.

A note about M-style motors:

The M-style SmartMotors only work on RS-485 and, therefore, need to be pre-addressed in nonvolatile memory such as a user program before being daisy-chained together and detected. To do this, you must:

1. Connect the first motor, address it (typically as motor 1), remove it,
2. Connect the second motor (typically as motor 2), address it, remove it,
3. And so on, until all motors have been pre-addressed.

After all the M-style motors are addressed:

4. Daisy-chain the motors as shown in Connecting the System on page 36.
5. Use the Detect Motors feature. For details, see Using the Detect Motors Feature on page 52.



CAUTION: Do NOT use the Address Motors feature. Doing so will overwrite the existing motor addresses.

Some notes about motor addressing:

The SmartMotors power up in non-echo state (so no response is sent to the next motor), 9600 KB communications and a Base address of 0 (zero).

As the system addresses the motors in the RS-232 daisy chain (remember, as discussed in the previous note, M-style motors use RS-485 and must be pre-addressed), it starts with the first motor in the daisy chain, sets its address to 1, enables echo, and then puts that motor to sleep. It proceeds to the next motor in the daisy chain, sets its address to 2, enables echo and puts it to sleep. This process continues until all the motors in the daisy chain are addressed.

When the motor is addressed, it contains a unique identifier that allows it to respond to commands intended for that motor and ignore commands intended for other motors. For example, 1RPA reports the position from motor 1 only; all other motors in the daisy chain ignore the command. However, a global command, like 0RPA, reports the positions from *all* motors. For more details on addressing and daisy chaining, see Daisy Chaining Multiple SmartMotors in the *SmartMotor™ Developer's Guide*.

Motor addresses are activated and stored as follows:

- For serial addresses:
 - These are stored in the SmartMotor's volatile memory, which means they are lost when motor power is turned off.
 - After setting the address, it goes into effect immediately (do not reboot or perform a system reset with the Z command; either of these actions will delete the addresses).
- For CAN addresses:
 - These are stored in the SmartMotor nonvolatile memory (NVRAM), which means they are retained when motor power is turned off.
 - After setting the address, it doesn't go into effect until the system is restarted or reset.
 - The CAN address of a motor is different than the serial address (because they are communicating on different networks). However, for ease of use, you can "store" the serial address in the CAN address by entering the command:

CADDR=ADDR

Then, whenever you reset the system (either with the Z command or turning the power off and back on), you can recall the serial addresses of the motors from the stored CAN addresses, by entering the command:

0ADDR=CADDR

Because the CAN address is permanently stored and doesn't change on power off or reset, this allows you to easily restore specific serial addresses. This method also works for DeviceNet, PROFIBUS and other industrial networks.

When addressing the motors, you can address serial and CAN in the same command, which means you can use the serial network to communicate with the CAN bus. The leading number is the serial address; the number following the colon character is the CAN address. Consider this example:

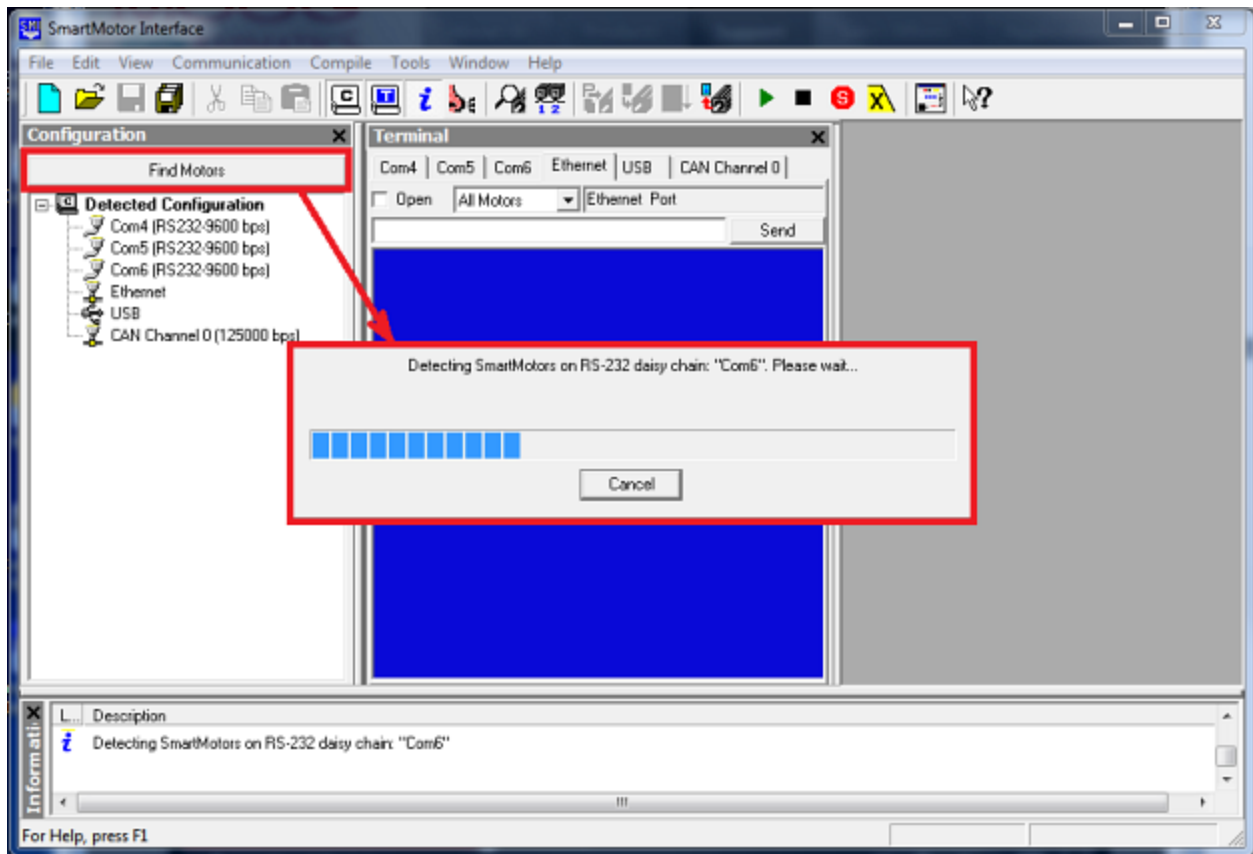
1RPA:2

The leading "1" is addressing the serial network motor 1; the ":2" is addressing the CAN network motor 2. In this example, the command is going out on the serial network to motor 1, then out the CAN port to motor 2, reading motor 2 position info, and then echoing it back to the host from CAN to motor 1 and then serial to host.

Using the Find Motors Button

The easiest way to locate any connected SmartMotor is to use the Find Motors button (see the following figure). This method searches every communications port (serial, USB, Ethernet, etc.) on the PC. If you don't know which port your motor is connected to, this method is the most thorough way to search. However, if you have many ports, this method can also take a long time.

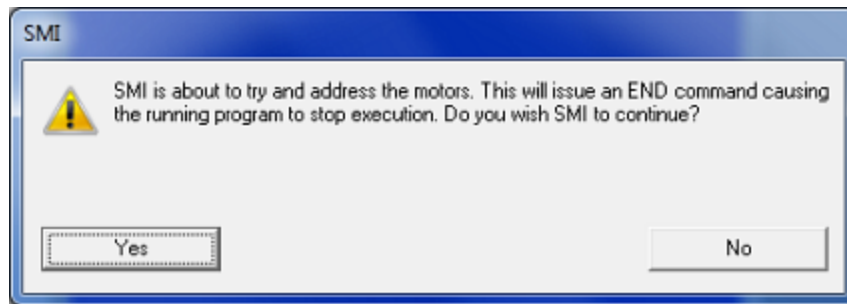
To begin searching for motors across all ports on the PC, in the Configuration window of the SMI software interface, click Find Motors. The SMI software begins searching for all SmartMotors connected to the PC.



Find Motors Detecting SmartMotors on the RS-232 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.



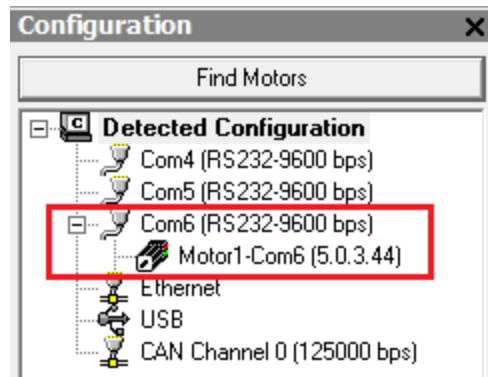
Address the Motors Prompt

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.

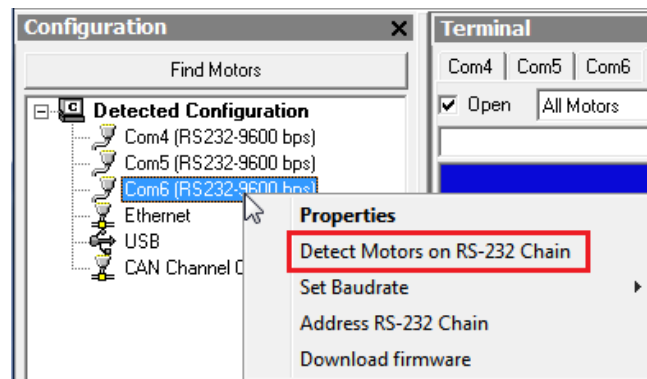


Configuration Window Showing Found/Addressed SmartMotor

Using the Detect Motors Feature

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.

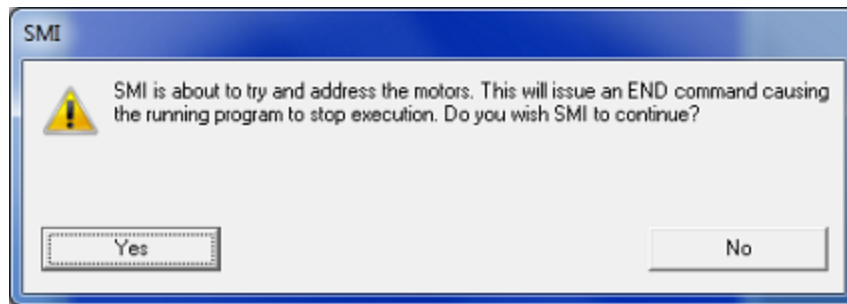


Selecting the Detect Motors Feature

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.



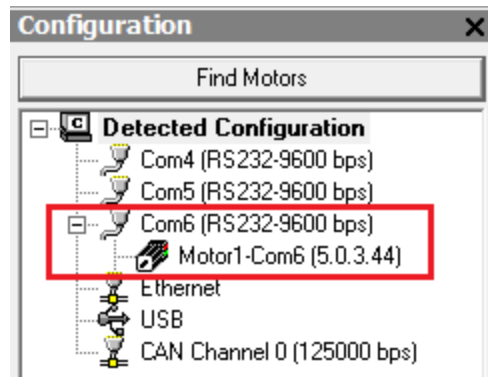
Address the Motors Prompt

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.



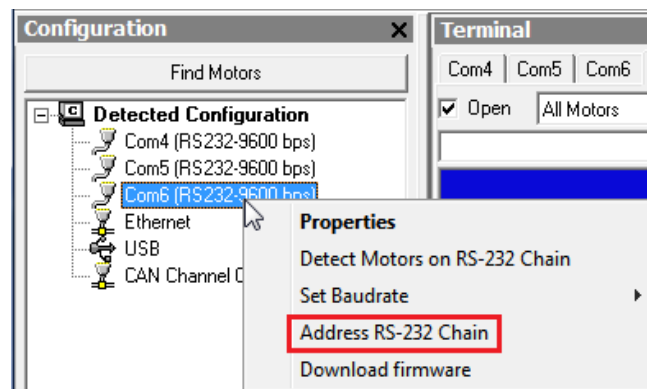
Configuration Window Showing Found/Addressed SmartMotor

Using the Address Motors Feature

This method assumes that there are motors connected to the specified port and will simply address each one that it finds.

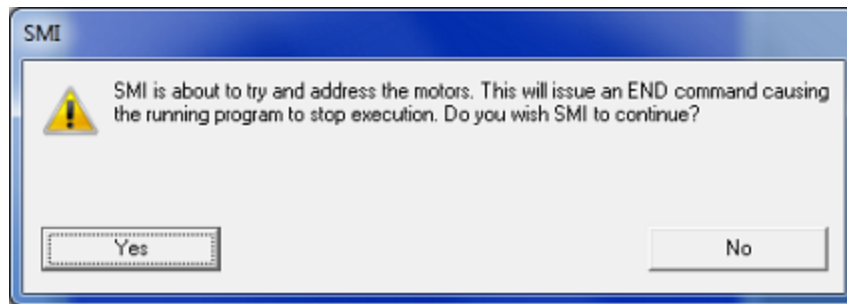
NOTE: This method will address (or re-address) every motor. If you pre-addressed your motors before connecting them, those motor addresses could be changed by this process.

To use the Address Motors feature, in the Configuration window of the SMI software, right-click the desired communications port and select Address RS-232 Chain from the menu.



Selecting the Detect Motors Feature

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



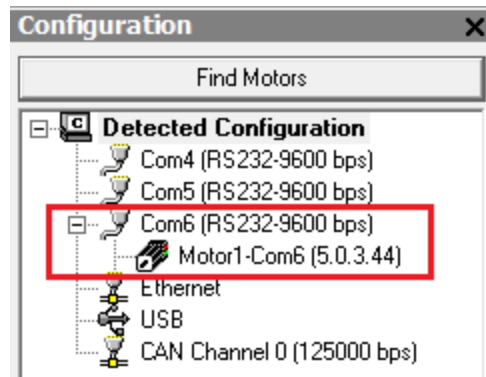
Address the Motors Prompt

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.

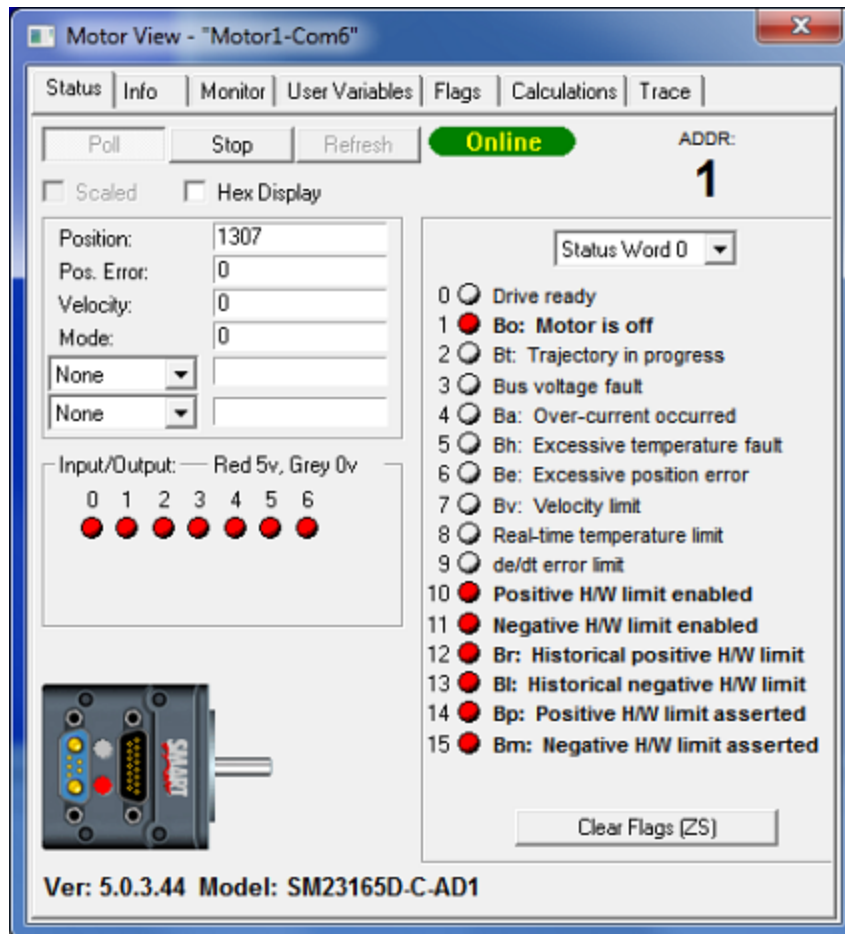
This procedure assumes that:

- The SmartMotor is connected to the computer. For details, see Connecting the System on page 36.
- The SmartMotor is connected to a power source. (M-style motors require separate control and drive power.) For details, see Understanding the Power Requirements on page 33 and Connecting the System on page 36.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 29.
- The SmartMotor has been detected and addressed. For details, see Detecting and Addressing the SmartMotors on page 48.

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).

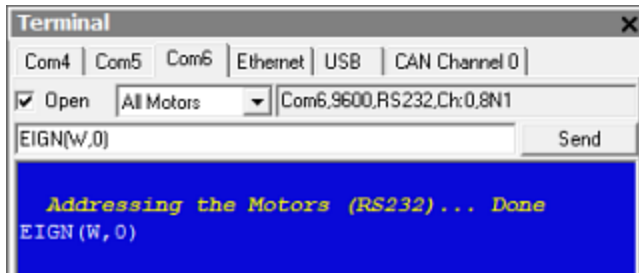
The EIGN() command is used to clear these status bits as described in the next section. EIGN stands for: Enable Inputs as General Use. In the case of EIGN(W,0), the W means a "word" or 16 bits of I/O; the 0 means first word or local I/O. There are only seven local I/O on the D-style motors. Therefore,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

Clearing the Overtravel Limits and Fault Bits

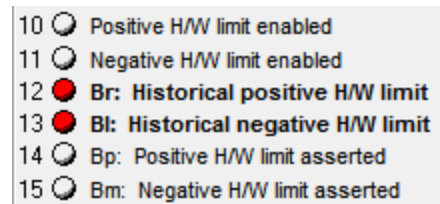
To disable (clear) the overtravel limits, enter EIGN(2) and EIGN(3) in the SMI software Terminal window. This sets I/O 2 (positive overtravel limit) and I/O 3 (negative overtravel limit) as general inputs/outputs instead of being used as travel limits. To set all status bits in Word 0 as general inputs/outputs,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

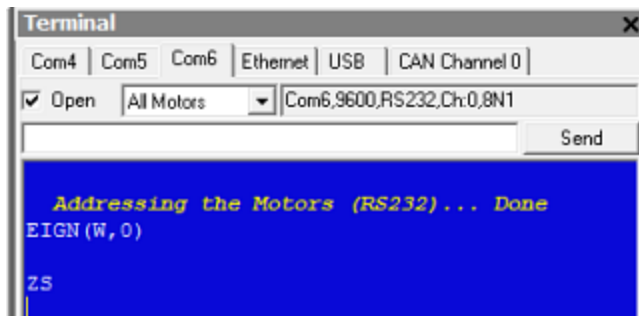


EIGN Command Entered

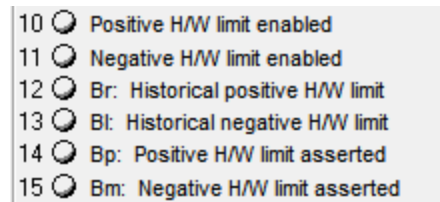


Active and Asserted Bits Cleared

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 36.
- The SmartMotor is connected to a power source. (M-style motors require separate control and drive power.) For details, see Understanding the Power Requirements on page 33 and Connecting the System on page 36.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 29.
- The SmartMotor has been detected and addressed. For details, see Detecting and Addressing the SmartMotors on page 48.
- The Drive Enable input on the M-series motor must be connected and activated with 24V. For the input location, see M-Style Motors: Connectors and Pinouts on page 44.
- The overtravel limits and fault bits have been cleared. For details, see Checking and Clearing the Status Bits on page 56.

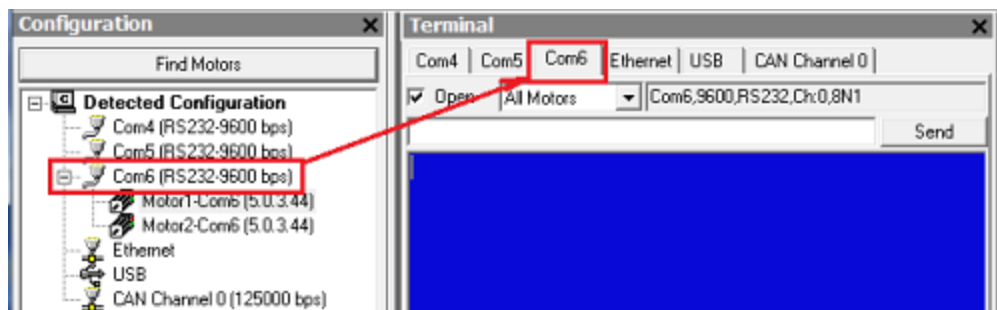
Making the Motor Move



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 9).

To make the SmartMotor move:

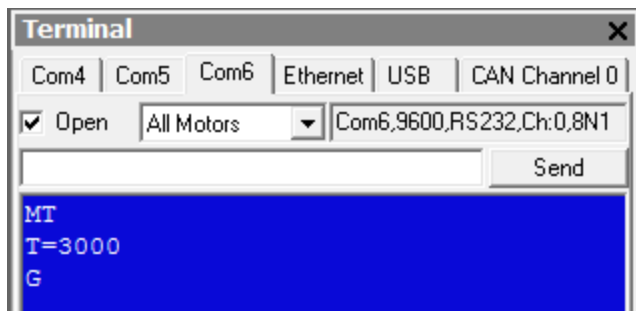
1. In the Terminal window, select the tab that matches the communications channel to which your motors are connected. To do this, look at the Configuration window, find the channel where the motors are listed and click that tab name in the Terminal window.



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 64 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 8000; you can view the current sample rate with the RSAMP command.

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 36.
- The SmartMotor is connected to a power source. (M-style motors require separate control and drive power.) For details, see Understanding the Power Requirements on page 33 and Connecting the System on page 36.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 29.
- The SmartMotor has been detected and addressed. For details, see Detecting and Addressing the SmartMotors on page 48.
- The overtravel limits and fault bits have been cleared. For details, see Checking and Clearing the Status Bits on page 56.

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
```

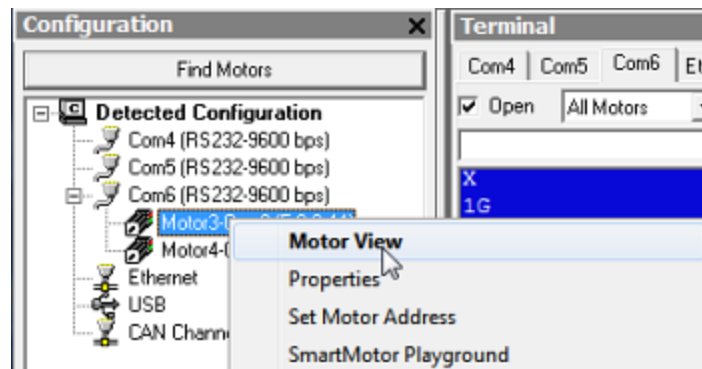
NOTE: The position is reported on the same line as the command; there is no line feed or carriage return for "report" commands.

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

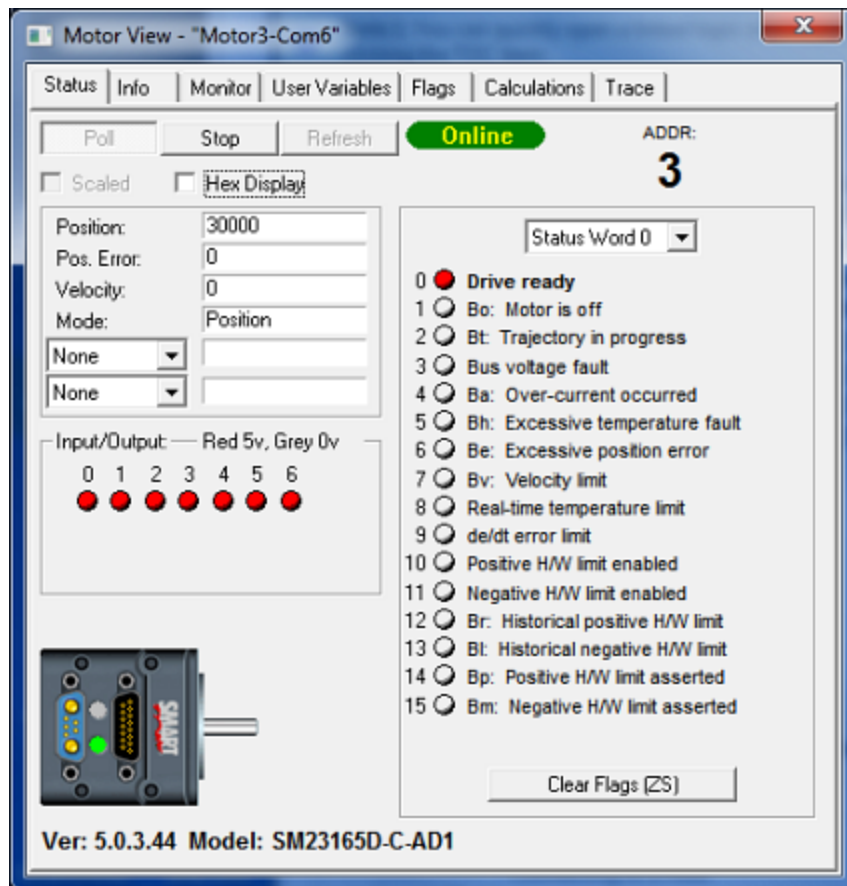
The Motor View tool provides another way to view the motor position. The advantage of using this tool is that the position is dynamically updated when the motor is moving.

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

For Further Information...

Now that your SmartMotor is installed and operating, the next step is to learn about its features, commands and programming in order to create a useful application.

Information on SMI software features, SmartMotor programming, communications, motion control and more is provided in the *SmartMotor™ Developer's Guide*. That guide also includes a complete SmartMotor command reference, and an Appendix of other related topics that are useful during application development.

Troubleshooting

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

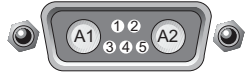
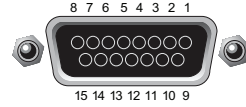
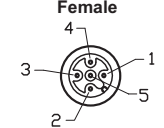
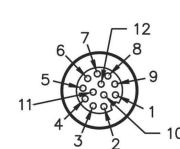
<http://www.animatics.com/support.html>

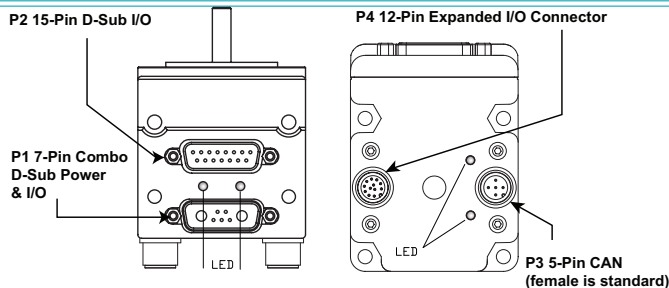
Issue	Cause	Solution
Communication and Control Issues		
Motor control power light does not illuminate.	Control power is off, disconnected or incorrectly wired.	Check that control power is connected to the proper pins and turned on. For connection details, see Connecting the System on page 36.
	Motor 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 is equipped with the DE option.	To energize control power, apply 24-48 VDC to pin 15 and ground to pin 14.
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.

Issue	Cause	Solution
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 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 5 D-Style Connector Pinouts

The following table shows the pinouts for the connectors on the Class 5 D-style SmartMotors.

PIN	MAIN POWER	Specifications:	Notes:	P1
1	I/O – 6 GP, Index Input or “G” Command	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	Redundant connection on I/O connector	7W2 Combo D-Sub Connector 
2	+5 VDC Out	50 mAmps Max (total)		
3	RS-232 Transmit	Com ch. 0	115.2 Kbaud Max	
4	RS-232 Receive	Com ch. 0	115.2 Kbaud Max	
5	SIG Ground			
A1	Main Power: +20-48VDC			
A2	Ground			
PIN	I/O CONNECTOR (5V TTL I/O)	Specifications:	Notes:	P2
1	I/O – 0 GP or Encoder A or Step Input	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	1.5 MHz Max as Encoder or Step Input	P2 DB-15 D-Sub Connector 
2	I/O – 1 GP or Encoder B or Direction Input	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	1.5 MHz Max as Encoder or Direction Input	
3	I/O – 2 Positive Over Travel or GP	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D		
4	I/O – 3 Negative Over Travel or GP	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D		
5	I/O – 4 GP, IIC or RS-485 A (Com ch. 1)	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	115.2 Kbaud Max	
6	I/O – 5 GP, IIC or RS-485 B (Com ch.1)	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	115.2 Kbaud Max	
7	I/O – 6 GP, Index Input or “G” Command	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	Redundant connection on Main Power Connector	
8	Phase A Encoder Output			
9	Phase B Encoder Output			
10	RS-232 Transmit	Com ch. 0	115.2 Kbaud Max	
11	RS-232 Receive	Com ch. 0	115.2 Kbaud Max	
12	+5 VDC Out	50 mAmp Max (total)		
13	SIG Ground			
14	Ground			
15	Main Power: +20-48 VDC	If DE Option, Control Power separate from Main Power		
PIN	CAN bus	Connection:	Notes:	P3
1	NC	NC		M12 5-Pin Female 
2	+V	NC except DeviceNet	Input current < 10 mA	
3	-V (ground)	Common Ground	Isolated	
4	CAN-H	1 Mbaud Max		
5	CAN-L	1 Mbaud Max		
PIN	Isolated 24 VDC I/O Connector	Max Load (sourcing)		P4
1	I/O – 16 GP	150 mAmps		M12 12-Pin Female End View 
2	I/O – 17 GP	150 mAmps		
3	I/O – 18 GP	150 mAmps		
4	I/O – 19 GP	150 mAmps		
5	I/O – 20 GP	300 mAmps		
6	I/O – 21 GP	300 mAmps		
7	I/O – 22 GP	300 mAmps		
8	I/O – 23 GP	300 mAmps		
9	I/O – 24 GP	300 mAmps		
10	I/O – 25 GP	300 mAmps		
11	+24 Volts Input	18-32 VDC		
12	GND-I/O			

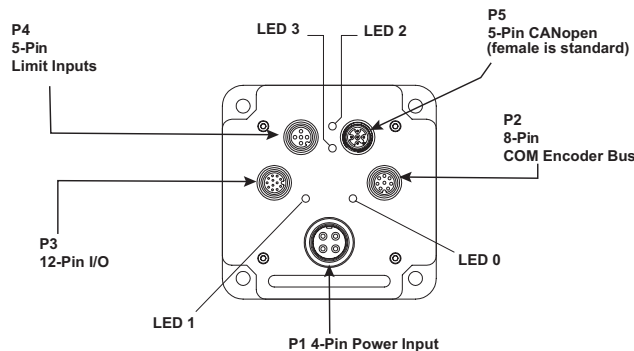


CAUTION: Pins 14 and 15 are intended for use with DE series motors for control power only. Attempting to power a non-DE motor through those pins, as main servo-drive power, may result in immediate damage to the electronics, which will void the warranty.

Class 5 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	+12.5V Min, 32V Max	Also supplies I/O	
2	Chassis			
3	Control, Com, I/O and Amplifier Ground	Common Ground	Unisolated	
4	Amplifier Power In	+12.5V Min, 48V Max	Powers Amplifier Only	
PIN	Communications Connector	Specifications:	Notes:	P2
1	Control, Com, I/O and Amp Ground	Common Ground	Unisolated	
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	I/O – 0 GP	150 mAmps Max		
2	I/O – 1 GP	150 mAmps Max		
3	I/O – 4 GP	150 mAmps Max		
4	I/O – 5 GP or Index	150 mAmps Max		
5	I/O – 6 GP or "G" Command	150 mAmps Max		
6	I/O – 7 GP	150 mAmps Max		
7	I/O – 8 GP or Brake Line Output	300 mAmps Max		
8	I/O – 9 GP	300 mAmps Max		
9	Not Fault Out	150 mAmps Max		
10	Drive Enable Input	150 mAmps Max		
11	+24 Volts Out	12.5V Min, 28V Max		
12	Ground Common	Common Ground	Unisolated	
PIN	24V I/O Connector	Specifications:	Notes:	P4
1	+24 Volts Out		From Control Pwr In	
2	I/O – 3 GP -Limit	150 mAmps Max	Configurable	
3	Ground	Common Ground	Unisolated	
4	I/O – 2 GP +Limit	150 mAmps Max	Configurable	
5	I/O – 10 GP	150 mAmps Max	Configurable	
PIN	CAN Connector	Specifications:	Notes:	P5
1	NC	NC		
2	+V	NC except DeviceNet	Input current < 10 mA	
3	-V (ground)	Common Ground	Unisolated	
4	CAN-H	1 Mbaud Max		
5	CAN-L	1 Mbaud Max		



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.

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Rev. A