

INSTALLATION AND STARTUP FOR

FULLY INTEGRATED SERVO MOTORS

CLASS 5 SMARTMOTOR™ WITH
COMBITRONIC™ TECHNOLOGY



Rev. L, March 2023

DESCRIBES THE INSTALLATION AND
STARTUP OF THE CLASS 5 D- AND
M-STYLE SMARTMOTORS

www.animatics.com

MOOG
 **ANIMATICS**

Copyright Notice

©2001-2023 Moog Inc.

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

This manual, as well as the software described in it, is furnished under license and may be used or copied only in accordance with the terms of such license. The content of this manual is furnished for informational use only, is subject to change without notice and should not be construed as a commitment by Moog Inc., Animatics. Moog Inc., Animatics assumes no responsibility or liability for any errors or inaccuracies that may appear herein.

Except as permitted by such license, no part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, recording, or otherwise, without the prior written permission of Moog Inc., Animatics.

The programs and code samples in this manual are provided for example purposes only. It is the user's responsibility to decide if a particular code sample or program applies to the application being developed and to adjust the values to fit that application.

Moog Animatics and the Moog Animatics logo, SmartMotor and the SmartMotor logo, Combitronic and the Combitronic logo are all trademarks of Moog Inc., Animatics. Other trademarks are the property of their respective owners.

Please let us know if you find any errors or omissions in this manual so that we can improve it for future readers. Such notifications should contain the words "Class 5 Installation and Startup Guide" in the subject line and be sent by e-mail to: animatics_marcom@moog.com. Thank you in advance for your contribution.

Contact Us:

Americas - West

Moog Animatics
2581 Leghorn Street
Mountain View, CA 94043
USA
Tel: 1 650-960-4215

Americas - East

Moog Animatics
1995 NC Hwy 141
Murphy, NC 28906
USA

Support: 1 (888) 356-0357

Website: www.animatics.com

Email: animatics_sales@moog.com

Table Of Contents

Introduction	6
Purpose	7
Combitronic Technology	7
I/O Device CAN Bus Controller	7
Safety Information	8
Safety Symbols	8
Other Safety Considerations	8
Motor Sizing	8
Environmental Considerations	8
Machine Safety	9
Documentation and Training	9
Additional Equipment and Considerations	10
Safety Information Resources	10
Additional Documents	11
Related Guides	11
Other Documents	11
Additional Resources	11
SmartMotor Overview	13
SmartMotor Introduction	14
SmartMotor Features and Options	15
D-Style Motors	15
M-Style Motors	16
Fieldbus Options	17
CANopen Fieldbus Protocol	18
DeviceNet Fieldbus Protocol	18
PROFIBUS Fieldbus Protocol	19
DE Option (D-Style Motors)	20
IP65 and IP67 M-Style Motors	21
SmartMotor Theory of Operation	22
Getting Started	24
Unpacking and Verifying Your Shipment	26
Installing the SMI Software	26
Installation Procedure	26
Installation Verification	29

Accessing the SMI Software Interface	29
Understanding the Power Requirements	31
SmartMotor Power Requirements	31
D-style CPU, I/O and Communications Power	32
CPU Power Requirements	32
I/O Power Requirements	32
Communications Power Requirements	32
M-Style CPU, I/O and Communications Power	32
CPU Power Requirements	32
I/O Power Requirements	32
Communications Power Requirements	33
M-Style Drive Enable Power	33
Connecting the System	33
Minimum Requirements	33
D-Style Motors: Connectors and Pinouts	35
D-Style Connections At A Glance	35
D-Style Motors: Demo or Development System	36
D-Style Motors: RS-232 Through USB	37
Adding a USB to Serial Adapter	37
D-Style Motors: RS-232 with Protective Shunt	37
D-Style Motors: RS-232 Multidrop with Add-A-Motor Cables	38
DE Option	38
D-Style Motors: CDS Option Schematic	39
CDS on the DA-15 Connector	39
CDS on the 7W2 Connector (CDS7)	40
M-Style Motors: Connectors and Pinouts	44
M-Style Connections At A Glance	44
M-Style Motors: Power, RS-485 Com and CAN Multidrop	45
M-Style Motors: Power Multidrop	45
M-Style Motors: RS-232 to RS-485 Multidrop	46
M-Style Motors: CANopen or DeviceNet Multidrop	47
Understanding the Status LEDs	48
Detecting and Addressing the SmartMotors	49
Understanding the Detection and Addressing Options	49
Using the Find Motors Button	51
Using the Detect Motors Feature	53
Using the Address Motors Feature	55
Checking and Clearing the Status Bits	57

Polling the Motor	58
Clearing the Overtravel Limits and Fault Bits	59
Moving the SmartMotor	60
Making the Motor Move	60
Setting and Reporting Torque	61
Checking the Motor Position	62
Viewing the Motor Position with a Report Command	62
Viewing the Motor Position with the Motor View Tool	62
Connectors, Pinouts and Examples	65
Class 5 D-Style Connector Pinouts	66
Class 5 D-Style I/O Connection Examples	67
Class 5 M-Style Connector Pinouts	69
Class 5 M-Style I/O Connection Examples	70
Troubleshooting	73
For Further Information...	74

Introduction

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

Purpose	7
Combitronic Technology	7
I/O Device CAN Bus Controller	7
Safety Information	8
Safety Symbols	8
Other Safety Considerations	8
Motor Sizing	8
Environmental Considerations	8
Machine Safety	9
Documentation and Training	9
Additional Equipment and Considerations	10
Safety Information Resources	10
Additional Documents	11
Related Guides	11
Other Documents	11
Additional Resources	11

Purpose

The *Class 5 SmartMotor™ Installation and Startup Guide* (the document you are currently reading) 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.

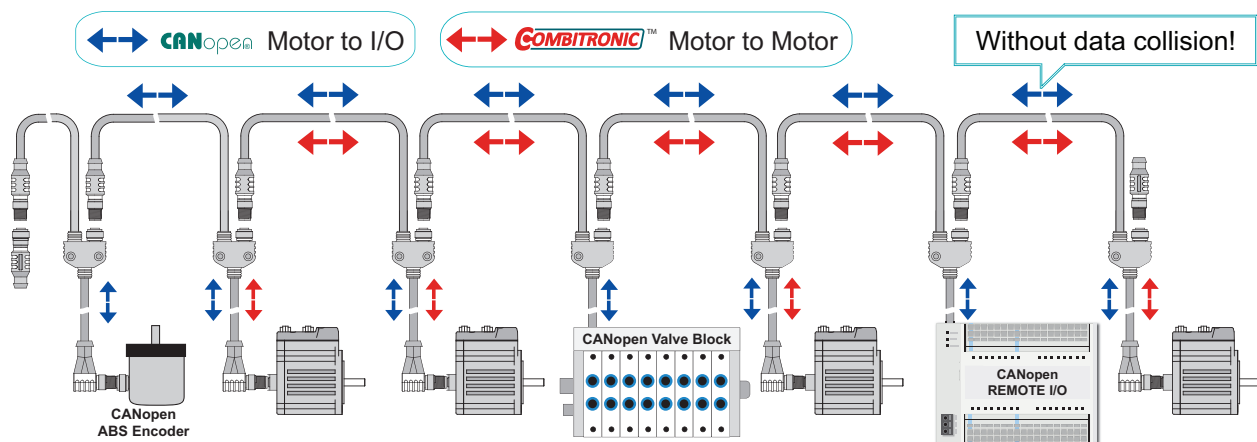
Combitronic Technology

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 the CANopen or DeviceNet protocols. It requires no single dedicated controller¹ 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*.

I/O Device CAN Bus Controller

Expanded I/O capability allows the SmartMotor to interface with standard CiA 301 CANopen devices and function as the I/O device CAN bus controller (i.e., no external bus controller is needed). For more details, see the *SmartMotor™ Developer's Guide*. For CANopen object descriptions, see the *SmartMotor™ CANopen Guide*.



Be sure to comply with the guidelines for CAN bus cabling and termination.

SmartMotor as I/O Device CAN Bus Controller

¹Moog Animatics has replaced the terms "master" and "slave" with "controller" and "follower", respectively.

Safety Information

This section describes the safety symbols and other safety information.

Safety Symbols

The manual may use one or more of these safety symbols:



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



CAUTION: This symbol indicates a potentially minor hazard, where failure to comply with 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, this 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 site 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 *System Best Practices* document, which is available on the Moog Animatics website, contains information and equations that can be used for selecting the appropriate motor for the application.

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

Environmental Considerations

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

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 site 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 next 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 site 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 topic "Controls - Notes and Cautions" located at:

<https://www.animatics.com/support/downloads/knowledgebase/controls---notes-and-cautions.html>

OSHA standards information can be found at:

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

ANSI-RIA robotic safety information can be found at:

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

UL standards information can be found at:

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

ISO standards information can be found at:

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

EU standards information can be found at:

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

Additional Documents

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

Related Guides

- Moog Animatics SmartMotor™ Installation and Startup Guides
<http://www.animatics.com/install-guides>
- *SmartMotor™ Developer's Guide*
<http://www.animatics.com/smartmotor-developers-guide>
- *SmartMotor™ Homing Procedures and Methods Application Note*
<http://www.animatics.com/homing-application-note>
- *SmartMotor™ System Best Practices Application Note*
<http://www.animatics.com/system-best-practices-application-note>

In addition to the documents listed above, guides for fieldbus protocols and more can be found on the website: <https://www.animatics.com/support/downloads/manuals.html>

Other Documents

- SmartMotor™ Certifications
<https://www.animatics.com/certifications.html>
- *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)
<https://www.animatics.com/support/downloads/knowledgebase.html>
- *Moog Animatics Product Catalog*
<http://www.animatics.com/support/moog-animatics-catalog.html>

Additional Resources

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

- General company information:
<http://www.animatics.com>

- Product information:
<http://www.animatics.com/products.html>
- Product support (Downloads, How-to Videos, Forums and more):
<http://www.animatics.com/support.html>
- Contact information, distributor locator tool, inquiries:
<https://www.animatics.com/contact-us.html>
- Applications (Application Notes and Case Studies):
<http://www.animatics.com/applications.html>

SmartMotor Overview

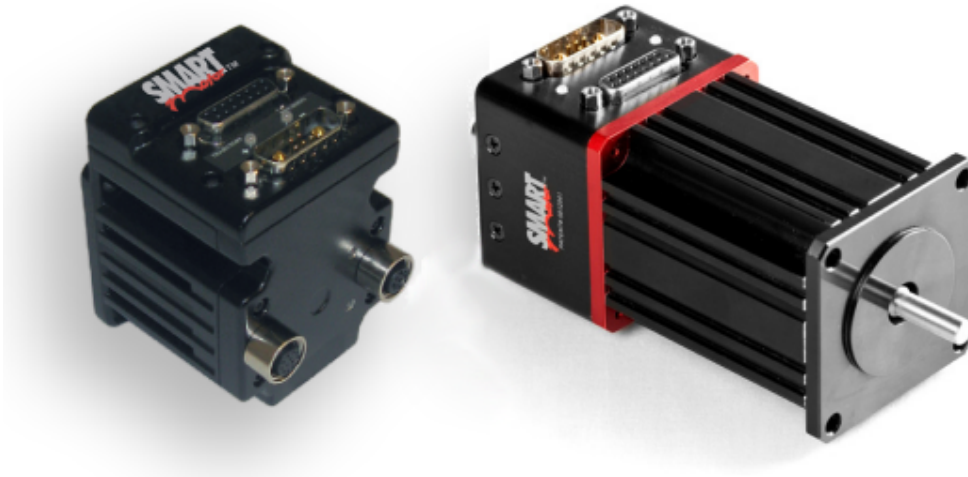
This chapter provides an overview of the design philosophy and functionality of the Moog Animatics SmartMotor. It also provides information on SmartMotor features and options, and where to find related documents and additional resources.

SmartMotor Introduction	14
SmartMotor Features and Options	15
D-Style Motors	15
M-Style Motors	16
Fieldbus Options	17
CANopen Fieldbus Protocol	18
DeviceNet Fieldbus Protocol	18
PROFIBUS Fieldbus Protocol	19
DE Option (D-Style Motors)	20
IP65 and IP67 M-Style Motors	21
SmartMotor Theory of Operation	22

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 these objectives:

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



Class 5 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

NOTE: All specifications are subject to change without notice. Consult the factory for the latest information.

The Class 5 SmartMotor is available in D-style and M-style configurations. All SmartMotors offer these 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. Add onto gearing for complex traverse and take-up winding patterns.
- Stand-alone, multi-axis linear interpolation with as many as 120 SmartMotors at a time
- Virtual-axis control into camming through gearing, which enables stand-alone, multi-axis coordinated motion
- Programmable and non-programmable protection features (both hardware and software)

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

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 to the Understanding SmartMotor Part Numbers document at this address:

<https://www.animatics.com/support/downloads.knowledgebase.html>

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

These industrial (Fieldbus protocol) communications options are available on the D-style motors. (Availability varies by model number; contact the factory for details.)

- CANopen option
- PROFIBUS option

- DeviceNet option

For more details, see Fieldbus Options on page 17.

All firmware options include:

- Modbus Remote Terminal Unit (RTU) Follower (RS-485 COM 1)
- DMX Follower (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 Option (D-Style Motors) on page 20.

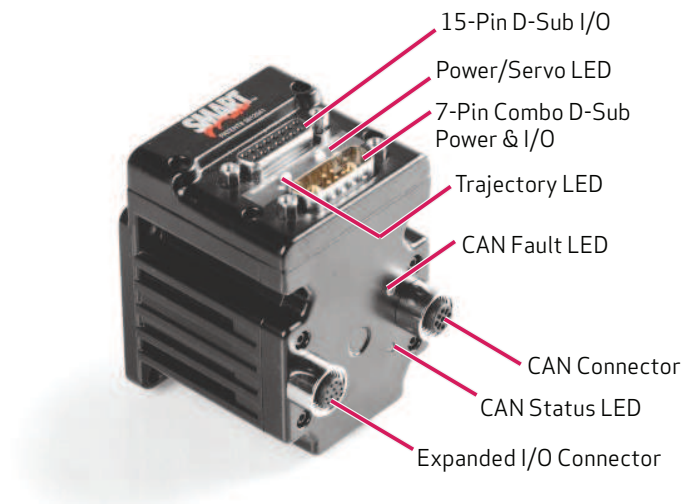


CAUTION: For D-style SmartMotors, pins 14 and 15 of the 15-pin D-sub port are intended for use with DE series motors for control power only. Attempts to power a non-DE motor through those pins as main servo drive power could result in immediate damage to the electronics and will void the warranty.

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

- NEMA 17
- NEMA 23
- NEMA 34

The next 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 35. For details on the LED functions, see Understanding the Status LEDs on page 48.



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

These 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:

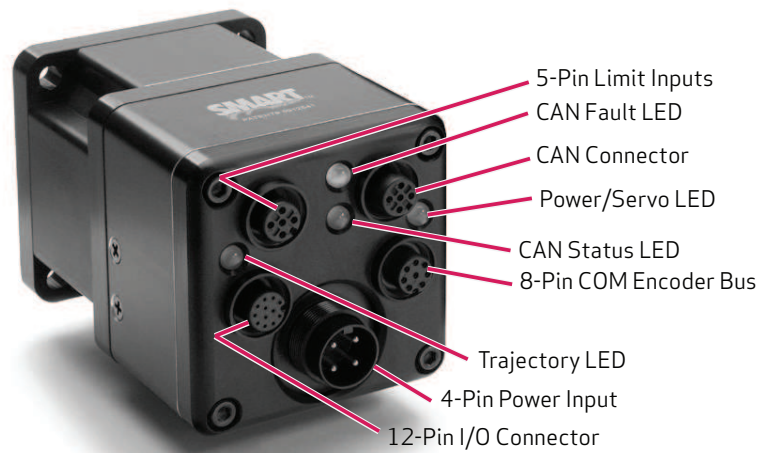
- Modbus Remote Terminal Unit (RTU) Follower (RS-485 COM 0)
- DMX Follower (RS-485 COM 0)

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 17 and DE Option (D-Style Motors) on page 20.

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

- NEMA 23
- NEMA 34

The next 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 48.



M-Style Motor Connectors and LEDs

Fieldbus Options

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

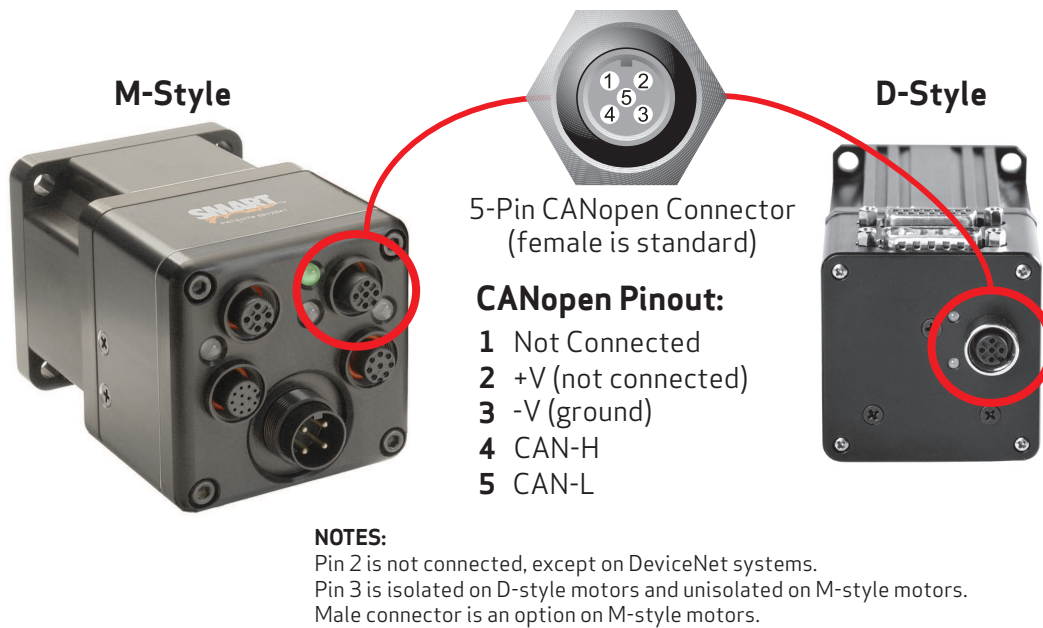
CANopen Fieldbus Protocol

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

The CANopen fieldbus protocol provides these features:

- Basic motion commands available through the CiA V4.02 specification
- Ability to read/write SmartMotor variables
- Use of onboard I/O through CANopen, SmartMotor programs or serial commands
- Ability to run 1000 SmartMotor subroutines through CANopen
- Online diagnostics of the SmartMotor through SMI software and serial connection
- Logical addressing for 127 nodes
- User program status/interrupts can be triggered by receive PDOs
- Baud rates of 20 Kbps, 50 Kbps, 125 Kbps (default), 250 Kbps, 500 Kbps and 1 Mbps
- Expanded I/O capability allows the SmartMotor to interface with standard CiA 301 CANopen devices and function as the I/O device CAN bus controller (i.e., no external bus controller is needed). For more details, see the *SmartMotor™ Developer's Guide*. For CANopen object descriptions, see the *SmartMotor™ CANopen Guide*.

The next 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 33

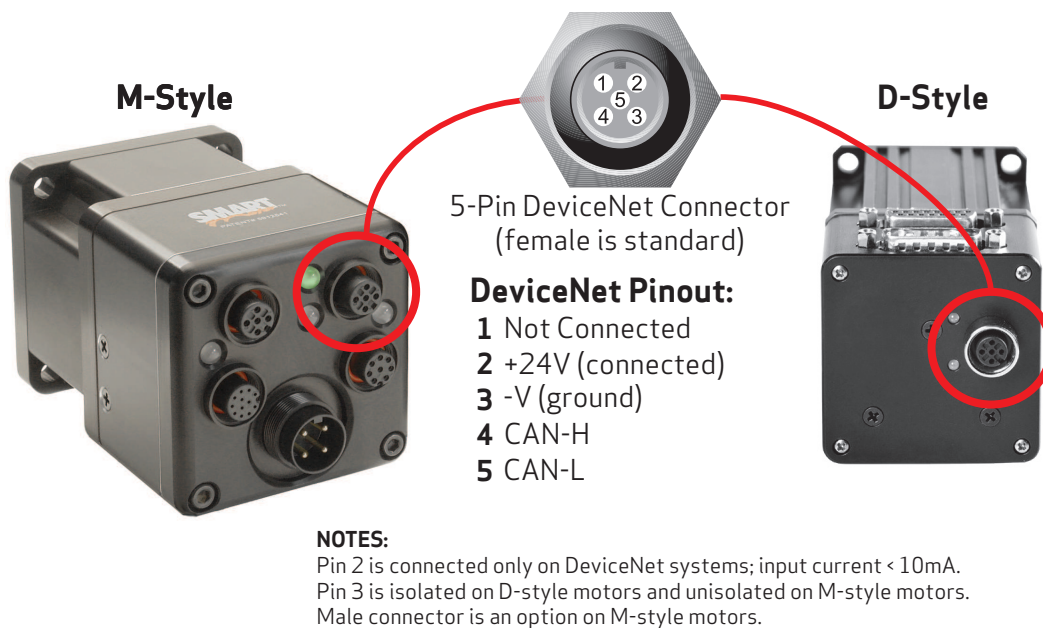
DeviceNet Fieldbus Protocol

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

The DeviceNet Fieldbus protocol provides these 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 next 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 33

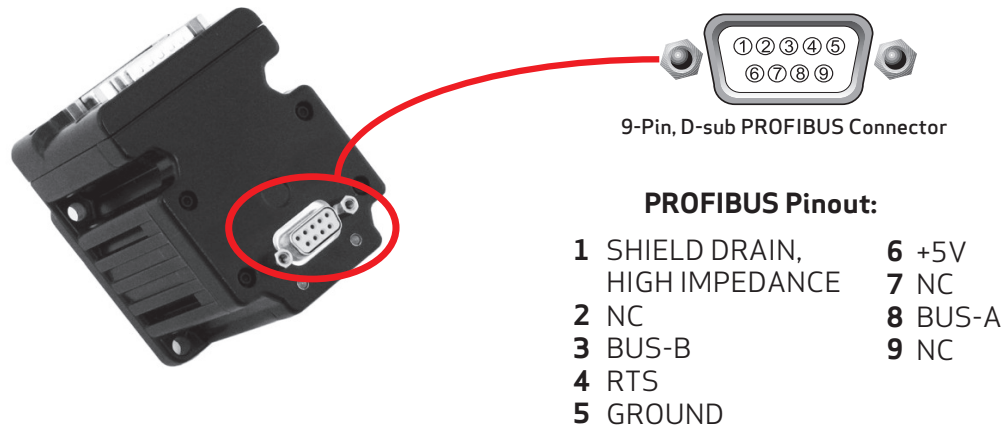
PROFIBUS Fieldbus Protocol

The PROFIBUS fieldbus protocol provides these 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 next 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

For more details, see the *Class 5 SmartMotor™ PROFIBUS Guide*.

DE Option (D-Style Motors)

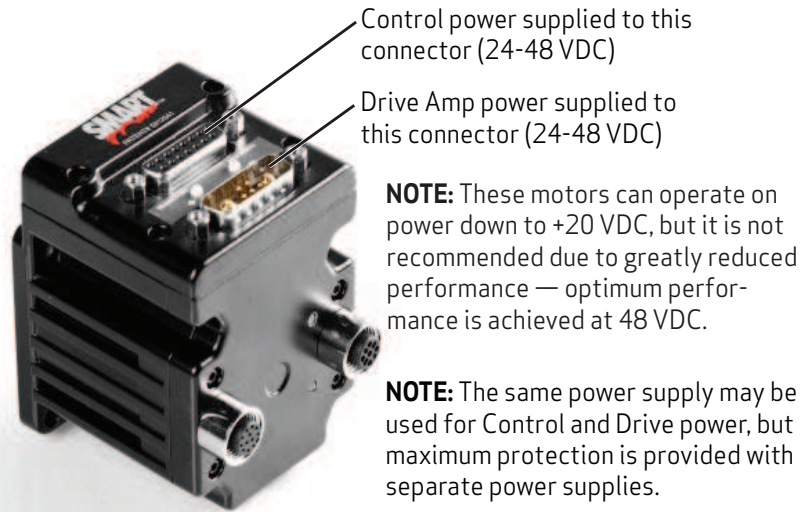
The D-style SmartMotor's hardware DE power option allows the controller and drive amplifier to be powered from separate DC power supplies (see the next figure). For a schematic diagram, see DE Option on page 38.

This option provides these advantages:

- Controller can be powered from a standard 24-48 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 SmartMotors are designed to allow the use of separate drive and control power supplies. No special ordering option is needed for those SmartMotors.

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



D-Style DE Power Option Drive and Control Power Connections

IP65 and IP67 M-Style Motors

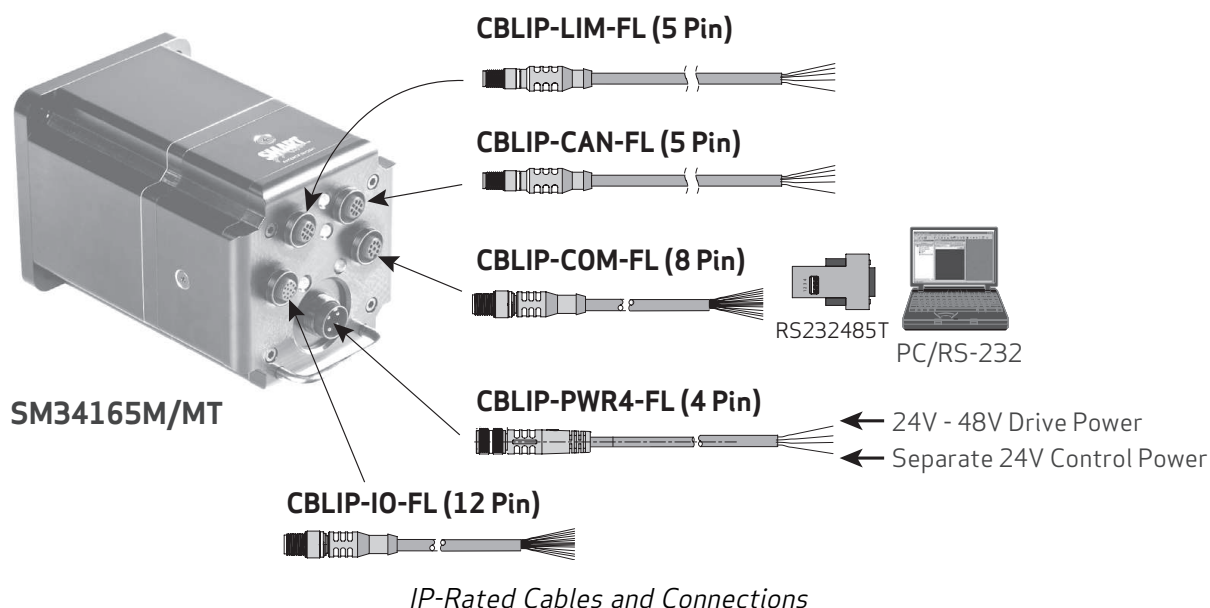
Certain models of M-style SmartMotors are available in IP-rated versions (see the *Moog Animatics Product Catalog* for details). The standard IP rating is IP65, which protects the motor from dust particles and splashing water. Additionally, certain motors can be ordered with the higher IP67 rating. Contact 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 after "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 (see CAUTION statement above), 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 next figure shows the cables, part numbers and corresponding connections.

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



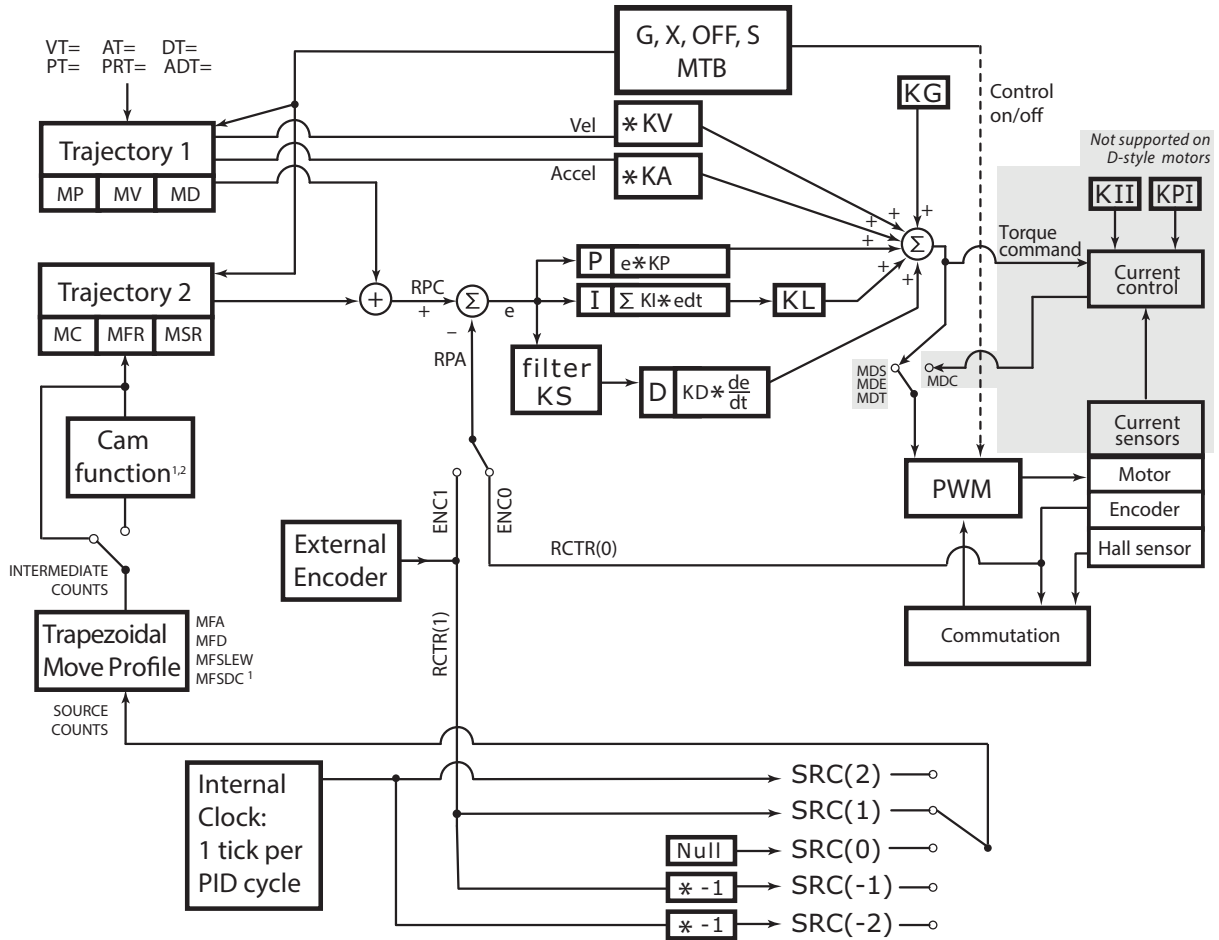
SmartMotor Theory of Operation

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, the two limit inputs are properly grounded or deactivated, and the Drive Enable input is satisfied (on M-style motors), 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 and 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 next 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 controller encoder counts selected by the SRC() command specifying internal virtual or external controller 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	26
Installing the SMI Software	26
Installation Procedure	26
Installation Verification	29
Accessing the SMI Software Interface	29
Understanding the Power Requirements	31
SmartMotor Power Requirements	31
D-style CPU, I/O and Communications Power	32
CPU Power Requirements	32
I/O Power Requirements	32
Communications Power Requirements	32
M-Style CPU, I/O and Communications Power	32
CPU Power Requirements	32
I/O Power Requirements	32
Communications Power Requirements	33
M-Style Drive Enable Power	33
Connecting the System	33
Minimum Requirements	33
D-Style Motors: Connectors and Pinouts	35
D-Style Connections At A Glance	35
D-Style Motors: Demo or Development System	36
D-Style Motors: RS-232 Through USB	37
Adding a USB to Serial Adapter	37
D-Style Motors: RS-232 with Protective Shunt	37
D-Style Motors: RS-232 Multidrop with Add-A-Motor Cables	38
DE Option	38
D-Style Motors: CDS Option Schematic	39
CDS on the DA-15 Connector	39
CDS on the 7W2 Connector (CDS7)	40
M-Style Motors: Connectors and Pinouts	44
M-Style Connections At A Glance	44
M-Style Motors: Power, RS-485 Com and CAN Multidrop	45
M-Style Motors: Power Multidrop	45

M-Style Motors: RS-232 to RS-485 Multidrop	46
M-Style Motors: CANopen or DeviceNet Multidrop	47
Understanding the Status LEDs	48
Detecting and Addressing the SmartMotors	49
Understanding the Detection and Addressing Options	49
Using the Find Motors Button	51
Using the Detect Motors Feature	53
Using the Address Motors Feature	55
Checking and Clearing the Status Bits	57
Polling the Motor	58
Clearing the Overtravel Limits and Fault Bits	59
Moving the SmartMotor	60
Making the Motor Move	60
Setting and Reporting Torque	61
Checking the Motor Position	62
Viewing the Motor Position with a Report Command	62
Viewing the Motor Position with the Motor View Tool	62

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:

- 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.
- Keep all boxes and packing materials. These may be needed for future storage or shipment of the equipment.

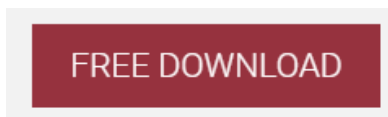
Installing the SMI Software

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 or USB stick, and is also available as a download from the Moog Animatics website. To download the latest version of the SMI software, use this address:

<http://www.animatics.com/smi>

Then scroll to the bottom of the page and click the Free Download button.



SMI Download Button

The installation package is downloaded to your system.

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

Installation Procedure

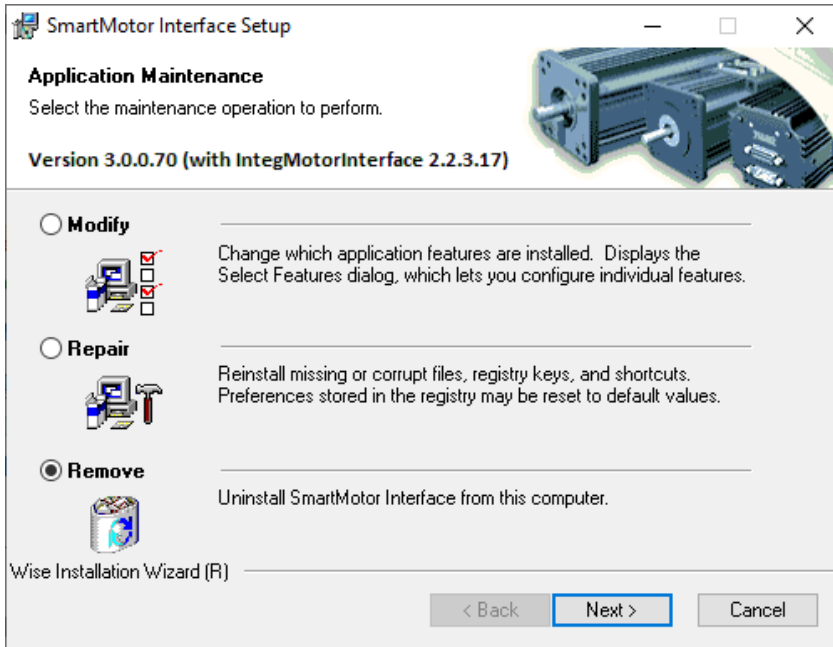
NOTE: Depending on the SMI software version and SmartMotor model being used, the software version and motor information may be different on your screens.

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.

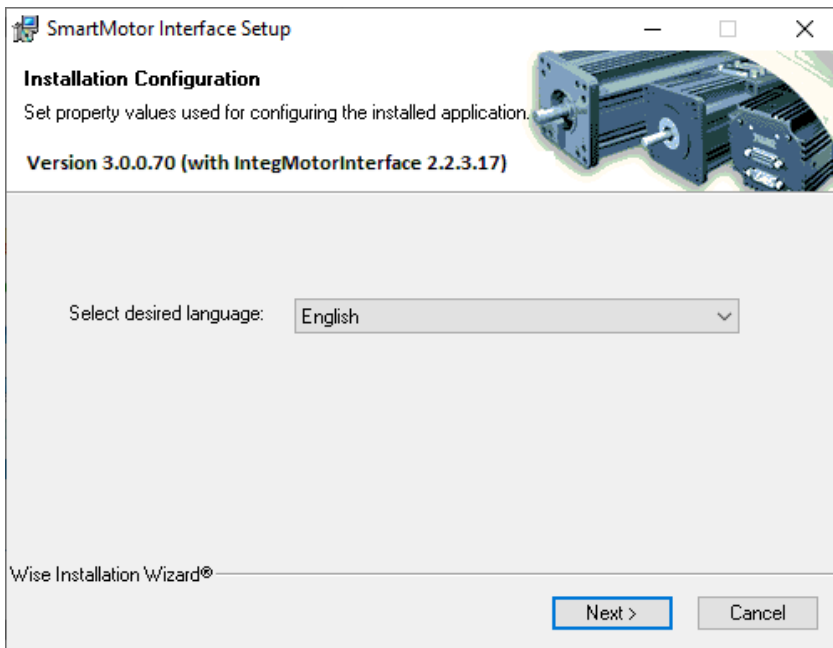
If this is an upgrade to a previous installation, you will see the window below. Select Remove, click Next and remove the existing software from your PC using the instructions.



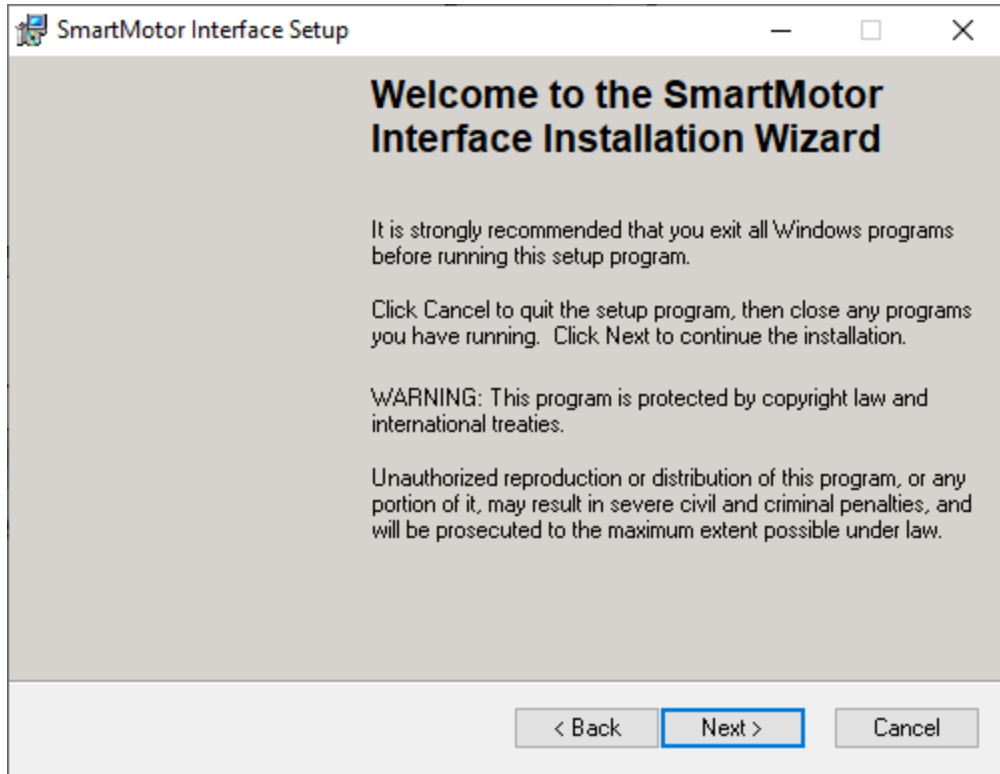
After removing the existing software, restart the installation process.

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

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

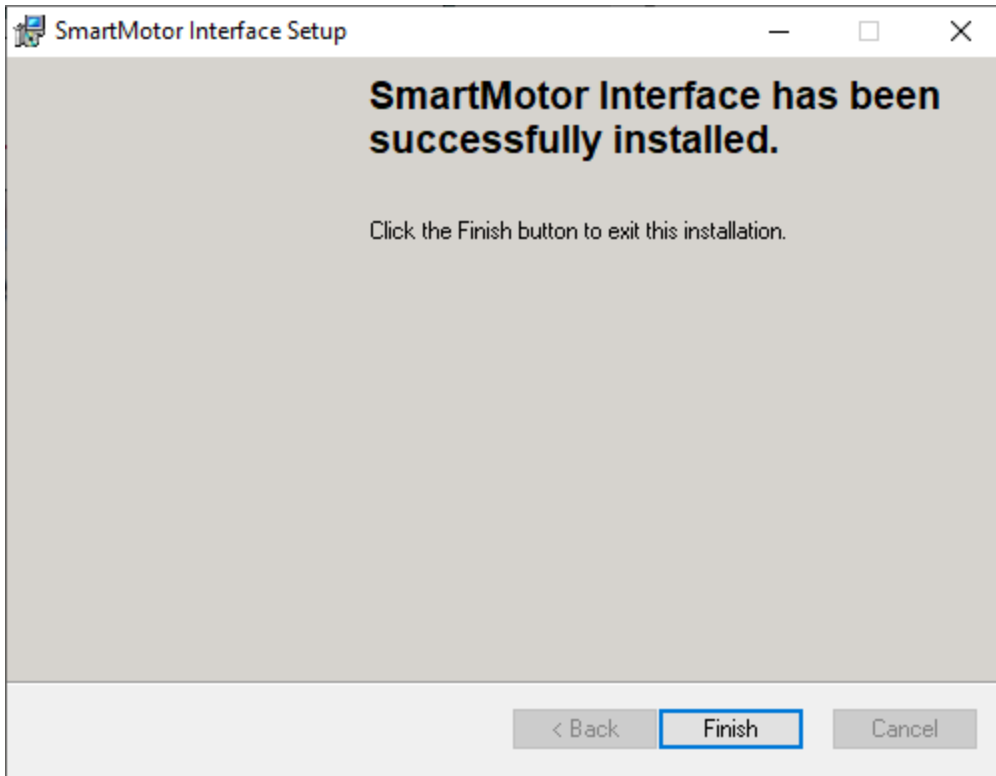


3. Click Next to proceed. The SMI software installation wizard starts and the Welcome page opens.



4. After you have finished reviewing the welcome information, click Next to proceed. Use the on-screen instructions to complete the SMI software installation.

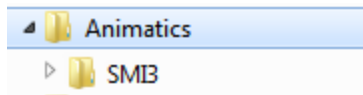
- When the installation has completed, the installation status message page opens, as shown in the next figure. Click Finish to complete the installation and close the installation wizard.



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:\Program Files (or folder C:\Program Files x86) folder. You should see these folders:



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.

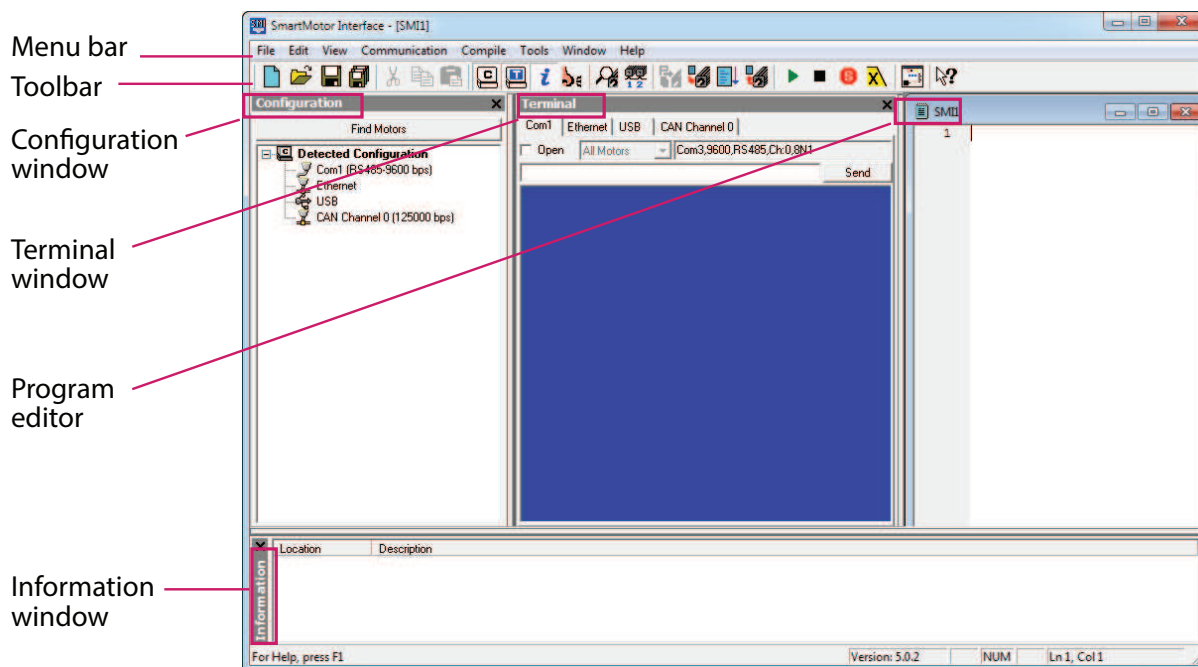


SmartMotor Interface Shortcut

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

Start > All Programs > Animatics > SMI3 > SmartMotor Interface

The SMI software interface opens, as shown in the next 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.

These 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 the SMI software online help, which can be viewed in SMI by pressing F1 or selecting Help > Contents - SMI Software Help.

Understanding the Power Requirements

This section describes the power requirements for SmartMotor power, CPU power, I/O power and Communications power. For individual pin specifications, refer to Class 5 D-Style Connector Pinouts on page 66, and Class 5 M-Style Connector Pinouts on page 69, for D-style and M-style, respectively.

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. Main power must be connected to a source capable of supplying the rated power of the motor.

NOTE: These motors can operate on power down to +20 VDC, but it is not recommended due to greatly reduced performance -- optimum performance is achieved at 48 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 VDC. They are not rated for 48 VDC.

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. Control power consumes much less current. The exact amount depends on I/O, communication and brake usage, but it is generally under 300 mA. For more information, see the CPU, I/O and Communications Power section.

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 SmartMotor, 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 = 25 mA; Maximum source amperage = 25 mA.

Details: Each on-board 5 V 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 25 mA and source up to 25 mA. Exceeding this could result in damage to the I/O port.

The AD1 option on the D-series motor provides isolated 24 V I/O. The user must supply the 24 VDC at the I/O power input (pin 11) 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: Power is supplied from the "control" power input () on the connector.

I/O Power Requirements

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

Details: Power is supplied from the "control" power input () on the 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: Power is supplied from the "control" power input () on the 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 topics listed below show system connections and cable diagrams for typical D-style and M-style motor installations. For connector specifications, I/O and Channel information, and example I/O connections, see Connectors, Pinouts and Examples on page 65.

For D-style motors:

- D-Style Motors: Connectors and Pinouts on page 35
- D-Style Motors: Demo or Development System on page 36
- D-Style Motors: RS-232 Through USB on page 37
- D-Style Motors: RS-232 with Protective Shunt on page 37
- D-Style Motors: RS-232 Multidrop with Add-A-Motor Cables on page 38
- Connecting the System on page 33
- DE Option on page 38
- D-Style Motors: CDS Option Schematic on page 39

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 45
- M-Style Motors: RS-232 to RS-485 Multidrop on page 46
- M-Style Motors: CANopen or DeviceNet Multidrop on page 47

As you can see, many configurations are possible.

- If you are installing one of these typical configurations and Moog Animatics-supplied cables, simply use the connection information in this section.
- If you are using your own cables or a non-typical configuration, review the information in this section and also see Connectors, Pinouts and Examples on page 65.

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

Minimum Requirements

At minimum, you will need these items:

1. A Class 5 D-style or M-style SmartMotor
2. A computer running Microsoft Windows and the SMI software

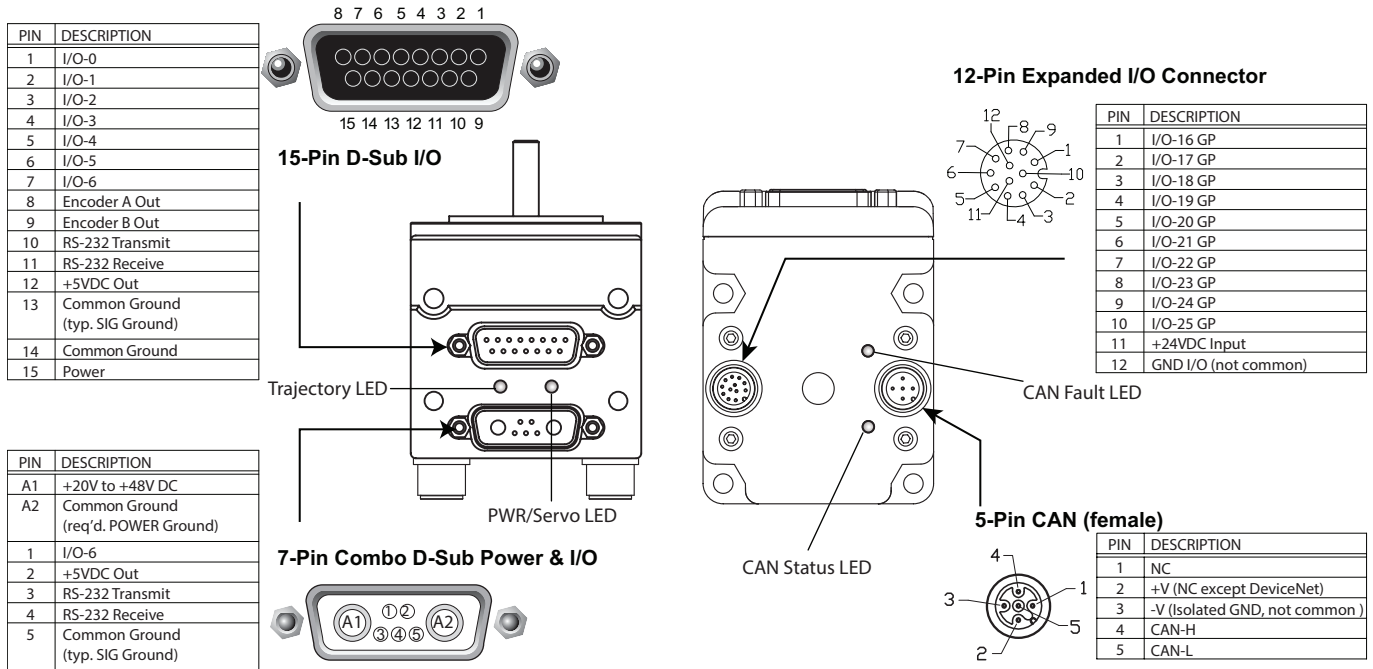
3. A DC power supply and power cable for the SmartMotor
4. A data cable to connect the SmartMotor to the computer's serial port or through a USB to serial adapter, see *D-Style Connections At A Glance* on page 35.

OR a USB cable to connect the SmartMotor to the computer's USB port, see *Connecting the System* on page 33,

OR if your SmartMotor is equipped with the Ethernet option, a Cat 5 (or better) Ethernet cable to connect the motor to the computer's Ethernet port, see *Connecting the System* on page 33.

D-Style Motors: Connectors and Pinouts

The next figure provides a brief overview of the connectors and pinouts available on the D-style SmartMotors. For full details, see Class 5 D-Style Connector Pinouts on page 66.



NOTE: The DE power option is recommended. For details, see DE Option on page 38.



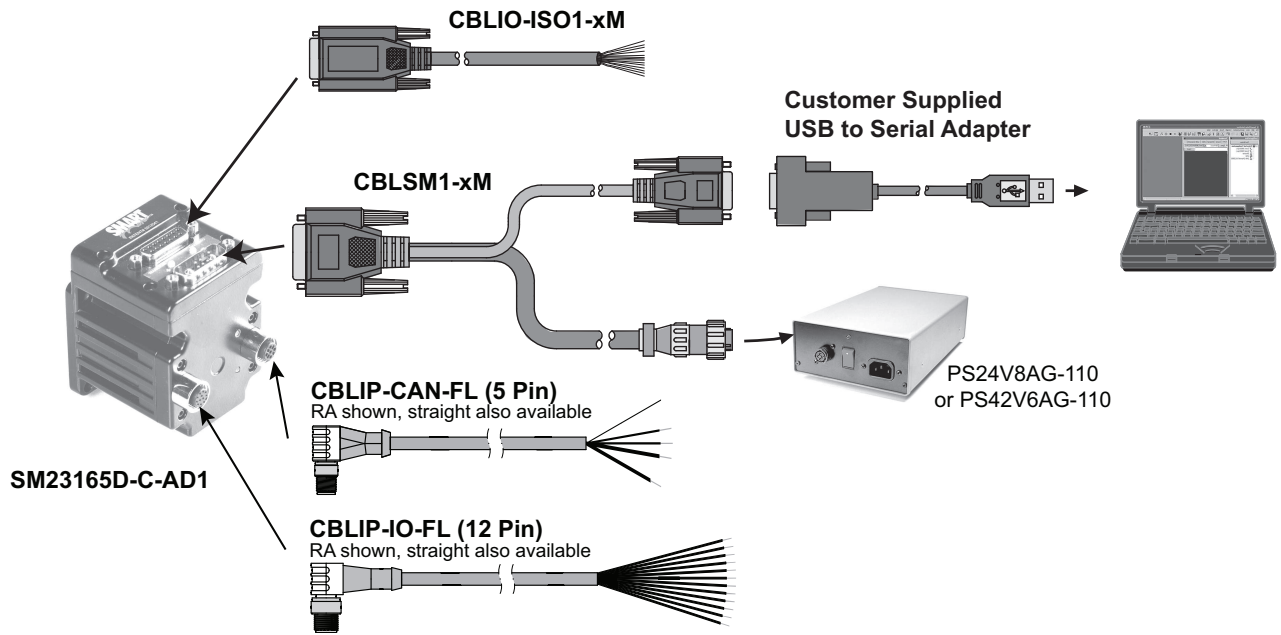
CAUTION: The 12-Pin Expanded I/O and the 5-Pin CAN connectors must be finger tightened only! DO NOT use a wrench or other tool. Doing so can cause overtightening of the connection, which may damage the connector and will void the warranty.



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 Connections At A Glance

The next figure provides a quick overview of the cables and connections for the Class 5 D-style motor.

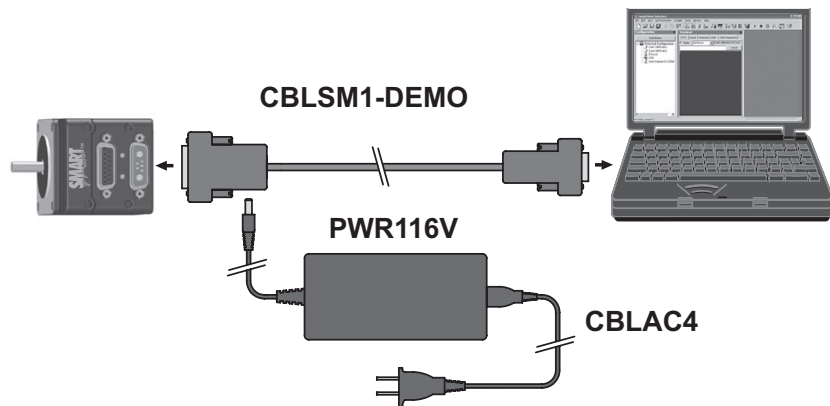


Class 5 M-Style SmartMotor Cable Connections

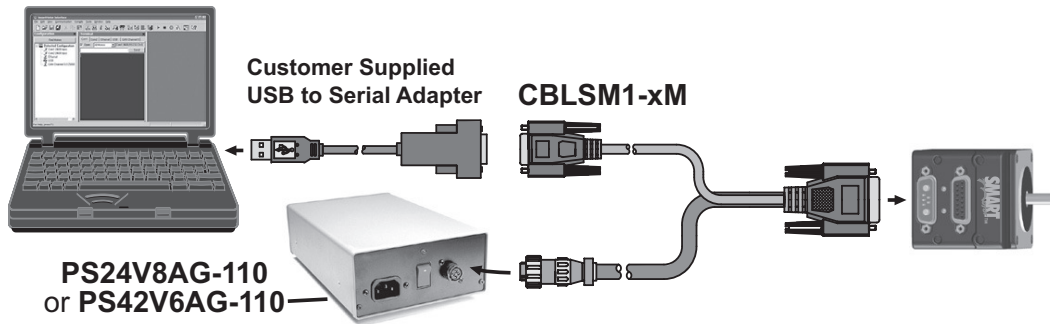
D-Style Motors: Demo or Development System



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



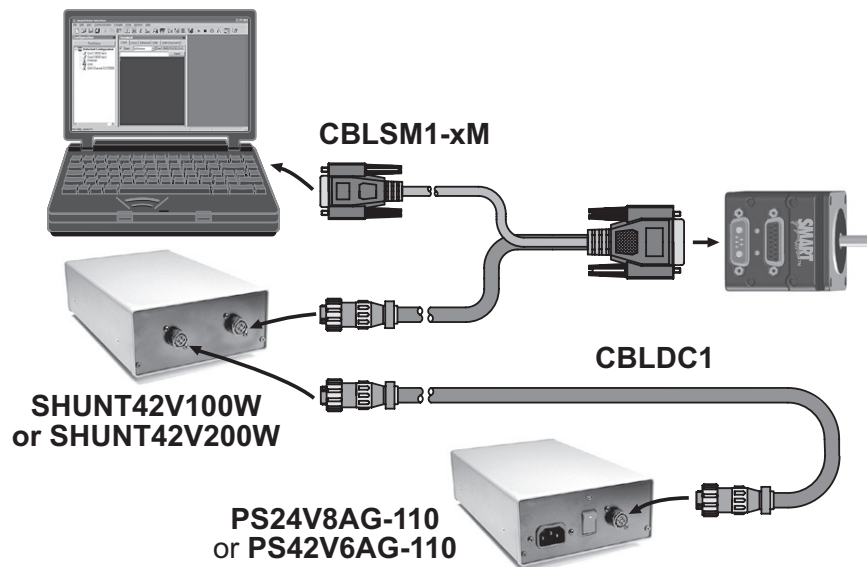
D-Style Motors: RS-232 Through USB



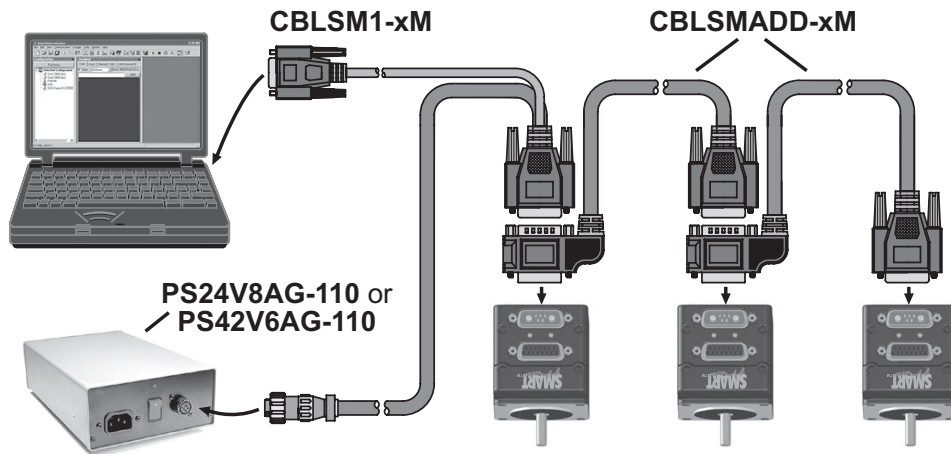
Adding a USB to Serial Adapter

For this application, the customer must provide a USB to Serial (FTDI chipset) adapter, 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 on the PC to the serial interface on the SmartMotor. The adapter simply connects between the USB port and the serial cable, as shown in the previous figure. These adapters are readily available from computer supply stores and online shopping websites.

D-Style Motors: RS-232 with Protective Shunt

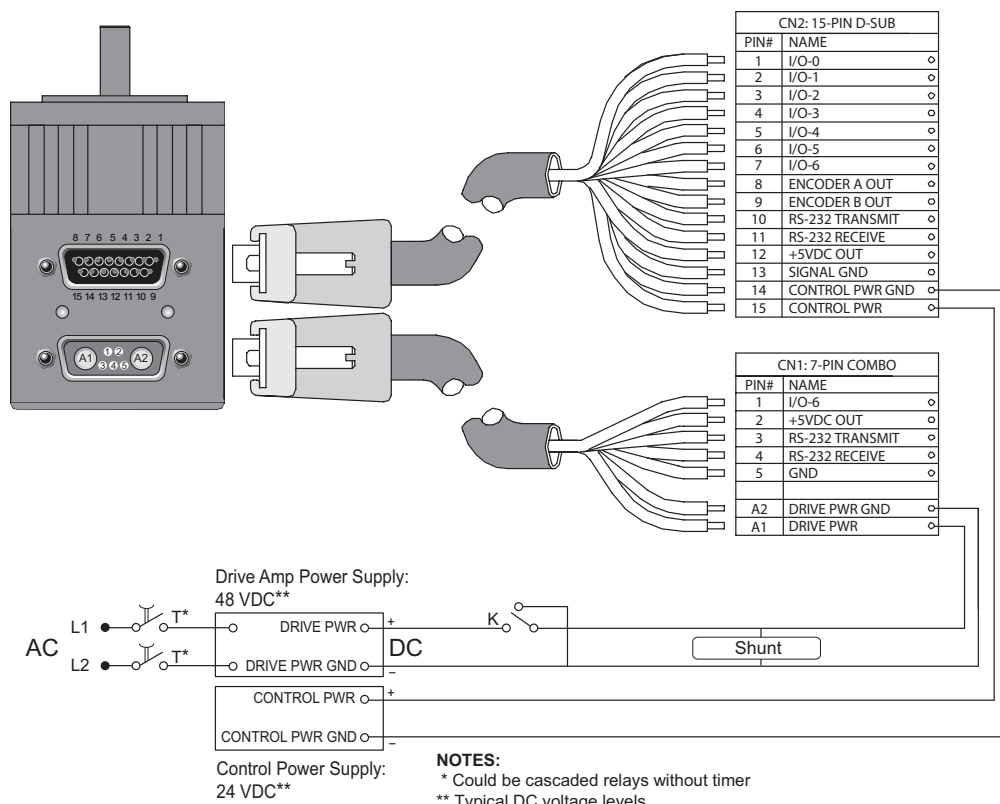


D-Style Motors: RS-232 Multidrop with Add-A-Motor Cables



DE Option

The DE (Drive Enable) option allows the controller and drive amplifier to be powered from two separate DC power supplies. It is highly recommended to use this power option .



Protective shunt should be placed between E-stop and motor drive power input to suppress Back EMF.

Optional shorting of motor input on dropped drive power provides the most protection against Back EMF, and unintended freewheel motion, by employing dynamic braking to stop the motor.

Relay T is time-delay open; relay K is immediate open; relay K must close before relay T to avoid any damage to relay K from SmartMotor in-rush currents.

This circuit is recommended for smoother startup of large switch-mode supplies where surge currents may cause noise issues.

NOTE: All M-style SmartMotors are designed to allow the use of separate drive and control power supplies. No special ordering option is needed for those SmartMotors.

D-Style Motors: CDS Option Schematic

This section provides schematics for wiring a Class 5 D-style SmartMotor through 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.

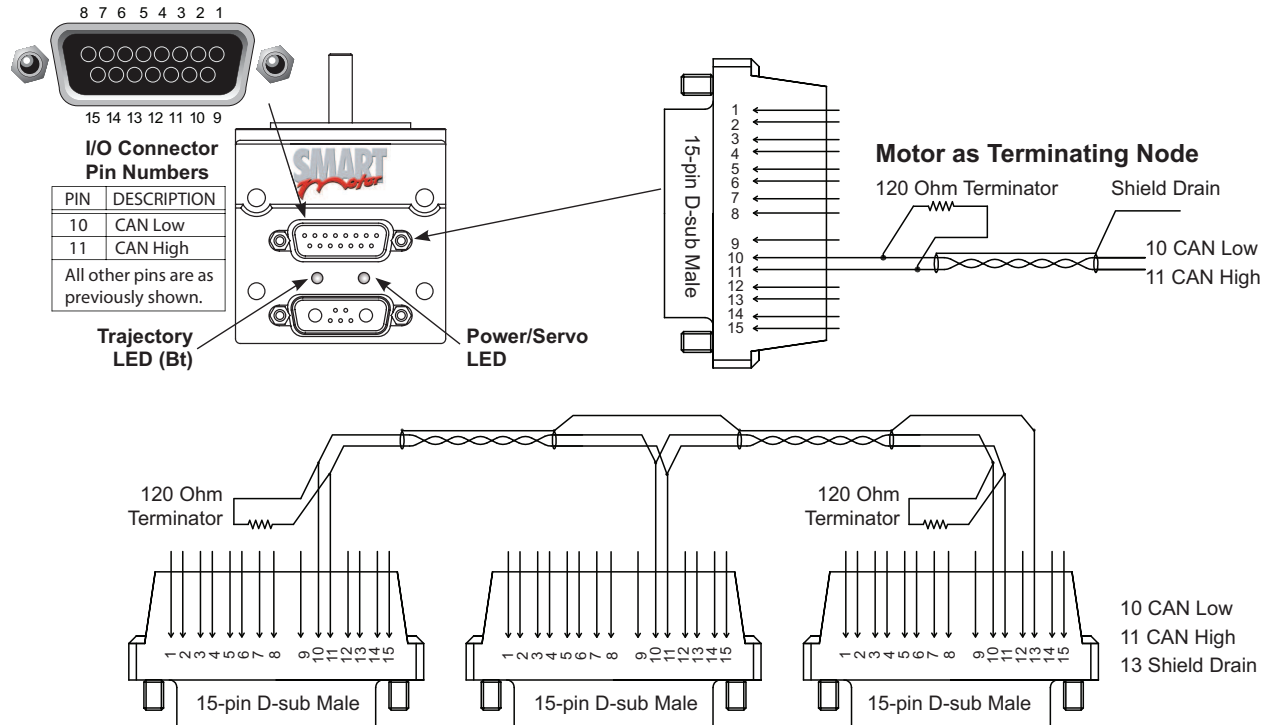
NOTE: The CDS Option is available only on specially equipped D-style SmartMotors. Contact Moog Animatics for details.

CDS on the DA-15 Connector

A special version of the D-style SmartMotor with the CDS CAN connector option allows CAN bus network wiring through the DA-15 connector (15-pin D-sub I/O connector shown in the next 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 terminating resistor (shunt) must be placed across pins 10 and 11. For details, see the next figure.

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



NOTE: A terminating resistor (shunt) or pass-thru terminator 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

CDS on the 7W2 Connector (CDS7)



CAUTION:

If you are using the blue-overmolded Add-A-Motor cables (CBLSMCDS-xM) with CAN bus already in them:

1. Do not create a parallel path between the same motors on the 15-pin (D15) D-sub connector, as that will cause impedance issues.
2. Any CAN nodes other than SmartMotors should be placed at the beginning and/or end of the SmartMotor chain using the 15-pin (D15) D-sub connector. Do NOT "branch" to them from that connector in the middle of the SmartMotor chain. Branching is not allowed on the CAN bus.
3. Be aware of CAN signal wires being present or not in the incoming power/signal cable to the first 7W2 connector. If also using the 15-pin (D15) D-sub connector to access the CAN signals, then this could form an unintended branch.

For more information on CAN best practices, visit CAN in Automation at www.can-cia.org.

Alternatively, the CDS7 option on the D-style SmartMotor allows CDS to be wired through pins 1 and 2 of the 7-pin D-Sub (7W2) connector as shown in the next figure. The wiring is accomplished through the use of a single Add-A-Motor cable (PN: CBLSMCDS) that carries Power, RS-232, and CAN bus to the

next motor in the chain. This method allows pins 10 and 11 on the 15-pin D-sub connector to be used as an easy terminating point on the last motor by simply placing a 120 Ohm terminating resistor (shunt) across those pins OR installing the Pass-Thru Terminator (PN: CBLSM-TR120) on that connector.

This design not only greatly simplifies motor installation, but also does the same for CAN bus addressing. With CDS7, the SmartMotor is the first and only single-cable, point-to-point integrated motor to have both motor-to-motor full communications and control capability, and only single-cable, point-to-point for both power and communications in general.

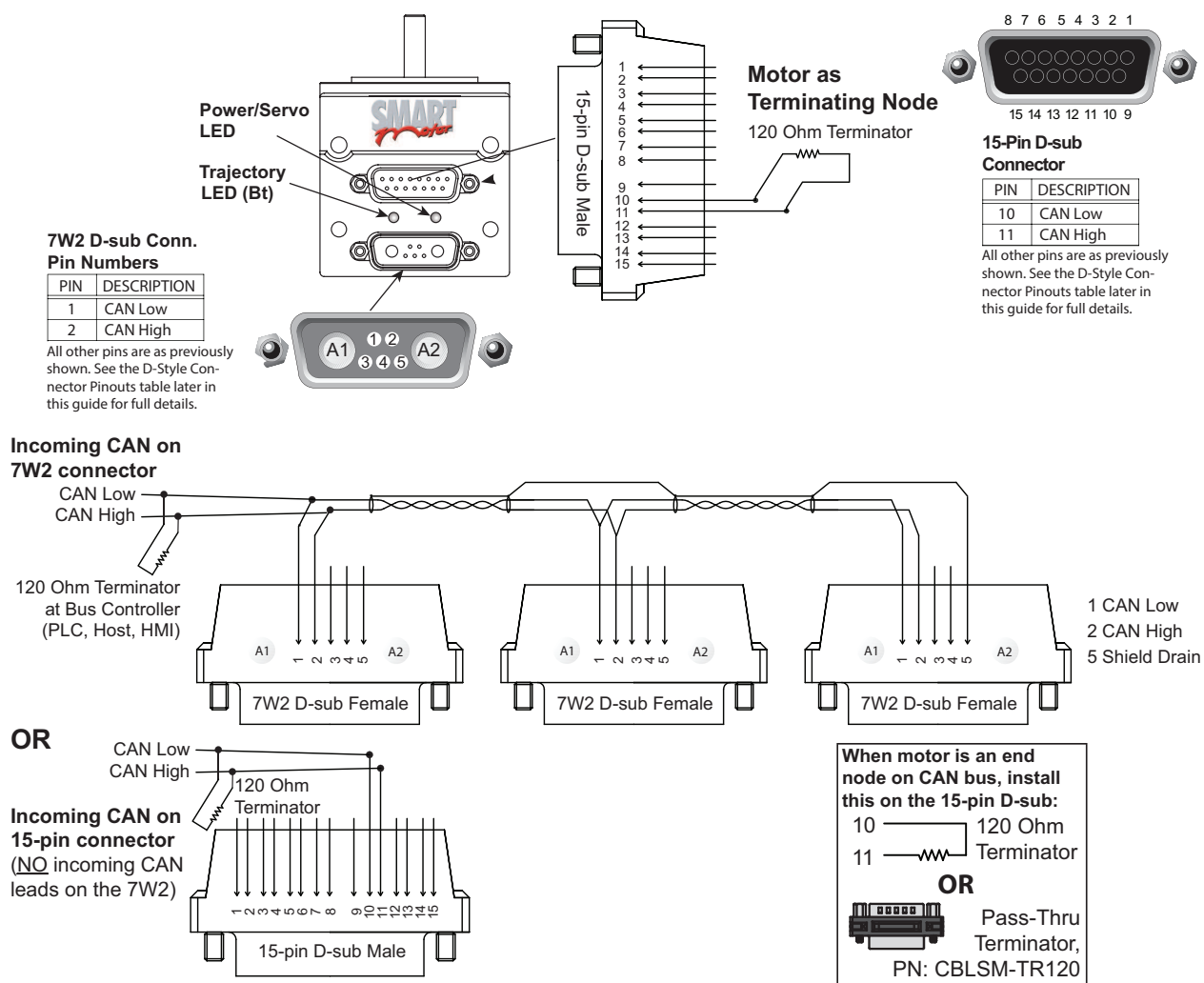
As a result:

- When you order the D-series CDS7 SmartMotors and CDS7 Add-A-Motor cables, you get prewired, instant, full-network capability, and those networked motors are auto-detectable directly from SMI.
- This allows for auto-addressing and ease of reconnection at the next power up.
- Unlike competitive CANopen devices, the CDS7 SmartMotors do not require single-node power up to set addresses. You can power up all at once, have SMI detect them and set all motor CAN bus addresses in a single line of code. For details, see Detecting and Addressing the SmartMotors on page 49.

CDS7 is fully backward compatible with the wiring method described in the previous section. Therefore, all -CDS7 option SmartMotors can be wired either through the D-sub connector or the 7W2 connector, and there is no change in motor part numbers for the 7W2 method. The only part change is the cabling used to connect the motors - refer to the figures, descriptions and part numbers later in this section.

When the SmartMotor is a terminating node on the CAN bus, the 120 Ohm terminating resistor (shunt) must be wired to pins 10 and 11 of the 15-pin D-sub connector. A 120 Ohm terminating resistor (shunt) is also required at the beginning of the CAN bus. See the next figures.

For further convenience, a 15-pin pass-through D-sub connector (Pass-Thru Terminator, PN: CBLSM-TR120) is available that contains a built-in 120 Ohm terminating resistor (shunt). When a SmartMotor is the terminating node and the 7W2 wiring method is used (described previously), you can simply install the pass-through connector on the SmartMotor's 15-pin D-sub connector to serve as the terminator.

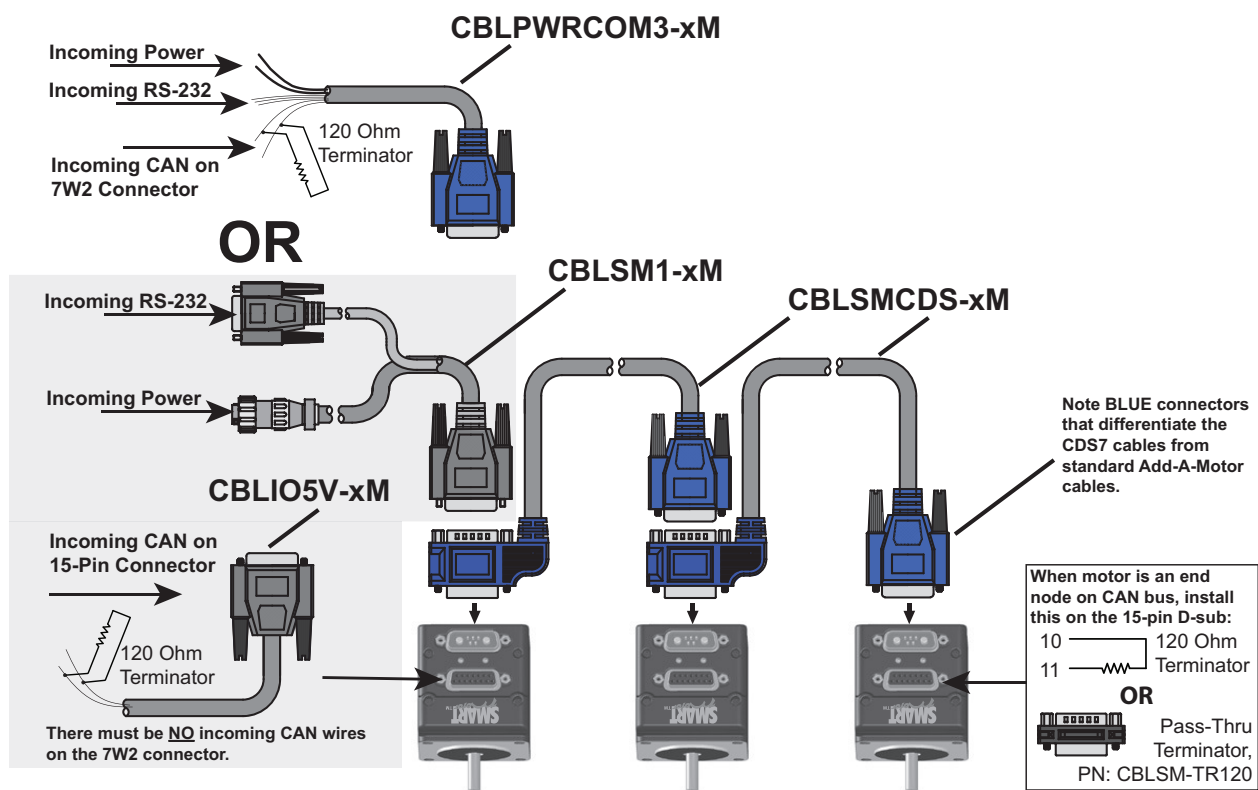


NOTE: A terminating resistor (shunt) or pass-thru terminator is required at each end of the bus. Bus must be multi-drop as shown, not a star network. 24V CAN bus power connection is not required at the motor.

Schematic for CDS7 Option, D-Style SmartMotor Used as Terminating Node

For the above methods, the incoming CAN bus signal is connected to the 7W2 connector OR the 15-pin connector, and the CDS Add-A-Motor cable (PN: CBLSMCDS-xM) will automatically provide CAN bus, RS-232 and power wiring in one cable between motors.

The next figure shows how factory cables are used to attach the incoming power and RS-232 communications to the 7W2 connector, and incoming CAN bus signal to the 7W2 connector OR the 15-pin connector (each method requires different cables).



NOTE: A terminating resistor (shunt) or pass-thru terminator 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.

CDS7 Option Cabling Diagram

Refer to these tables for part numbers and cable lengths:

CDS7 Cable PN	Length (Meters)	Power/Com Cable PN	Length (Meters)
CBLSMCDS-0.3M	0.3	CBLPWRCOM3-xM*	5, 10
CBLSMCDS-0.9M	0.9	CBLSM1-xM**	3, 10
CBLSMCDS-3.0M	3.0	CBLIO5V-xM**	3, 10
CBLSM-TR120	Pass-thru terminator		
CAUTION: As noted by the BLUE connectors, these are NOT the same as the Add-A-Motor cables shown on page 38, and they are NOT interchangeable.		*Recommended method **Optional method	

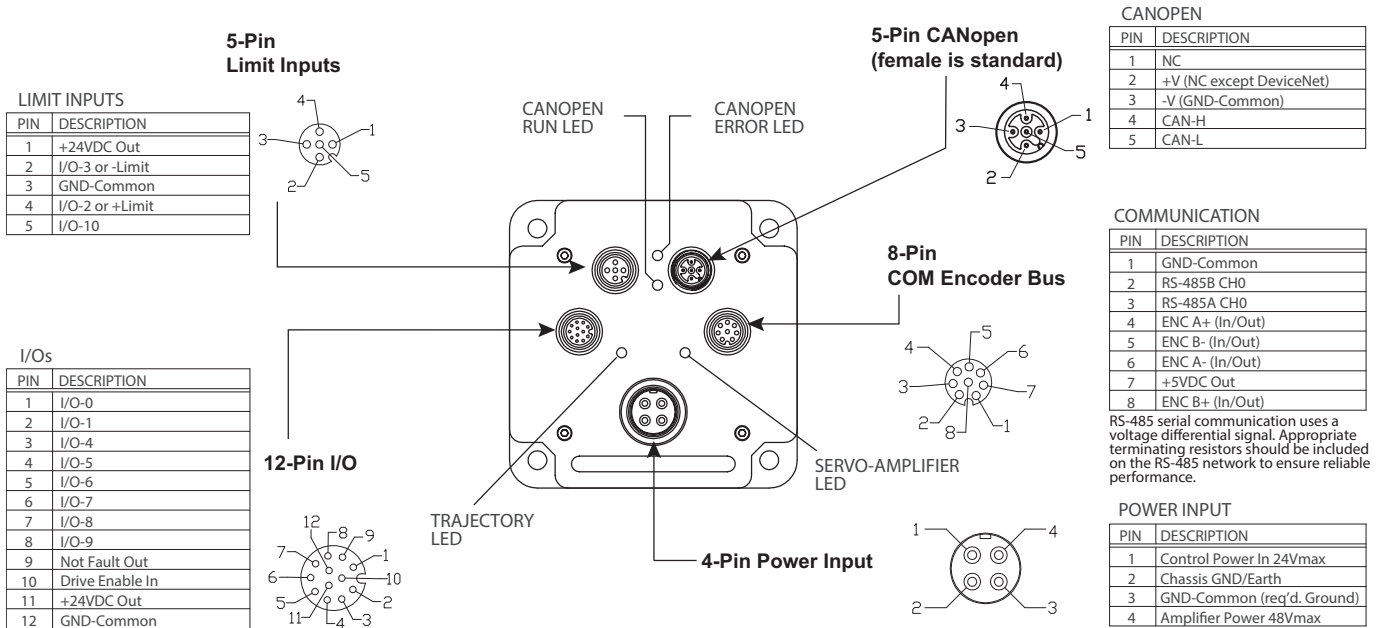
See the cable data on the website or consult the factory for the schematic diagrams.

M-Style Motors: Connectors and Pinouts

The next figure provides a brief overview of the connectors and pinouts available on the M-style SmartMotors. For full details, see Class 5 M-Style Connector Pinouts on page 69.

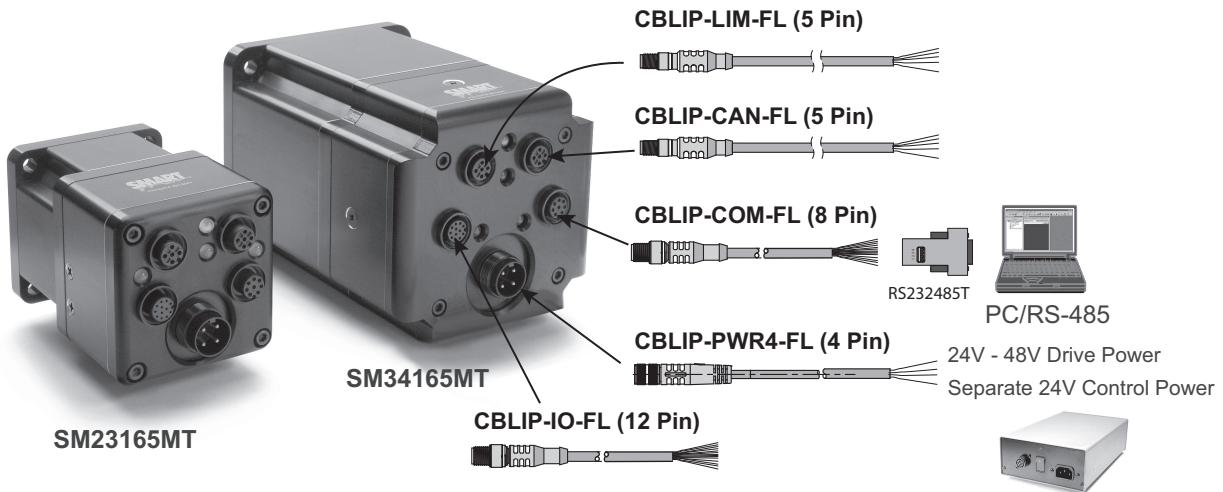


CAUTION: M-style connectors must be finger tightened only! DO NOT use a wrench or other tool. Doing so can cause overtightening of the connection, which may damage the connector and will void the warranty.



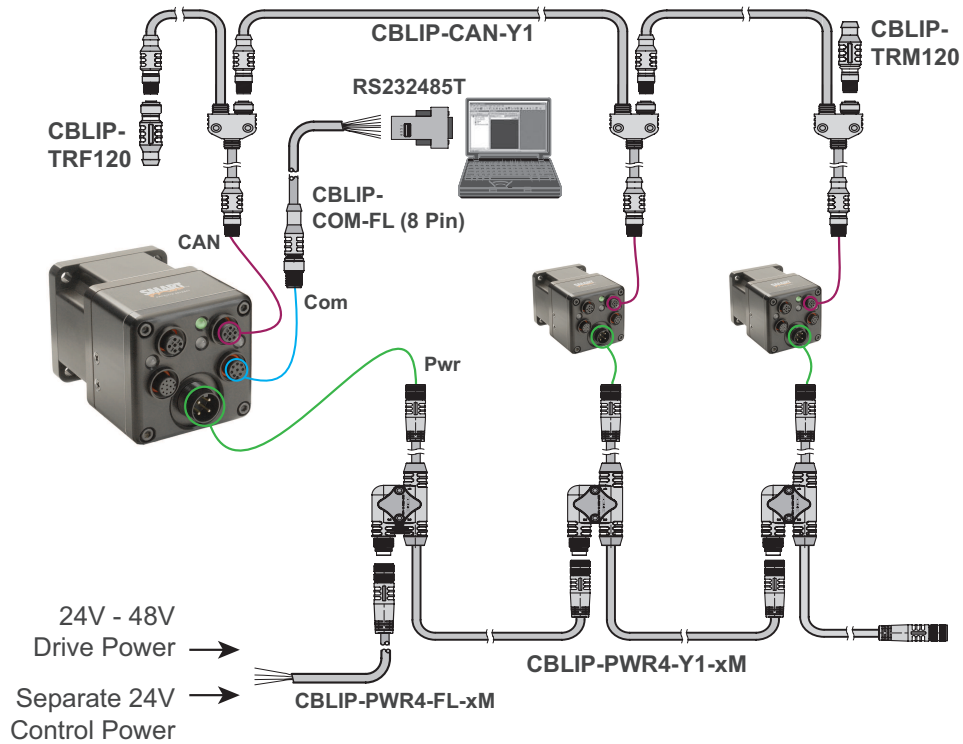
M-Style Connections At A Glance

The next figure provides a quick overview of the cables and connections for the Class 5 M-style motor.

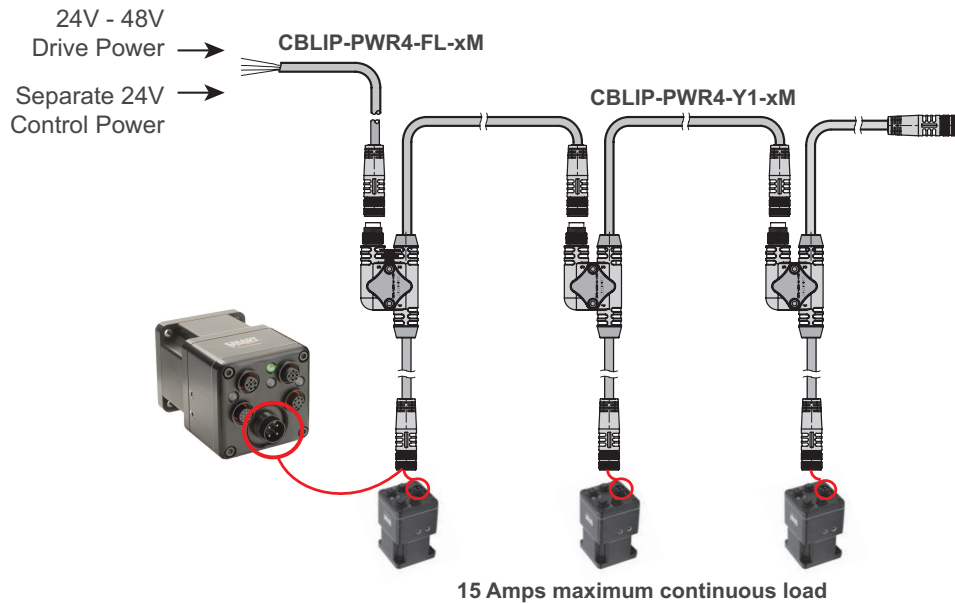


Class 5 M-Style SmartMotor Cable Connections

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

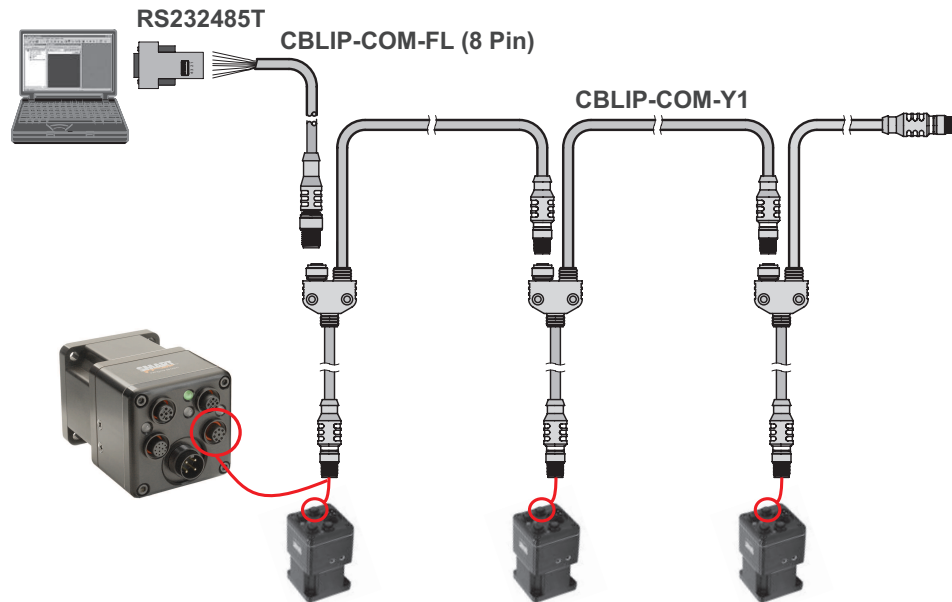


M-Style Motors: Power Multidrop



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

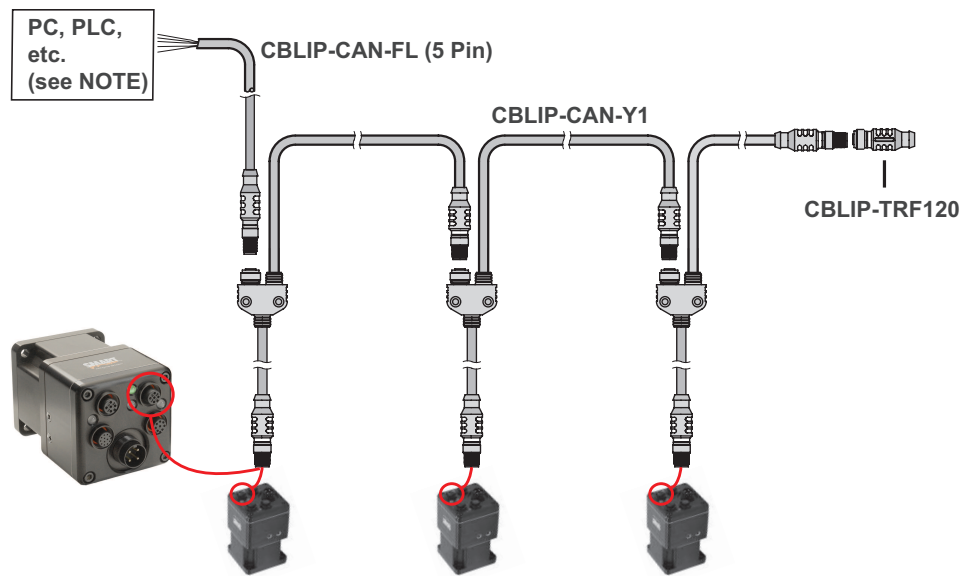
M-Style Motors: RS-232 to RS-485 Multidrop



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 complies with 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 45.

M-Style Motors: CANopen or DeviceNet Multidrop

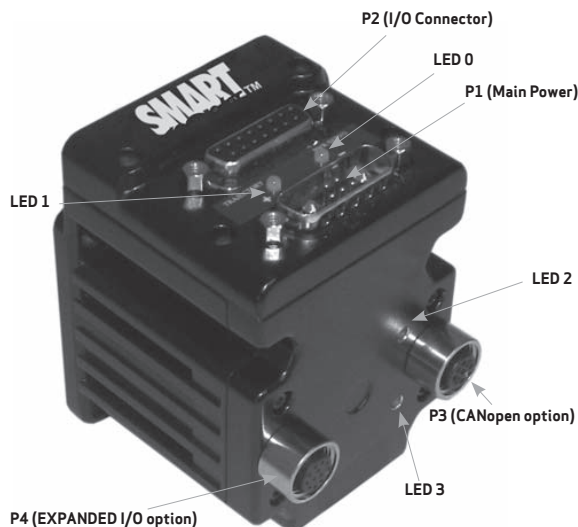
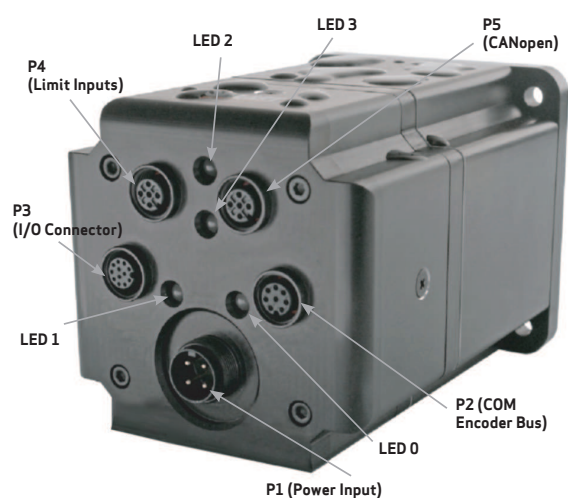


NOTE: The bus requires a termination resistor at each end. If the controller device (PC, PLC, etc.) does not include one, then an external termination resistor must be supplied.

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 45.

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
Flashing red	CAN error (CDS/CDS7 only)
Alt. red/green	CAN error (CDS/CDS7 only) while 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 (M-style) or high (D-style):
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 (M-style) or low (D-style):
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.

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 33.
- 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 31 and Connecting the System on page 33.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 26.

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 51.
- 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 53.
- 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 55.

These methods are described in the next 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 33.
5. Use the Detect Motors feature. For details, see Using the Detect Motors Feature on page 53.



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 ORPA, 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 in this manner:

- 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:

```
OADDR=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 after the colon character is the CAN address. Consider this example:

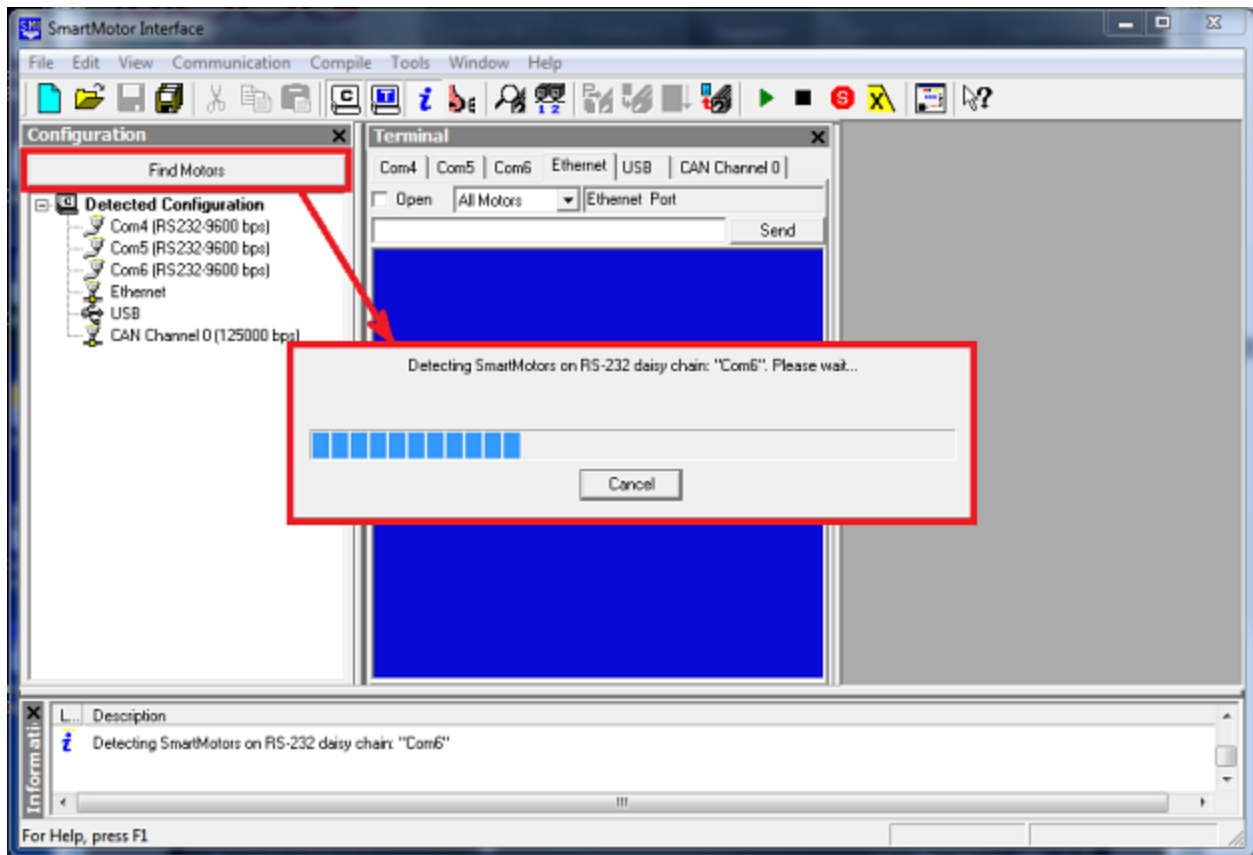
```
1RPA:2
```

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 next 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.

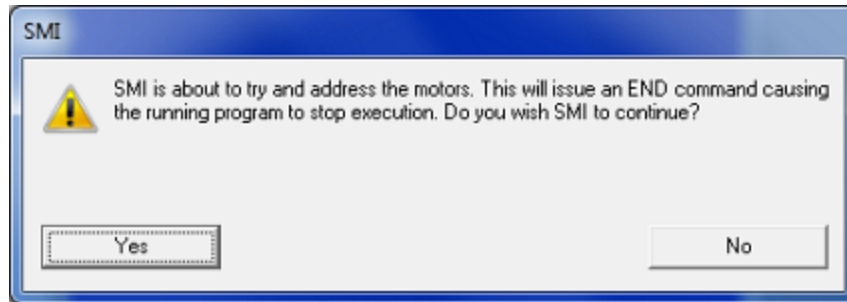
To begin searching for motors across all ports on the PC, in the Configuration window of the SMI software interface, click Find Motors. The SMI software begins searching for all SmartMotors connected to the PC.



Find Motors Detecting SmartMotors on the RS-232 Chain

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

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



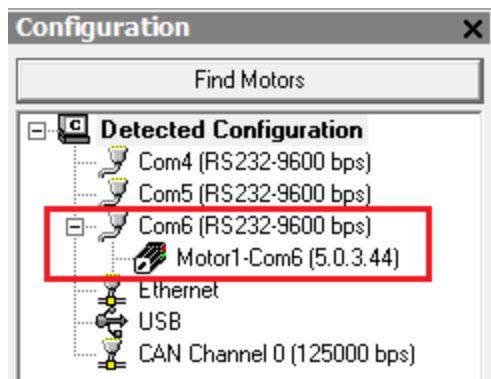
Address the Motors Prompt

A progress bar displays a "Getting motor information" message while the SMI software addresses the motors. During this process, the SMI software is collecting 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.

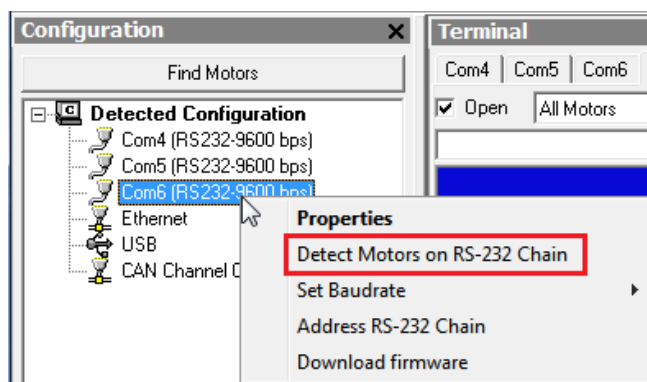


Configuration Window Showing Found/Addressed SmartMotor

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.

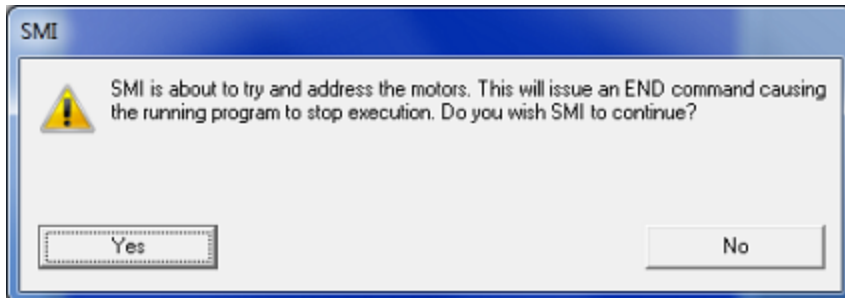


Selecting the Detect Motors Feature

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.

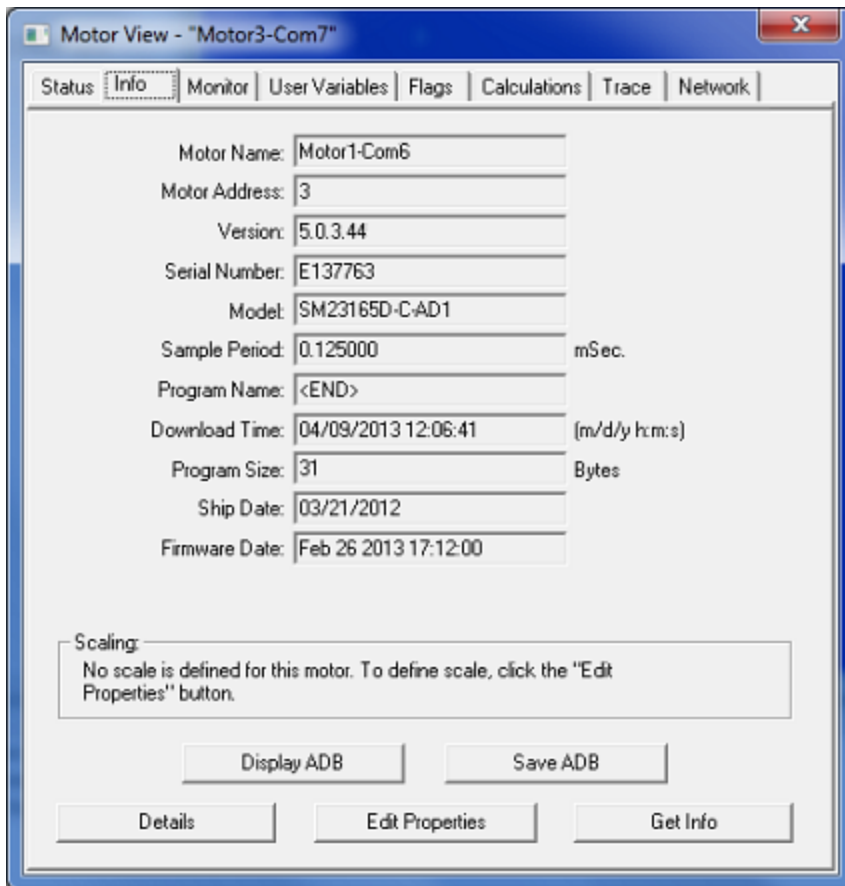
After the motors are detected, the SMI software will address them if needed. The next steps are only used when the SMI software finds motors that do not have addresses.

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



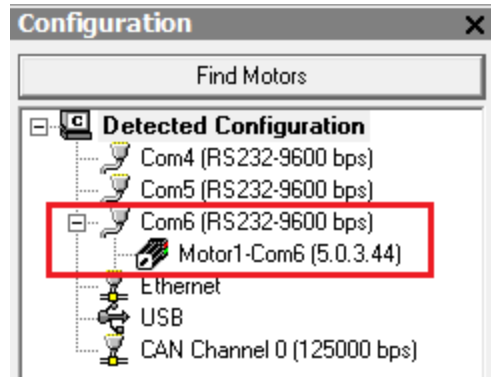
Address the Motors Prompt

A progress bar displays a "Getting motor information" message while the SMI software addresses the motors. During this process, the SMI software is collecting 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.



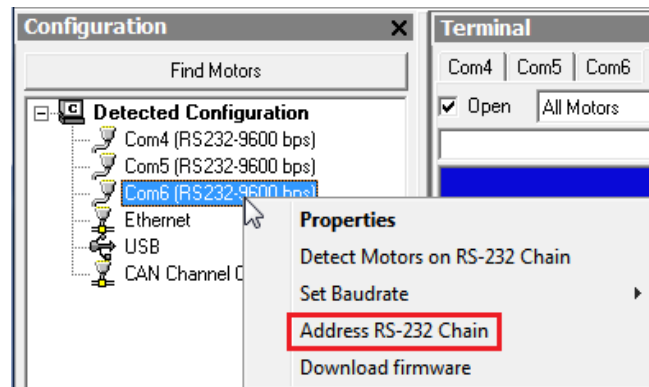
Configuration Window Showing Found/Addressed SmartMotor

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.

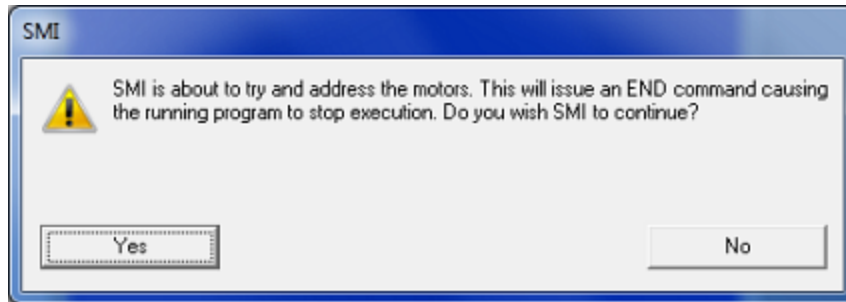
NOTE: This method will address (or re-address) every motor. If you pre-addressed your motors before connecting them, those motor addresses could be changed by this process.

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.



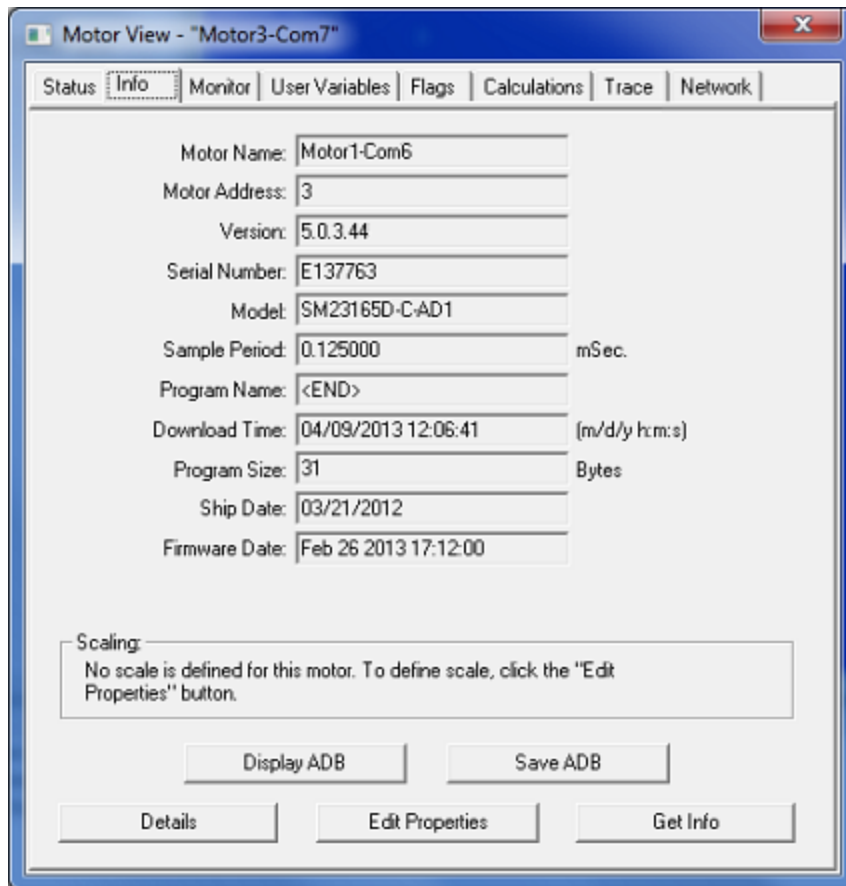
Selecting the Detect Motors Feature

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



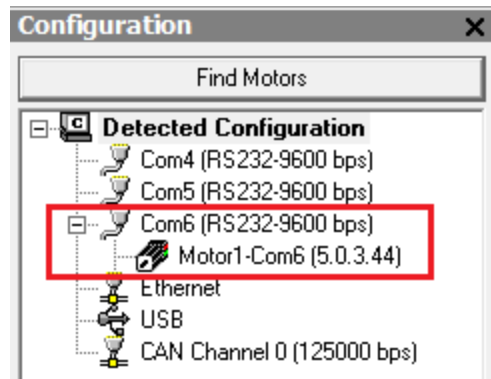
Address the Motors Prompt

A progress bar displays a "Getting motor information" message while the SMI software addresses the motors. During this process, the SMI software is collecting 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.

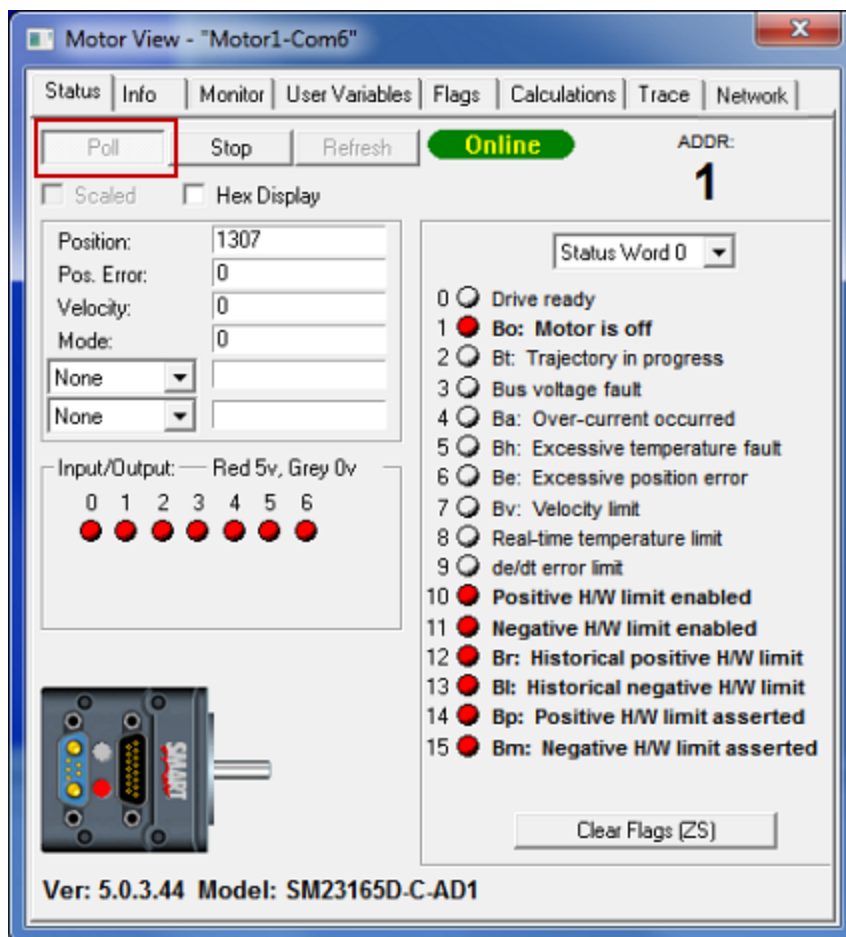
This procedure assumes that:

- The SmartMotor is connected to the computer. For details, see *Connecting the System* on page 33.
- 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 31 and *Connecting the System* on page 33.
- The SMI software has been installed and is running on the computer. For details, see *Installing the SMI Software* on page 26.
- The SmartMotor has been detected and addressed. For details, see *Detecting and Addressing the SmartMotors* on page 49.

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 next 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).

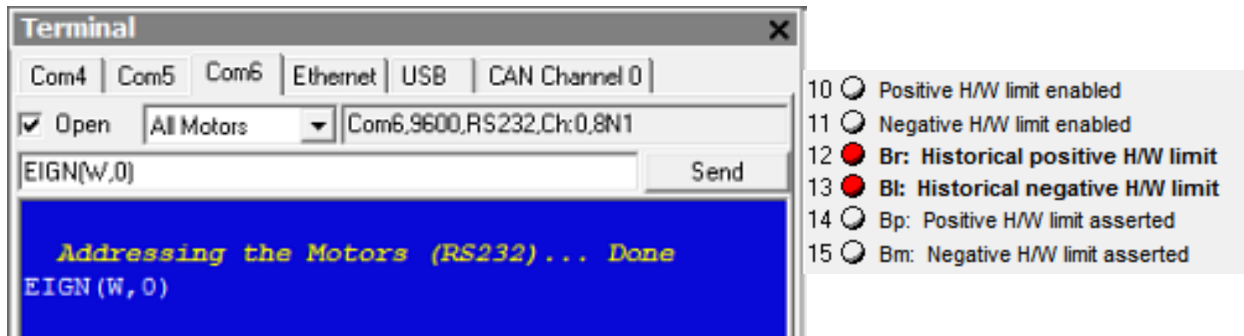
The EIGN() command is used to clear these status bits as described in the next section. EIGN stands for: Enable Inputs as General Use. In the case of EIGN(W,0), the W means a "word" or 16 bits of I/O; the 0 means first word or local I/O. There are only seven local I/O on the D-style motors. Therefore,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

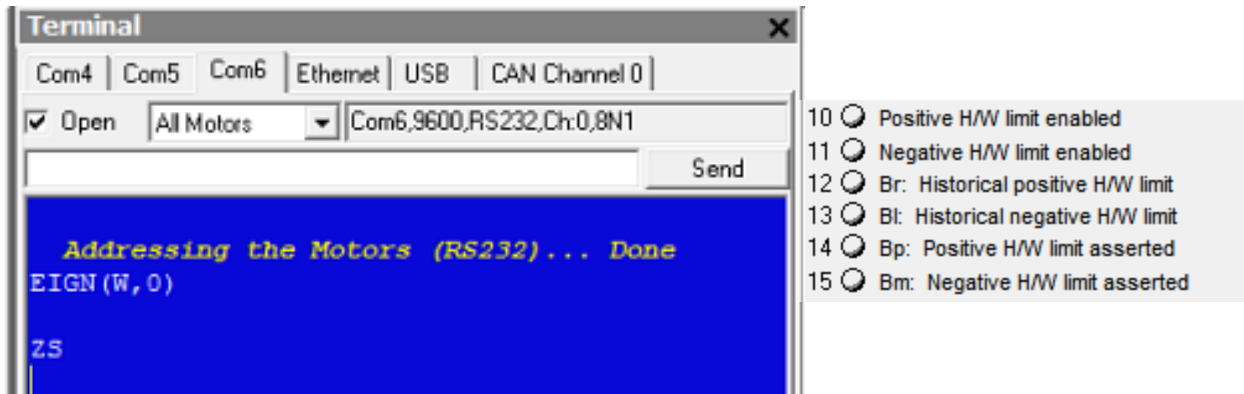
The active and asserted bits are cleared, as shown in the next figures.



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 next 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 33.
- 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 31 and Connecting the System on page 33.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 26.
- The SmartMotor has been detected and addressed. For details, see Detecting and Addressing the SmartMotors on page 49.
- 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 57.

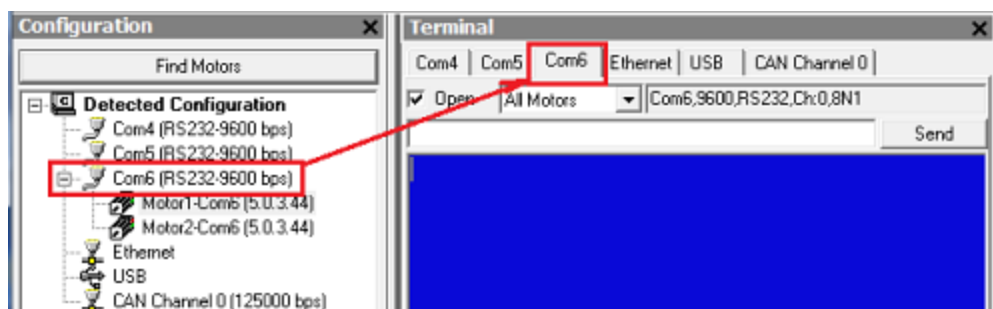
Making the Motor Move



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 8).

To make the SmartMotor move:

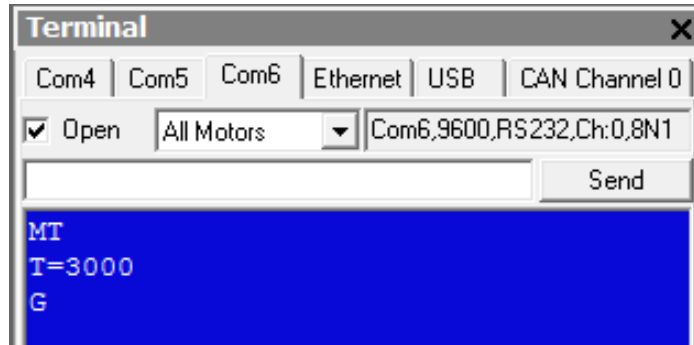
1. In the Terminal window, select the tab that matches the communications channel to which your motors are connected. To do this, look at the Configuration window, find the channel where the motors are listed and click that tab name in the Terminal window.



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 these 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 73 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 commands in this section are related to the previous motion procedure. For more details on these commands, see the *SmartMotor™ Developer's 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. The value returned by TRQ (and RTRQ) will typically be one less than the T (torque) value due to internal calculations. It may also be reduced in cases where the motor's output is in limitation. TRQ represents the output effort of the motor in both MT (torque mode) and servo modes (MV, MP, etc.). Therefore, it provides a seamless transfer across those modes without causing a ripple or bump in force 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 next 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 33.
- 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 31 and Connecting the System on page 33.
- The SMI software has been installed and is running on the computer. For details, see Installing the SMI Software on page 26.
- The SmartMotor has been detected and addressed. For details, see Detecting and Addressing the SmartMotors on page 49.
- The overtravel limits and fault bits have been cleared. For details, see Checking and Clearing the Status Bits on page 57.

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
```

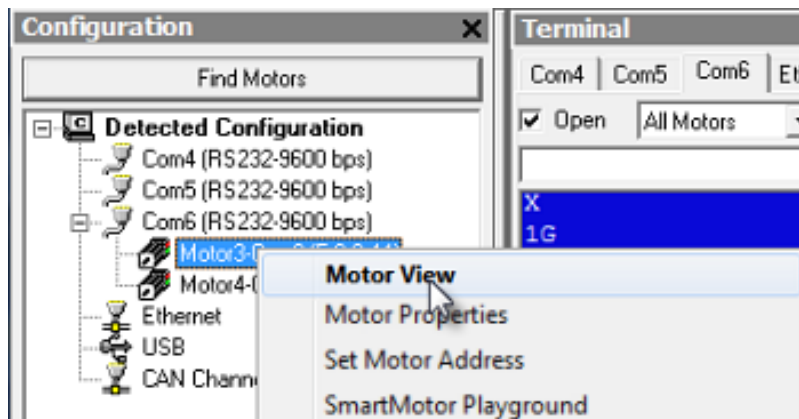
NOTE: The position is reported on the same line as the command; there is no line feed or carriage return for "report" commands.

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

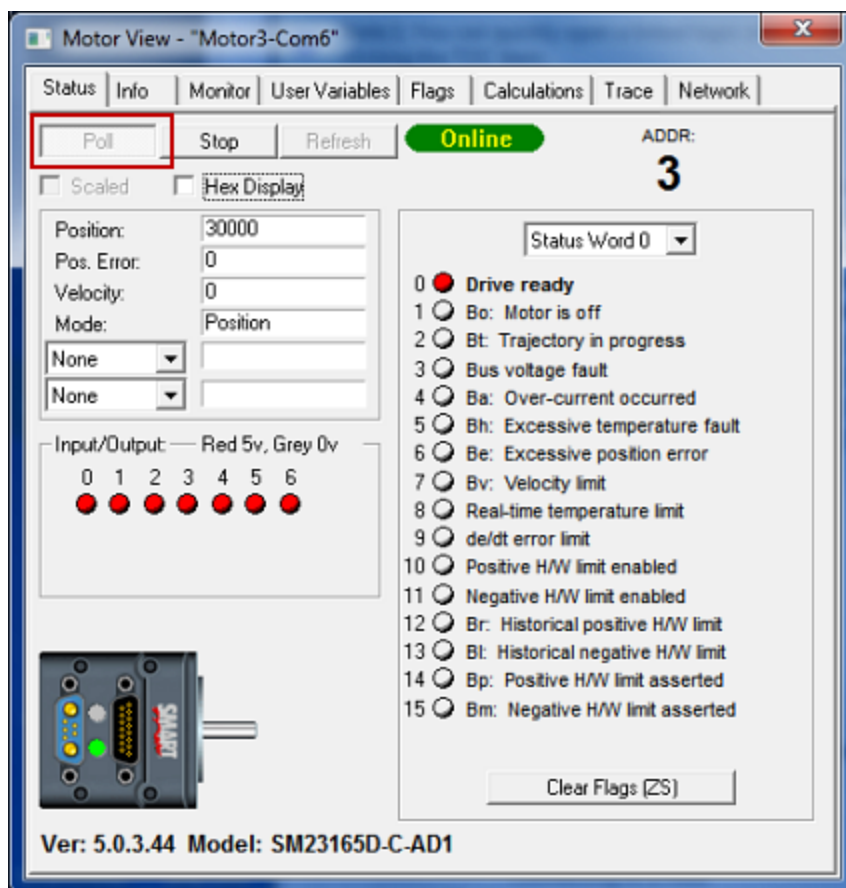
The Motor View tool provides another way to view the motor position. The advantage of using this tool is that the position is dynamically updated when the motor is moving.

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

Connectors, Pinouts and Examples

This chapter provides information on the Class 5 SmartMotor connector pinouts and specifications for both D-style and M-style motors. It also provides example I/O connection diagrams. For information on connecting the motors, see *Connecting the System* on page 33.

Class 5 D-Style Connector Pinouts	66
Class 5 D-Style I/O Connection Examples	67
Class 5 M-Style Connector Pinouts	69
Class 5 M-Style I/O Connection Examples	70

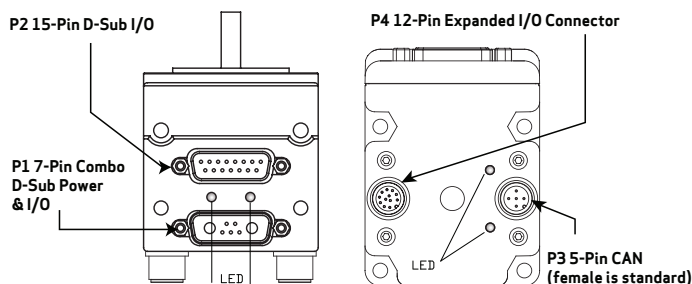
Class 5 D-Style Connector Pinouts

This 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; For -CDS7, CAN-L only	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	Redundant connection on I/O connector	<p>7W2 Combo D-Sub Connector</p>
2	+5 VDC Out; For -CDS7, CAN-H only	50 mAmps Max (total)		
3	RS-232 Transmit	Com ch. 0	115.2 KBaud Max	
4	RS-232 Receive			
5	Common Ground (typ. SIG Ground)			
A1	Main Power	+24-48 VDC	See NOTE	
A2	Common Ground (req'd. POWER Ground)		Must be Main Power Ground	
PIN	I/O CONNECTOR (5V TTL I/O)	Specifications:	Notes:	P2
1	I/O - 0 GP or Encoder A or Step Input		1.5 MHz Max as Encoder or Step Input	<p>P2 DB-15 D-Sub Connector</p>
2	I/O - 1 GP or Encoder B or Direction Input		1.5 MHz Max as Encoder or Direction Input	
3	I/O - 2 Positive Over Travel or GP			
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 (SDA) or RS-485 A (Com ch. 1)		115.2 KBaud Max	
6	I/O - 5 GP, IIC (SCL) or RS-485 B (Com ch.1)			
7	I/O - 6 GP, Index Input or "G" Command		Redundant connection on Main Power Connector	
8	Phase A Encoder Output	24 mAmp Sink or Source		
9	Phase B Encoder Output			
10	RS-232 Transmit; For -CDS/7, CAN-L only	Com ch. 0	115.2 KBaud Max	
11	RS-232 Receive; For -CDS/7, CAN-H only			
12	+5 VDC Out	50 mAmp Max (total)		
13	Common Ground (typ. SIG Ground)			
14	Common Ground			
15	Main Power: +20-48 VDC	If DE Option, Control Power separate from Main Power		
NOTE: I/O ports input impedance = 5 kohm (5 kohm pull-up resistor)				
PIN	CAN bus	Connection:	Notes:	P3
1	NC	NC		<p>M12 5-Pin Female</p>
2	+V	NC except DeviceNet	Input current < 10 mA	
3	-V (ground, not common)	CAN Ground	Isolated	
4	CAN-H	1 MBaud Max		
5	CAN-L	1 MBaud Max		
PIN	Isolated 24 VDC I/O Connector	Max Load (sourcing)	Notes:	P4
1	I/O - 16 GP			<p>M12 12-Pin Female End View</p>
2	I/O - 17 GP	150 mAmps		
3	I/O - 18 GP			
4	I/O - 19 GP		These I/O ports also support analog input	
5	I/O - 20 GP			
6	I/O - 21 GP			
7	I/O - 22 GP			
8	I/O - 23 GP	300 mAmps		
9	I/O - 24 GP			
10	I/O - 25 GP			
11	+24 Volts Input	18-32 VDC		
12	Ground-I/O (not common)		Isolated	

NOTE: These motors can operate on power down to +20 VDC, but it is not recommended due to greatly reduced performance — optimum performance is achieved at 48 VDC.

NOTE: All specifications are subject to change without notice. Consult the factory for the latest information.

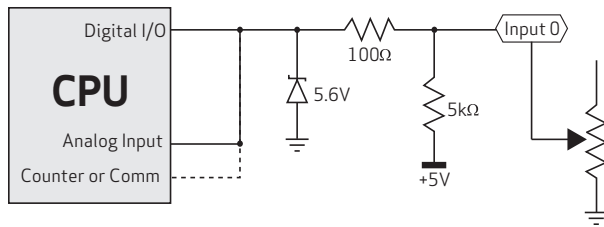
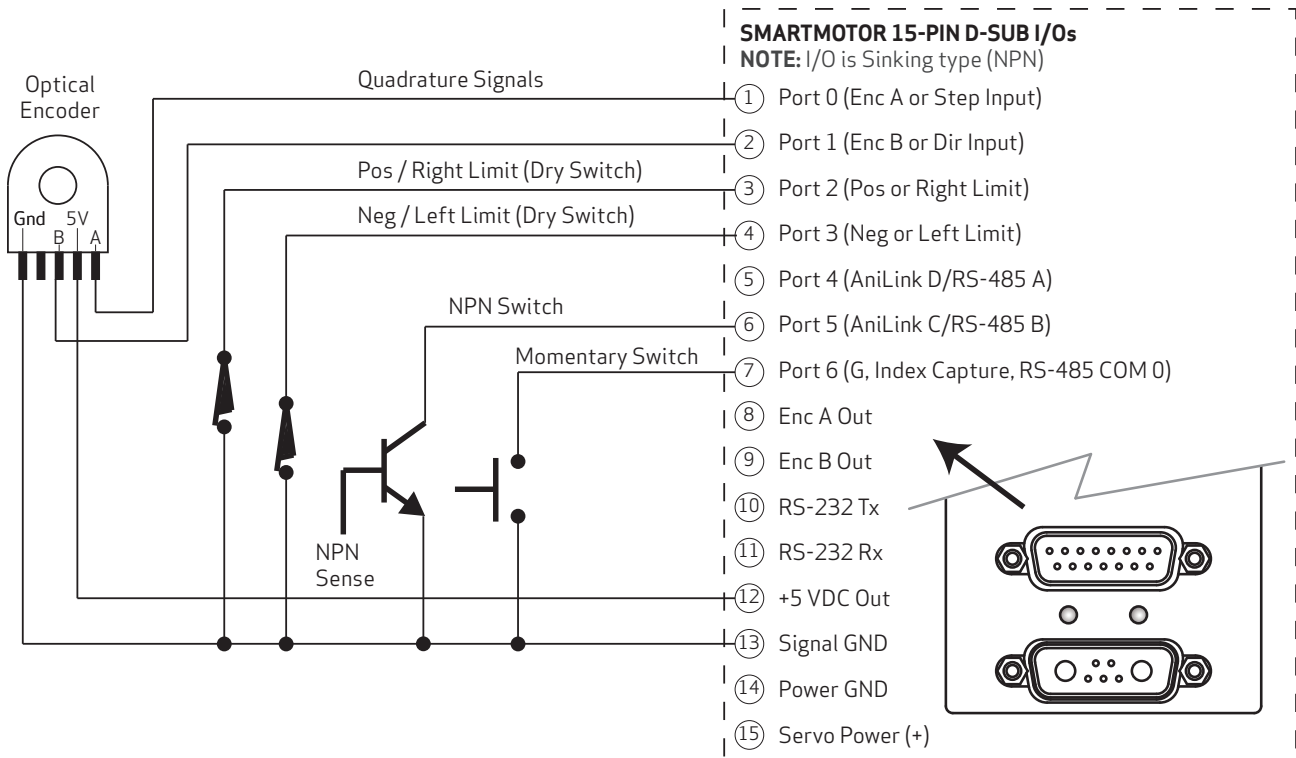


CAUTION: Pins 14 and 15 are intended for use with DE series motors for control power only. Attempting to power a non-DE motor through those pins, as main servo-drive power, may result in immediate damage to the electronics, which will void the warranty.

CAUTION: Connectors P3 and P4 must be finger tightened only! DO NOT use a tool. Doing so can cause overtightening of the connection, which may damage the connector and will void the warranty.

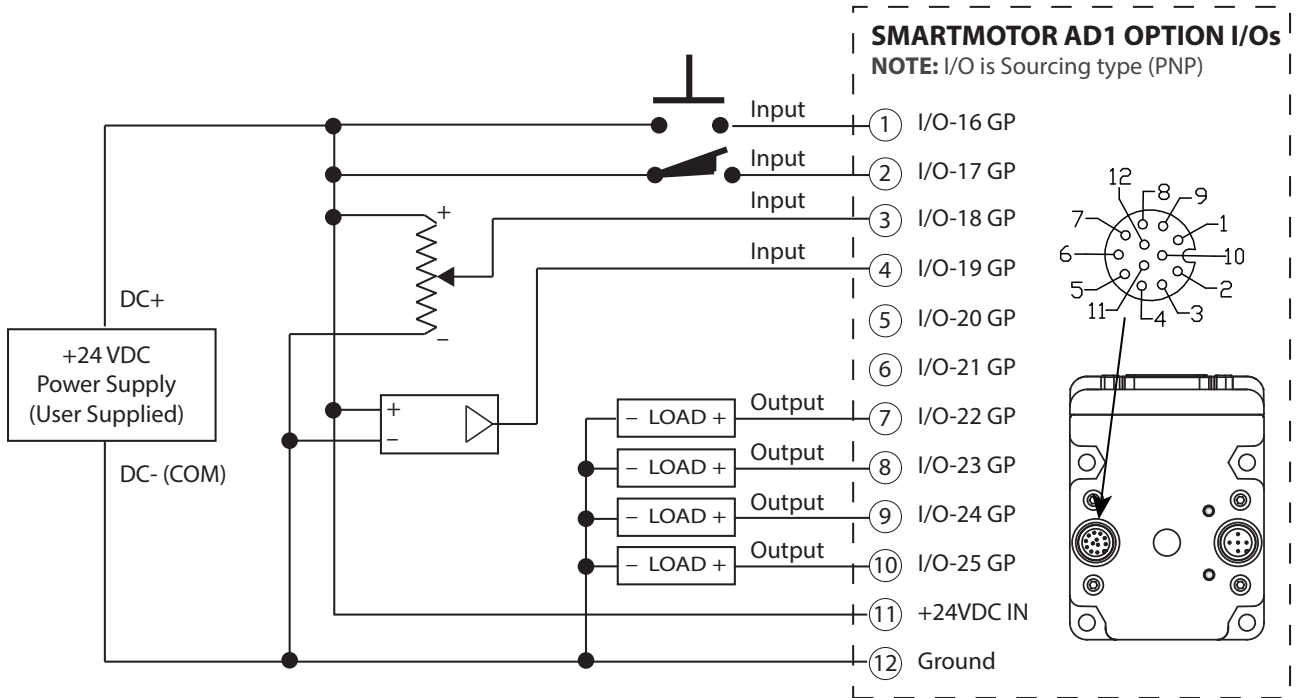
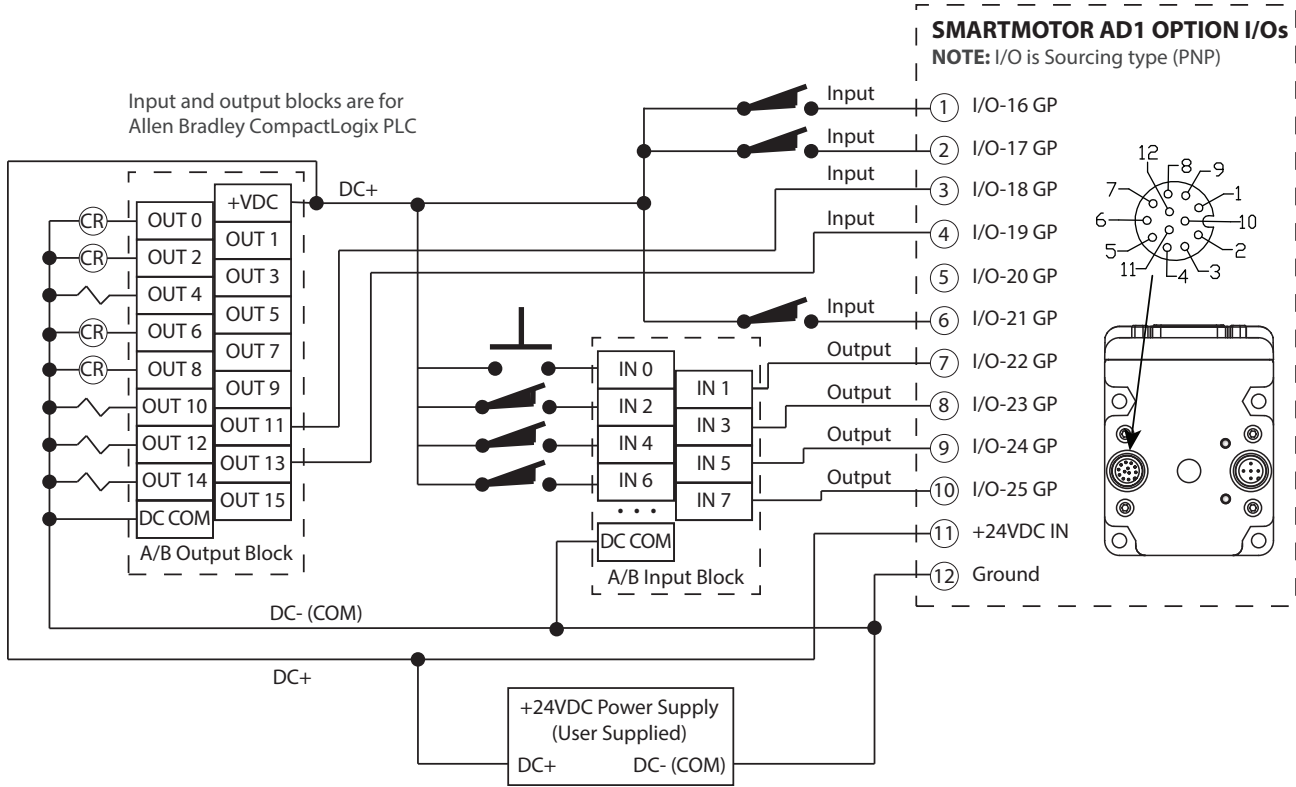
Class 5 D-Style I/O Connection Examples

The next figures show I/O connection examples for the Class 5 D-Style motors. Also, refer to Class 5 D-Style Connector Pinouts on page 66 for connector specifications.



Knowing the SmartMotor's internal schematic can be useful when designing external interfaces. SmartMotor I/O is logic 0 for voltages below 1.2V and logic 1 for voltages above 3.0V. Note that logic states for voltages between these are unpredictable.

NOTE: For improved linearity of analog potentiometers, select one that is less than or equal to the motor's internal pull-up resistor. For example, if the motor's pull-up resistor is 5 kohm, use a potentiometer that is no greater than 5 kohm.



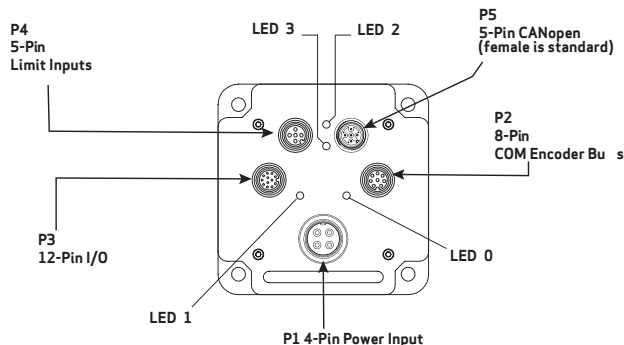
NOTE: Be sure that voltage drop across the potentiometer is appropriate for the rated wattage of the potentiometer, i.e., $Watts = Voltage^2 / Ohms$. For example, at 24 VDC and using a 10 kohm pot: $V^2/R = 0.06 Watts$.

Class 5 M-Style Connector Pinouts

This table shows the pinouts for the connectors on the Class 5 M-style SmartMotors.

PIN	Main Power	Specifications:	Notes:	P1
1	Control Power In	+12.5V Min, 32V Max	Also Supplies I/O	
2	Chassis Ground	Chassis Ground Only	Not Connected to Common	
3	Control, Com, I/O and Amplifier Ground	Common Ground (Req'd. Ground)	Nonisolated	
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	Nonisolated	
2	RS-485 B, Com ch. 0	115.2 Kbaud Max		
3	RS-485 A, Com ch. 0			
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	These I/O ports also support analog input	
2	I/O - 1 GP			
3	I/O - 4 GP			
4	I/O - 5 GP or Index			
5	I/O - 6 GP or "G" Command	300 mAmps Max		
6	I/O - 7 GP			
7	I/O - 8 GP or Brake Line Output	150 mAmps Max		
8	I/O - 9 GP			
9	Not Fault Out	12.5V Min, 28V Max		
10	Drive Enable Input			
11	+24 Volts Out	Common Ground	Nonisolated	
12	Ground Common			
NOTE: I/O ports input impedance > 10 kohms				
PIN	24V I/O Connector	Specifications:	Notes:	P4
1	+24 Volts Out	150 mAmps Max	From Control Pwr In	
2	I/O - 3 GP -Limit		Configurable (supports analog in)	
3	Ground	Common Ground	Nonisolated	
4	I/O - 2 GP +Limit	150 mAmps Max	Configurable (supports analog in)	
5	I/O - 10 GP			
Note: I/O ports input impedance > 10 kohms				
PIN	CAN Connector	Specifications:	Notes:	P5
1	NC	NC	Input current < 10 mA	
2	+V	NC except DeviceNet		
3	-V (ground)	Common Ground		
4	CAN-H	1 Mbaud Max		
5	CAN-L			

NOTE: All specifications are subject to change without notice. Consult the factory for the latest information.



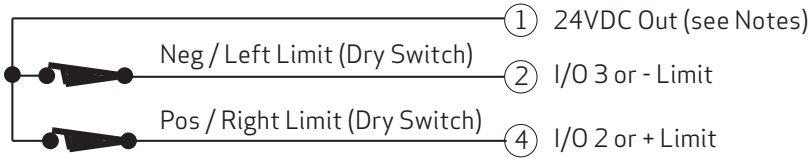
CAUTION: Exceeding 32 VDC into control power on any of the +24V pins may cause immediate damage to the internal electronics. Exceeding a sustained voltage of 48V to pin 4 of the P1 Power Input may cause immediate damage to the internal electronics. Exceeding these voltage limits will void the warranty.

CAUTION: M-style connectors must be finger tightened only! DO NOT use a tool. Doing so can cause overtightening of the connection, which may damage the connector and will void the warranty.

Class 5 M-Style I/O Connection Examples

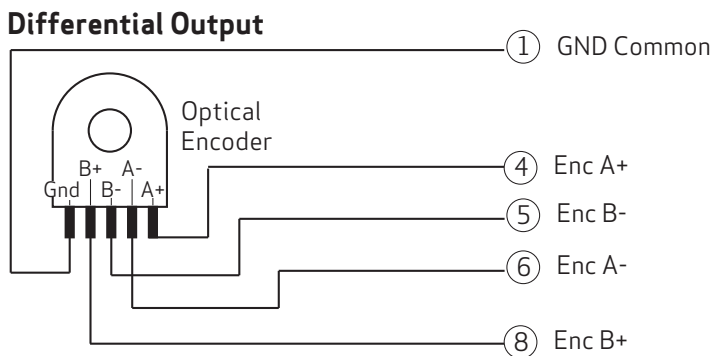
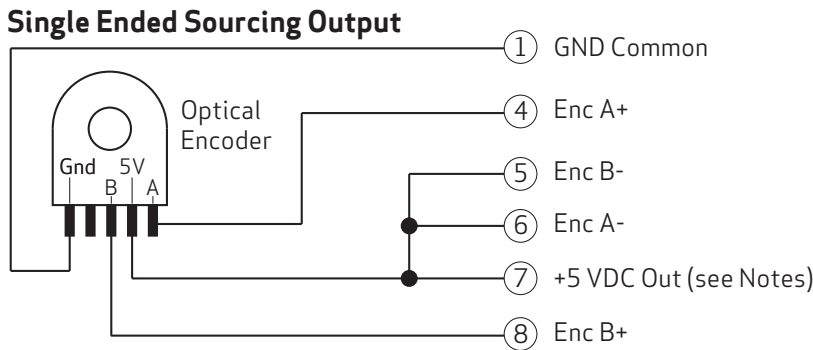
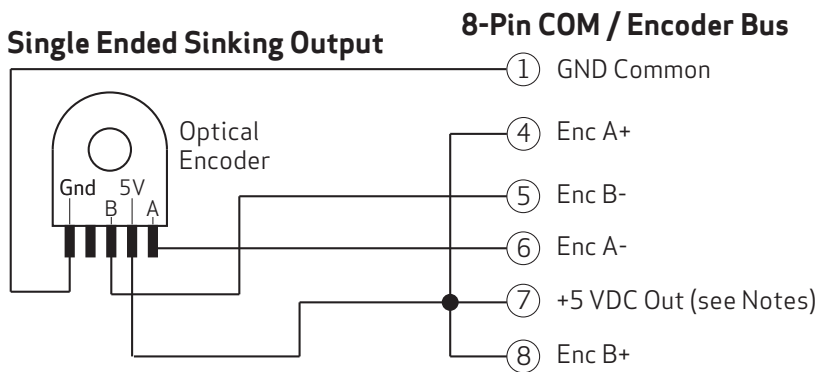
The next figures show I/O connection examples for the Class 5 M-Style motors. See the Notes at the end of this section. Also, refer to Class 5 M-Style Connector Pinouts on page 69 for connector specifications.

5-Pin Limit Inputs

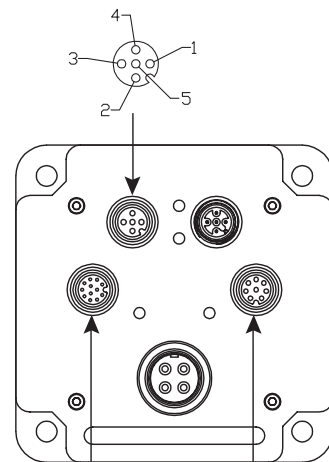


LIMIT INPUTS

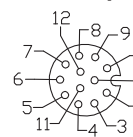
PIN	DESCRIPTION
1	+24VDC Out
2	I/O-3 or -Limit
3	GND-Common
4	I/O-2 or +Limit
5	I/O-10



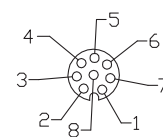
5-Pin Limit



12-Pin I/O

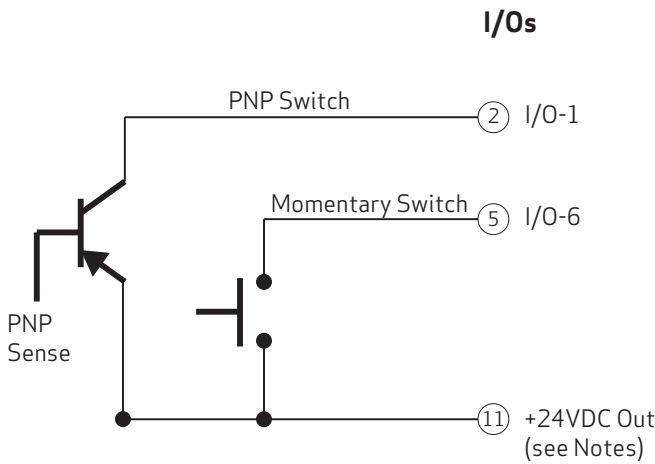


8-Pin COM



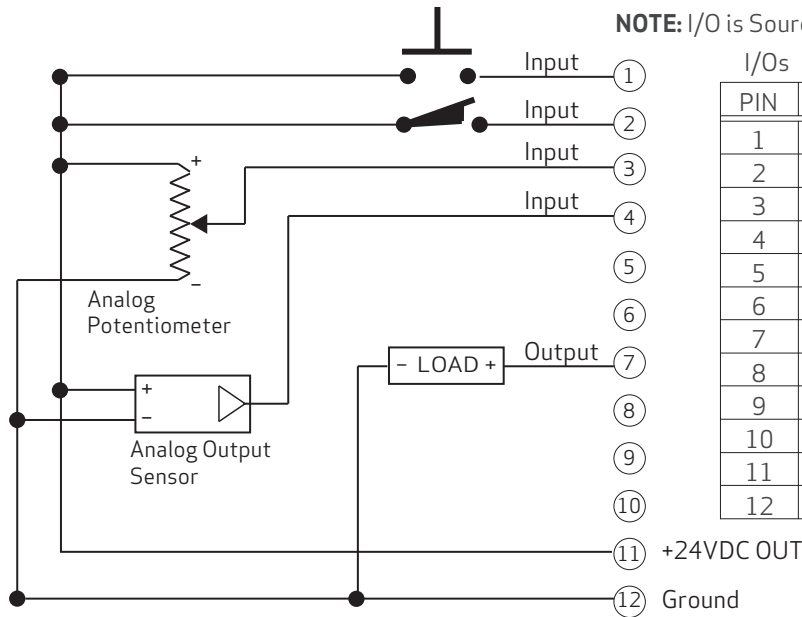
COMMUNICATION

PIN	DESCRIPTION
1	GND-Common
2	RS-485B CHO
3	RS-485A CHO
4	ENC A+ (In/Out)
5	ENC B- (In/Out)
6	ENC A- (In/Out)
7	+5VDC Out
8	ENC B+ (In/Out)



I/Os	
PIN	DESCRIPTION
1	I/O-0 GP
2	I/O-1 GP
3	I/O-4 GP
4	I/O-5 GP or Index
5	I/O-6 GP or G Cmd
6	I/O-7 GP
7	I/O-8 GP or Brake Line Output
8	I/O-9 GP
9	Not Fault Out
10	Drive Enable In
11	+24 VDC Out
12	GND-Common

Class 5 M-Style Analog Pot and Sensor



NOTE: I/O is Sourcing type (PNP)

I/Os	
PIN	DESCRIPTION
1	I/O-0 GP
2	I/O-1 GP
3	I/O-4 GP
4	I/O-5 GP or Index
5	I/O-6 GP or G Cmd
6	I/O-7 GP
7	I/O-8 GP or Brake Line Output
8	I/O-9 GP
9	Not Fault Out
10	Drive Enable In
11	+24 VDC Out
12	GND-Common

NOTE: Be sure that voltage drop across the potentiometer is appropriate for the rated wattage of the potentiometer, i.e., $Watts = Voltage^2 / Ohms$. For example, at 24 VDC and using a 10 kohm pot: $V^2/R = 0.06 Watts$.

NOTES:

I/O TYPE

The Class 5 M-Style motor I/O is Sourcing type (PNP).

DRIVE ENABLE

The Drive Enable input (pin 10) must be satisfied in order for the motor to turn.

24 VOLTS DC POWER

- If you supply control power on the main connector, the I/O connector should not be a feed through for loads, and the I/O devices should be sourced from an external power supply.
- Loads on specific outputs are allowed (when within the described limits).

DIFFERENTIAL ENCODER

The Differential Encoder inputs use the standard RS-485 chipset:

- If a true differential output TTL encoder is used, just wire A and B signals as labeled.



CAUTION: NO differential encoder signals higher than 5V TTL should be used!

+5 VDC PIN

The +5 VDC pin can only source 50 mA and is meant for RS-485 biasing only. If it is used to power an external 5V TTL encoder, the device must not draw more than 50 mA max.

Troubleshooting

This section provides troubleshooting information for common problems. For additional support resources, see: <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 33.
	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. This is done in the Windows Device Manager> Advanced Settings dialog box for the associated COM port driver.
	Poor connection on cable from motor to PC.	Check the cable connections and/or replace it.
	Power supply unit (PSU) brownout.	PSU may be 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 redetection.	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. If there is more than one motor in a serial daisy chain, ensure the ECHO command is in the downloaded program.
Red PWR SERVO light illuminated.	Red LED indicates the drive stage is OFF. This may be due to never having been turned on yet, or a critical shaft protection fault.	To discover the source of the fault, use the Motor View tool located on the SMI software Tools menu.
Motor doesn't turn.	Faults not cleared and/or drive enable not satisfied.	Clear faults (see Checking and Clearing the Status Bits on page 57). Satisfy the drive enable input (see M-Style Drive Enable Power on page 33).
Common Faults		
Bus voltage fault.	Bus voltage is too high for operation.	Check servo bus voltage. Check for excessive regenerative energy from motor due to no/insufficient shunt resistor.
	Bus voltage is too low for operation.	If motor uses the DE power option (separate drive and control power supplies), ensure that both power supplies are connected and are sized correctly for the motor.
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 lower acceleration profiles.

For Further Information...

Issue	Cause	Solution
Excessive temperature fault.	Motor has exceeded internal PCB 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. Check motor sizing for the application in terms of continuous rating. 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. Also, ensure you are not voltage limited for the torque at speed required. If running from less than 48 VDC, check ratings for lower bus voltages and ensure the motor is within required torque capacity.
Motor faults on position error only after a certain amount of time.	Motor sized incorrectly.	Check motor sizing for the application in terms of continuous rating. Also, ensure you are not voltage limited for the torque at speed required. If running from less than 48 VDC, check ratings for lower bus voltages and ensure the motor is within required torque capacity.
Motor is not accurately corresponding to trajectory.		
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.
No "Drive Ready" state.	Absolute Encoder Battery fault.	Check Status Word 6, bit 12.
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 Motor Properties.

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.

TAKE A CLOSER LOOK

Moog Animatics, a sub-brand of Moog Inc. since 2011, is a global leader in integrated automation solutions. With over 30 years of experience in the motion control industry, the company has U.S. operations and international offices in Germany and Japan as well as a network of Automation Solution Providers worldwide.

Americas - West
Moog Animatics
2581 Leghorn Street
Mountain View, CA 94043
United States

Americas - East
Moog Animatics
1995 NC Hwy 141
Murphy, NC 28906
United States

Europe
Moog GmbH
Memmingen Branch
Allgaeustr. 8a
87766 Memmingerberg
Germany

Asia
Moog Animatics
Kichijoji Nagatani City Plaza 405
1-20-1, Kichijojihoncho
Musashino-city, Tokyo 180-0004
Japan

Tel: +1 650-960-4215
Email: animatics_sales@moog.com

Tel: +49 8331 98 480-0
Email: info.mm@moog.com

Tel: +81 (0)422 201251
Email: mcg.japan@moog.com

For Animatics product information, visit www.animatics.com

For more information or to find the office nearest you, email animatics_sales@moog.com

Moog is a registered trademark of Moog Inc. and its subsidiaries.
All trademarks as indicated herein are the property of Moog Inc. and its subsidiaries.
©2001-2023 Moog Inc. All rights reserved. All changes are reserved.

Moog Animatics Class 5 SmartMotor™ Installation and Startup Guide,
Rev. L, March 2023, PN: SC80100000-002