PROFINET® IMPLEMENTATION FOR

FULLY INTEGRATED SERVO MOTORS

CLASS 6 SMARTMOTOR™ WITH COMBITRONIC™ TECHNOLOGY

Rev. G, October 2022

DESCRIBES THE CLASS 6 SMARTMOTOR™ SUPPORT FOR THE PROFINET® PROTOCOL

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MOOG ANIMATICS

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Moog Animatics Class 6 SmartMotor™ PROFINET Guide, Rev. G, PN: SC80100007-001.

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 "PROFINET 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

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

Purpose

This manual explains the Moog Animatics Class 6 SmartMotor™ support for the PROFINET® protocol. It describes the major concepts that must be understood to integrate a SmartMotorfollower with a PLC or other PROFINET controller[1]. However, it does not cover all the low-level details of the PROFINET protocol.

NOTE: The feature set described in this version of the manual refers to motor firmware 6.0.2.41 (Class 6 M) / 6.4.2.50 (Class 6 D) or later.

This manual is intended for programmers or system developers who understand the use of PROFINET. (The PROFINET v2.2 specifications are detailed in the following IEC publications: IEC61158-6-10 Ed2.0, IEC61158-5-10 Ed2.0 and IEC61784-2 Ed2.0.) Therefore, this manual is not a tutorial on those specifications or the PROFINET protocol. Instead, it should be used to understand the specific implementation details for the Moog Animatics SmartMotor. Additionally, examples are provided for the various modes of motion and accessing those modes through PROFINET to operate the SmartMotor.

The Command and Response Code chapter of this manual includes details about the specific commands available in the SmartMotor through the PROFINET protocol. The commands include those required by the specification and those added by Moog Animatics. For details, see Command and Response Codes on page 50. Also, see User Program Commands on page 35.

In addition to this manual, it is recommended that you visit the PROFINET/PROFIBUS website (at http://www.profibus.com), where you will find documentation, tutorials, and other useful resources.

Class 6 M-Style SmartMotor: MT (Left) vs. MT2 (Right)

Class 6 D-Style SmartMotor

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

PROFINET Overview

PROFINET is an independent, open fieldbus standard that allows different manufacturers of automation products to communicate without special interface adjustments. Specifically, PROFINET, which is optimized for high speed, is designed to communicate between control systems and distributed I/O at the device level.

Moog Animatics has defined a set of 8-bit command and response codes to be transmitted and received over PROFINET. For details, see Command Packet Codes to Motor Commands on page 51. These codes generally correspond to Class 5 and Class 6 SmartMotor™ commands. To set target position, for example, the "set target position" command code is transmitted together with the data consisting of the target position value.

The PROFINET SmartMotor is a SmartMotor with the addition of the PROFINET connectors and interface board, which then accepts commands as a follower over a PROFINET network. In addition to communicating over PROFINET, SmartMotor commands may be sent through other communication interfaces of the SmartMotor. Depending on the SmartMotor model, it may also communicate over RS-232, RS-485 and/or USB.

The Moog Animatics communications profile over PROFINET is intended to integrate well with a PLC that continuously transmits and receives cyclic data. The command and response codes achieve this through a handshaking mechanism.

Certain configuration data is held in nonvolatile storage in the SmartMotor. Therefore, the motor data EEPROM must be correctly initialized before PROFINET operation.

A PROFINET Generic Station Description (GSD) configuration file, which is an XML file (also referred to as a "GSDML" file), is necessary for the host to configure the PROFINET controller and to connect to the follower motor. Make sure you obtain the latest version of the file, which is available from the Moog Animatics website Download Center. For more details, see Software on page 9.

Document sections include Output and Input data formats (PROFINET cargo), a list of the Moog Animatics PROFINET command codes explained in terms of the equivalent SmartMotor commands, and a list of Moog Animatics PROFINET response codes explained in terms of the equivalent SmartMotor commands.

Equipment Required

The section describes the required PROFINET hardware and software.

Hardware

The following hardware is required:

- Moog Animatics PROFINET SmartMotor™
- Moog Animatics power supply or user-supplied equivalent
- Moog Animatics RS-485 or USB communications cable that is compatible with the SmartMotor
- User-supplied PC with the Microsoft Windows operating system
- User-supplied PLC with PROFINET controller or other PROFINET controller
- Moog Animatics PROFINET cable, or equivalent, to connect the PLC to the SmartMotor's industrial Ethernet port (for details, see Motor Connectors and Pinouts on page 1)

Software

The following software is required:

- User-supplied PLC configuration software
- Moog Animatics SMI software (latest version), which is available on the Moog Animatics website Support > Downloads > Software tab at:

  www.animatics.com/support/downloads.software.html

- Moog Animatics PROFINET GSDML file, which is available on the Moog Animatics website Products > SmartMotor > Resources tab at:

  www.animatics.com/products/smartmotor.resources.html

  After opening that page, click Fieldbus Configurator Files > PROFIBUS.

  NOTE: The PROFINET GSD configuration file name will have the form "GSDML-Vx.x-MOOG ANIMATICS-SMC06DEV01-date.XML", where 'x.x' is the version and 'date' is the release date. Make sure you obtain the latest version of the file.

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 11.

Motor Sizing

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

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

Environmental Considerations

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

Machine Safety

In order to protect personnel from any safety hazards in the machine or system, the machine/system builder must perform a "Risk Assessment", which is often based on the ISO 13849 standard. The design/implementation of barriers, emergency stop (E-stop) mechanisms and other safeguards will be driven by the Risk Assessment and the safety standards specified by the governing authority (for example, ISO, OSHA, UL, etc.) for the 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

- *Class 6 D-Style SmartMotor™ Installation and Startup Guide*

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

- *Class 6 M-Style SmartMotor™ Installation and Startup Guide*

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

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

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

Additional Resources

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

PROFINET and PROFIBUS Resources

PROFINET and PROFIBUS are common standard maintained by PROFIBUS and PROFINET International (PI):

- PROFIBUS and PROFINET International (PI) website:

  http://www.profibus.com/

Status LEDs

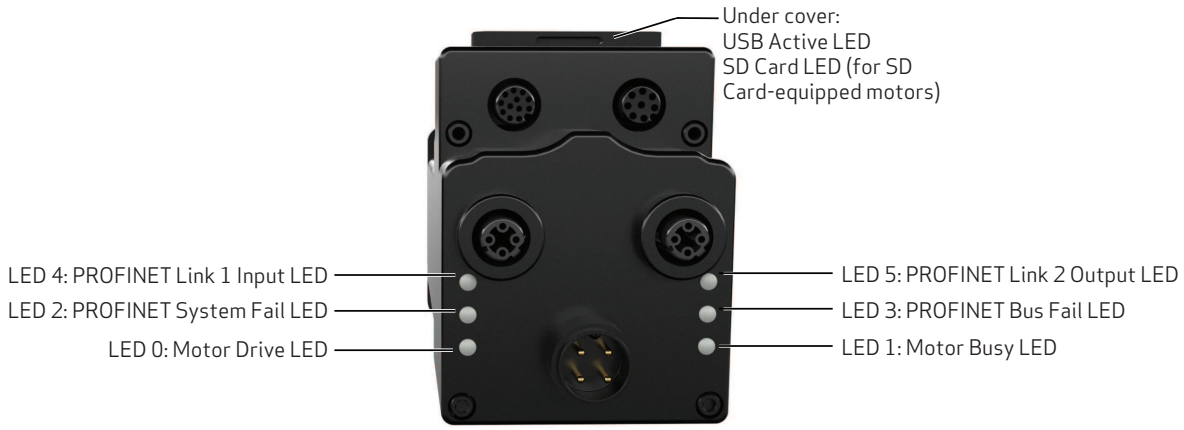
This chapter provides a description of the SmartMotor status LEDs.

NOTE: For information on the SmartMotor's connector pinouts and cable diagrams, refer to the corresponding SmartMotor Installation and Startup Guide.

NOTE: If you have set your PC's network adapter to a fixed IP address for temporary connections to SmartMotors with SMI, remember to return it to DHCP when done to avoid local area network connectivity issues.

Status LEDs - Class 6 M-Style

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



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

SD Card LED (for SD Card-equipped motors)

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

USB Active LED

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

LED 0: Motor Drive LED

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

LED 1: Motor Busy LED

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

LED 2: PROFINET System Fail LED

Off	No error
Flashing red	Network detected, configured, waiting for connection
Solid red	Application controller failure

LED 3: PROFINET Bus Fail LED

Off	No Error
Solid red	PROFINET Bus failed

LED 4: PROFINET Link 1 Port LED

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

LED 5: PROFINET Link 2 Port LED

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

LED Status on Power-up:

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

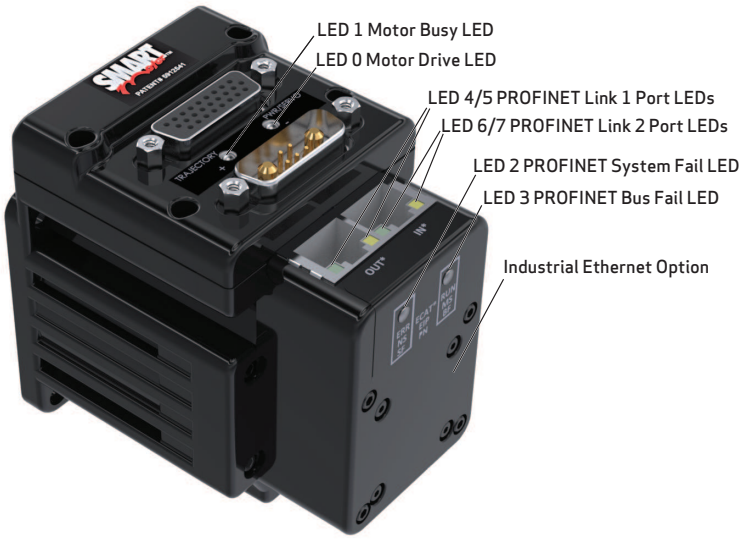
LED 1 Fault Codes:

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

*Busy LED pauses for 2 seconds before flashing the code

Status LEDs - Class 6 D-Style

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



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

LED 0: Motor Drive LED

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

LED 2: PROFINET System Fail LED

Off	No error
Flashing red	Network detected, configured, waiting for connection
Solid red	Application controller failure

LED 4 & 5: PROFINET Link 1 Port LEDs

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

LED 1: Motor Busy LED

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

LED 3: PROFINET Bus Fail LED

Off	No Error
Solid red	PROFINET Bus failed

LED 6 & 7: PROFINET Link 2 Port LEDs

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

LED Status on Power-up:

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

LED 1 Fault Codes:

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

*Busy LED pauses for 2 seconds before flashing the code

PROFINET Configuration

The following sections describe how to configure your SmartMotor to communicate over PROFINET.

Configure Motor with PC

Use the following procedure to configure the SmartMotor for communication with the PC. Refer to the figures in PROFINET Communication Example on page 23.

1. Connect the SmartMotor to the power supply.
2. If the motor is already configured, you may skip the balance of this procedure.
3. Connect the motor to the PC.
4. Launch the SmartMotor™ Interface (SMI) software, version 2.4.3.6 or later.

User Program Requirements

No user program is specifically required by the Class 6 PROFINET SmartMotor.

Required Nonvolatile EEPROM Values

The nonvolatile settings can be entered using the SMI software's Terminal window. For details on using the Terminal window, see the SMI software online help.

After the configuration settings have been entered, cycle the SmartMotor's power for the new configuration to take effect.

To change the nonvolatile station name for PROFINET within a user program, see the following code example:

```
...
SNAME("mymotor1")
a=ETH(0)
IF(a&2)
  Z       'Execute reset if Station Name changed
ENDIF
...
```

Configure PLC with PC

Use the following procedure to configure the PLC for communication with the PC. Refer to the figures in PROFINET Communication Example on page 23.

NOTE: You may skip this section if the PLC is already configured.

1. Using the PLC configuration software running in a PC, load the SmartMotor's GSDML (XML) file, set it up as a PROFINET device from the catalog, and define the correct Station Name. For more details on the GSDML file, see Software on page 9.
2. Determine the location of the PLC memory to exchange three words (six bytes) of PROFINET output to the motor and the seven words (fourteen bytes) of input from the SmartMotor. The GSDML file defines the three output words and seven input words, but it does not specify where this is located in the PLC memory. That location is determined by the configuration tools supplied by the PLC manufacturer.

Configure SmartMotor to PROFINET

Use the following procedure to configure the SmartMotor to PROFINET. Refer to the Status LEDs - Class 6 M-Style on page 16 or Status LEDs - Class 6 D-Style on page 17.

1. Verify the corresponding Link LED is ON (green) with possible occasional flashing, which indicates there is communication traffic.
2. After connecting the motor, the System Fail LED should go from solid red to flashing red, which indicates it is waiting for an I/O controller.
3. After the I/O controller makes a connection, the System Fail LED turns off.

PLC Sends Commands to Motor

Program the PLC or modify by hand the PLC memory areas, as described below, to send the desired commands over PROFINET and communicate with the motor.

The following are sequences of commands sent, which show all the intermediary PROFINET packet output data states.

NOTE: Bold characters indicate changes in the PLC memory output buffer and input buffer values.

Network Data Format Example

Each byte below is represented as two hexadecimal characters. For example, 7A represents hex 7A or decimal 122.

COMMAND FROM I/O CONTROLLER						RESPONSE FROM SMART MOTOR			
Cmd Code	Resp Code	Data		Cmd Code Ack	Resp Code Ack	Resp Data	Status Word	Measured Position	Pos Error
00	7A	0000 0000	.....	00	00	0000 0000	0680	0000 0000	0000

The following are the SmartMotor's Status Word response bit definitions (the response shown above is 0680).

Bit	Description
0	Busy Trajectory
1	Historical + limit (hardware and software limit)
2	Historical - limit (hardware and software limit)
3	Index report available for the rising edge of internal encoder
4	Position wraparound occurred
5	Position error fault
6	Temperature limit fault
7	Drive off
8	Index input active
9	+ limit active (hardware and software limit)
10	- limit active (hardware and software limit)
11	Communication error of any type
12	Network user bit, defined by ETHCTL(12,x) command, see User Program Commands on page 35
13	Command error (includes math and array errors)
14	Peak overcurrent occurred
15	Drive ready

PLC Memory

Each byte below is represented as two hexadecimal characters. For example, 0680 represents hex 680 or decimal 134.

Output to follower motor:	Input from follower motor:
3 two-byte words out	7 two-byte words in
0000 0000 0000	0000 0000 0000 0086 0000 0000 0000

A status word of 0x0680 (which breaks down to the bits 0000 0110 1000 0000) indicates the servo is off, the left and right limits have been activated, and the drive is not ready.

Sequence to Set Report Data to Motor Clock

Command Code	Response Code	Data	Motor Command
	0x7A		RCLK

Insert response code 0x**7A** in the output buffer, which is being transmitted continuously (i.e., cyclically) by the controller to the follower motor. See Command Packet Codes to Motor Commands on page 51 to find response code RCLK and its value, hex 7A.

00**7A** 0000 0000 0000 0000 0000 0680 0000 0000 0000

Wait for response code acknowledge in the input buffer, which is being received continuously (i.e., cyclically) by the controller as a response from the follower motor. The clock data begins being cyclic updates.

007A 0000 0000 00**7A** 0000 03A1 0680 0000 0000 0000

As time goes on, the clock data is updated.

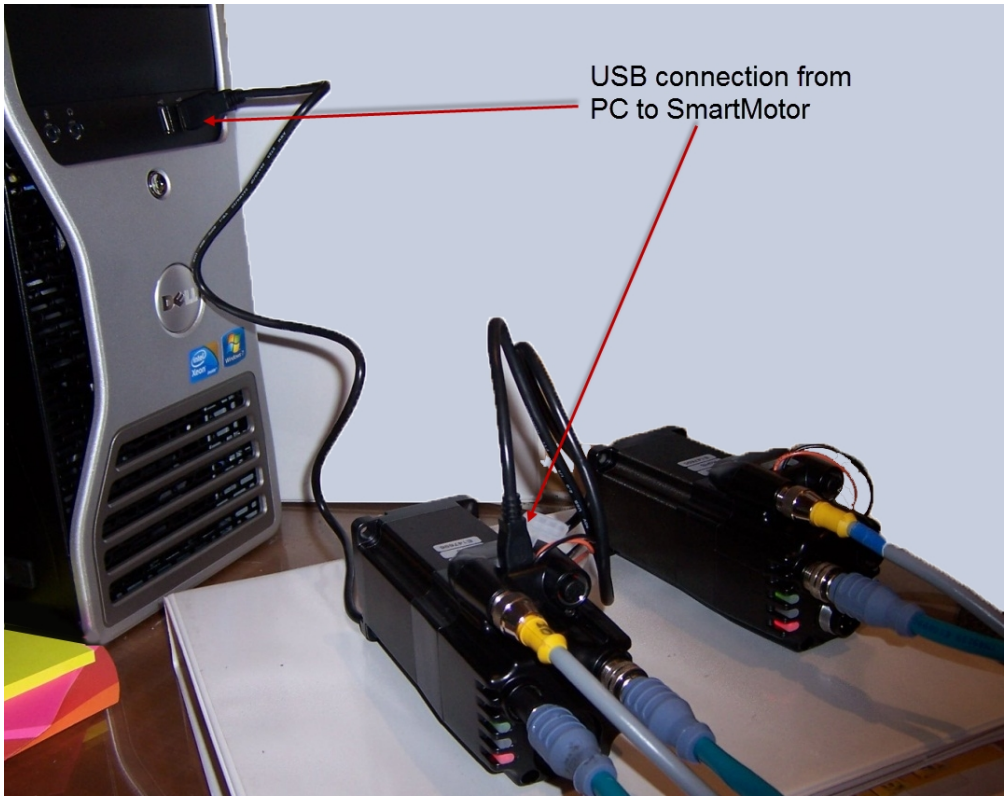
007A 0000 0000 007A **0001 B01A** 0680 0000 0000 0000

PROFINET Communication Example

The following example illustrates PROFINET communications. It sends commands from a PLC over PROFINET to cause the SmartMotor to continually report its changing clock value to the PLC. The value is displayed by the PLC registers containing the PROFINET data received from the motor. It changes as the updated clock value is received.

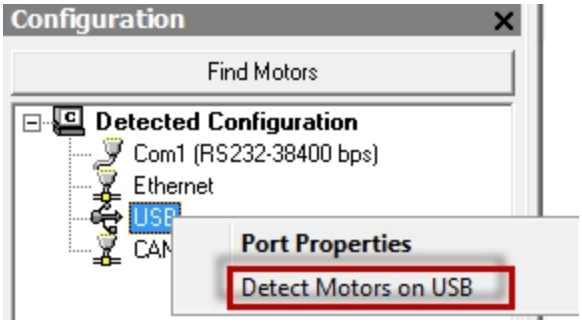
To create a PROFINET connection to the SmartMotor:

1. Install the SMI software. For more details, see the *Moog Animatics Class 6 SmartMotor™ Installation & Startup Guide*.
2. Connect control power to the 12-pin connector.
    a. Pin 11 is 24 Volt control power.
    b. Pin 12 is Ground or 24 Volt low.
3. Connect a USB cable from the PC to the USB connector on the SmartMotor. Refer to the following figure.

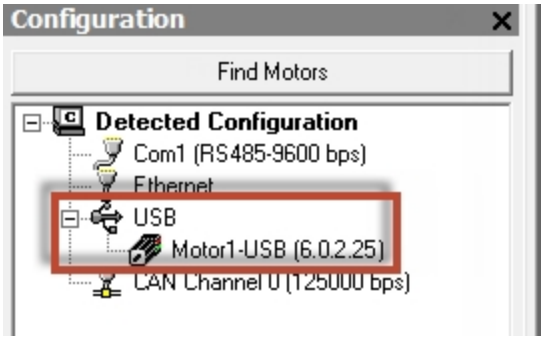


USB Connection from PC to SmartMotor

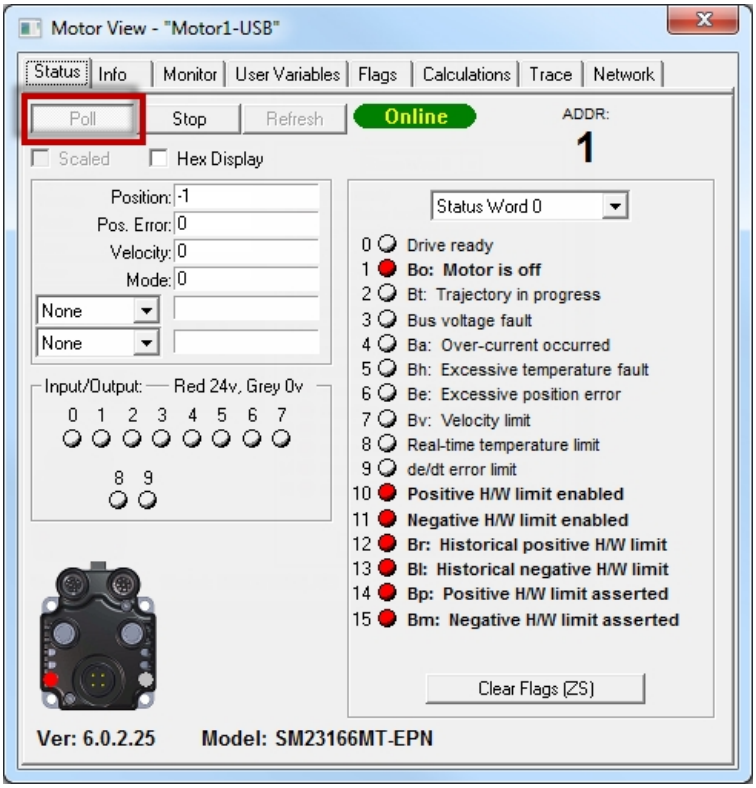
4. In the SMI software Configuration window, right-click the USB category and select Detect Motors on USB from the menu.



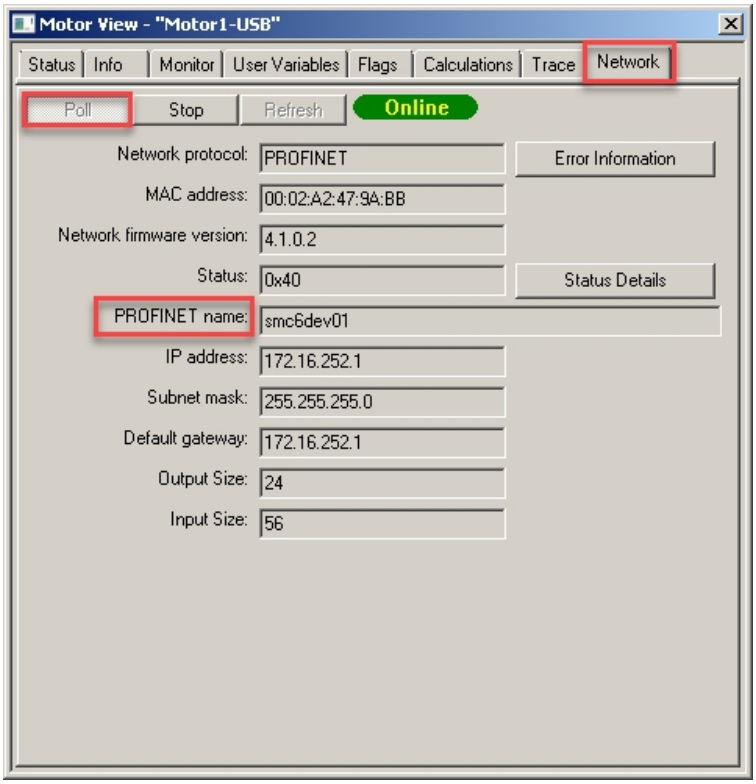
When detection has completed, Motor 1 will be shown under the USB network.



5. Double click Motor1 to open the Motor View tool. Click Poll to update the Status.



6. Select the Network tab and then Poll again. Note the default PROFINET name.



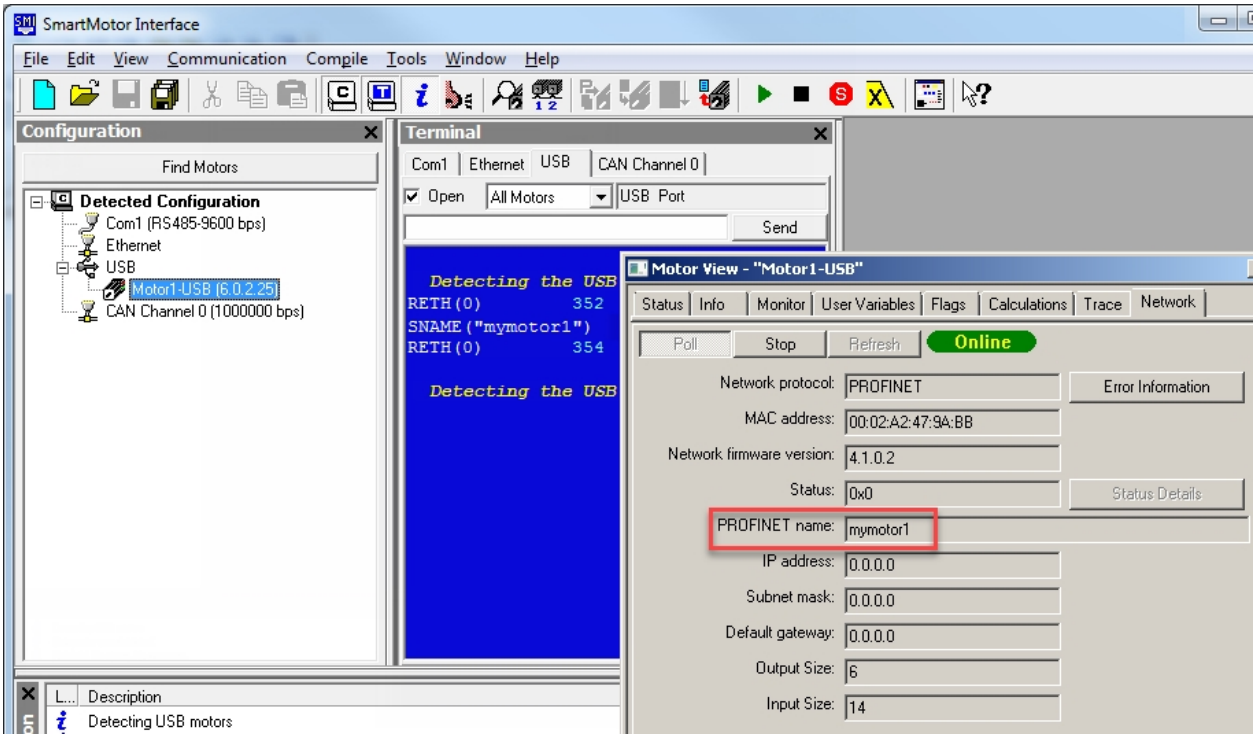
7. Set the station name. Refer to the Terminal window in the following figure.
    a. Execute RETH(0) to get the current Ethernet interface status bit (352 decimal = 160 hex).
    b. Type SNAME("mymotor1") into the Terminal window.

       Use the following PROFINET name conventions:

       - Characters a-z (lowercase only, uppercase is not permitted)
       - Numbers 0-9, but cannot start with a number
       - No underscores or other special characters; the hyphen and period are permitted, but not as the first or last character
       - No more than 127 characters total or 63 characters as a name component within the device name (e.g., a character string between two periods); may be further limited by your configuration software
       - Cannot be formatted as an IP address (dotted-decimal notation)
       - Cannot begin with the characters "port-nnn-", where "nnn" are three numeric characters 0-9 (e.g., port-735-)

    c. Execute RETH(0) to get the updated Ethernet interface status bit (354 decimal = 162 hex). After the station name has changed, the status for the report from RETH(0) should indicate a PROFINET status configuration change on Bit 1 (zero based). Refer to User Program Commands on page 35.

       NOTE: The new station name in the following figure (in the red box) won't be shown until power is cycled and the motor is redetected. Refer to the next step.



Entering and Verifying the Station Name

8. Cycle motor power to use the new configuration and station name. Refer to the red box in the previous figure.
9. Configure your PLC through its serial port using a PC that is running your PLC configuration software.
    a. Load the motor's PROFINET GSDML file.
    b. Assign and display the PLC registers associated with the motor's PROFINET input and output data.
10. Connect the PROFINET cable to the PLC and the SmartMotor.
11. Power cycle the SmartMotor to initialize it with the configured values.
12. Enter the PROFINET motor response code to report the motor clock in the PLC PROFINET data registers (i.e., in the "3 words out", the second byte is the motor response code).
    a. Using a PC that is running your PLC software, and with your PLC online, enter the PROFINET response code 122 decimal, x7A hex into the "response code" field.
    b. Watch the clock value being updated in your PLC PROFINET input registers "7 words in", bytes 2-5.

For examples of sending command sequences and communication handshaking, refer to Sample Command Sequences on page 27.

Sample Command Sequences

This chapter contains sample PROFINET command sequences.

Overview

These sequences illustrate:

- Disabling limits from preventing motion
- Turning the shaft in torque mode
- Moving a relative distance
- Command and response codes
- Handshaking of messages

Command and Response Codes

The command and response codes are described in Command Packet Codes to Motor Commands on page 51 The symbolic command and response codes are listed, along with their values and the related SmartMotor™ command. See Output and Input Packets on page 41 for further explanation of how to use the command and response codes.

Handshaking of Messages

Handshaking of output message changes is included in the protocol to ensure coherence in the packet. See Output and Input Packets on page 41 for an explanation of handshaking.

Disabling Limits from Preventing Motion

At power up, if limit switches are not connected to the motor, the electrical state of the limit pins will default to indicate that the motor is at the limits. This will prevent motion unless the limits are disabled and any limit faults are cleared.

These commands may be included in the user program that is downloaded to the motor and runs at power up. If the user program does *not* include these commands or the limits are not held inactive at power-up, before attempting to turn the motor shaft, you must perform the command sequence described in Disable Limits and Clear Fault Status on page 29.

Turning the Motor Shaft

After disabling the limits and clearing any faults, the shaft may be turned using the following command sequences:

- Initiate Mode Torque on page 31
- Initiate Relative Position Move on page 33

These sequences are described in following sections.

Disable Limits and Clear Fault Status

Commands

Command Code	Response Code	Data	Resulting SmartMotor Command
0x01		0x30	EIGN(2)
0x01		0x33	EIGN(3)
0x01		0x44	ZS

PLC Memory

Output to follower motor:

3 words out

0000 0000 0000

Input from follower motor:

7 words in

0000 0000 0000 0680 0000 0000 0000

Cmd Code	Resp Code	Data		Cmd Code Ack	Resp Code Ack	Resp Data	Status Word	Measured Position	Pos Error
00	7A	0000 0000	.....	00	00	0000 0000	0680	0000 0000	0000

Disable positive limit, command EIGN(2)

Insert command EIGN(2) data = 0x30 in the output buffer, which is being transmitted continuously (i.e., cyclically) by the controller to the follower motor.

0000 0000 00**30** 0000 0000 0000 0680 0000 0000 0000

Set command code 0x01 in the output buffer.

0100 0000 0030 0000 0000 0000 0680 0000 0000 0000

Wait for a command code acknowledge in the input buffer, which is being received continuously (i.e., cyclically) by the controller as a response from the follower motor.

0100 0000 0030 **01**00 0000 0000 0480 0000 0000 0000

The command code acknowledges the motor has received the command.

Clear the command code in the output buffer (handshake) to prepare for the next command.

0000 0000 0030 0100 0000 0000 0480 0000 0000 0000

Wait for acknowledgment of the cleared command code.

0000 0000 0030 **00**00 0000 0000 0480 0000 0000 0000

Disable negative limit, command EIGN(3)

Insert command EIGN(3) data = 0x33 in the output buffer, which is being transmitted continuously (i.e., cyclically) by the controller to the follower motor.

0000 0000 00**33** 0000 0000 0000 0480 0000 0000 0000

Set command code 0x01in the output buffer.

0100 0000 0033 0000 0000 0000 0480 0000 0000 0000

Wait for command code acknowledge in the input buffer, which is being received continuously (i.e., cyclically) by the controller as a response from the follower motor.

0100 0000 0033 **01**00 0000 0000 **0080** 0000 0000 0000

The command code acknowledges the motor has received the command.

Clear the command code in the output buffer (handshake) to prepare for the next command:

0000 0000 0033 0100 0000 0000 0080 0000 0000 0000

Wait for acknowledgment of the cleared command code.

0000 0000 0033 **00**00 0000 0000 0080 0000 0000 0000

Clear fault status, command ZS

Insert command ZS data = 0x44 in output buffer, which is being transmitted continuously (i.e., cyclically) by the controller to the follower motor.

0000 0000 00**44** 0000 0000 0000 **0086** 0000 0000 0000

Set command code 0x01in the output buffer.

0100 0000 0044 0000 0000 0000 0086 0000 0000 0000

Wait for command code acknowledge in the input buffer, which is being received continuously (i.e., cyclically) by the controller as a response from the follower motor. Fault status is reported cleared to 0x**0080**.

0100 0000 0044 **01**00 0000 0000 **0080** 0000 0000 0000

The command code acknowledges the motor has received the command.

Clear command code in output buffer (handshake) to prepare for the next command.

0000 0000 0044 0100 0000 0000 0080 0000 0000 0000

Wait for acknowledgment of the cleared command code.

0000 0000 0044 **00**00 0000 0000 0080 0000 0000 0000

Initiate Mode Torque

Commands

Command Code	Response Code	Data	Resulting SmartMotor Command
0x94	0xA2	3072 (0x0c00)	T=3072 RVA (polled motor response)
0x01	0xA2	0x21	MT RVA (polled motor response)
0x01		0x0C	G (begin motion)

PLC Memory

Output to follower motor:	Input from follower motor:
3 words out	7 words in
0000 0000 0000	0000 0000 0000 0080 0000 0000 0000

Set torque value, specify the response data

This will command T=3072 and specify the response data to be the current velocity.

Begin to set torque T=3072 by putting **x 00 00 0C 00** in output data.

0000 **0000 0C00**	0000 0000 0000 0080 0000 0000 0000

Insert command code 0x**94** and response code 0x**A2**.

94A2 0000 0C00	0000 0000 0000 0080 0000 0000 0000

Wait for acknowledge in input buffer:

94A2 0000 0C00	**94A2** 0000 0000 0080 0000 0000 0000

Now, T=3072 (0x0c00), and the response data value will be velocity. Clear the command code output buffer (handshake) to prepare for the next command.

00A2 0000 0C00	94A2 0000 0000 0080 0000 0000 0000

Wait for acknowledgment of command code clear in input buffer.

00A2 0000 0C00	**00**A2 0000 0000 0080 0000 0000 0000

Initiate torque mode, command MT

Insert command 0x21 data to begin torque mode.

00A2 **0000 0021**	00A2 0000 0000 0080 0000 0000 0000

Insert command code 0x01.

01A2 0000 0021	00A2 0000 0000 0080 0000 0000 0000

Wait for command code 1 acknowledgment.

01A2 0000 0021	**01**A2 0000 0000 0080 0000 0000 0000

Insert command code 0x00.

00A2 0000 0021	01A2 0000 0000 0080 0000 0000 0000

Wait for command code 0 acknowledgment.

00A2 0000 0021	**00**A2 0000 0000 0080 0000 0000 0000

Insert command 0x0C data to initiate open-loop motion.

00A2 0000 **000C**	00A2 0000 0000 0080 0000 0000 0000

Insert command code 0x01.

01A2 0000 000C	00A2 0000 0000 0080 0000 0000 0000

When the command is received by the motor, the motor shaft will begin turning if it is not in a fault state.

Wait for command code acknowledgment in the input buffer.

01A2 0000 000C	**01**A2 0000 0000 0080 0000 0000 0000

Velocity becomes nonzero, and it is reported as 0x**00 14 00 00** in this example. Status changes are reported as 0x**0009** in this example. Position becomes nonzero, and it is reported as 0x**00 00 00 A2** in this example.

01A2 0000 000C	01A2 **0014 0000 0009 0000 00A2** 0000

Insert command code 0x00 to clear the command code output buffer (handshake) to prepare for the next command. The position is continually updated. Velocity is a filtered value measured in:

encoder counts per sample period x 65,536

00A2 0000 000C	01A2 0014 0000 0009 **0000 02EE** 0000

Wait for the command code clear acknowledge in the input buffer.

00A2 0000 0000	**00**A2 0014 0000 0009 **0000 05DC** 0000

Set data to 0.

0000 0000 0000	00A2 0014 0000 0009 0000 05DC 0000

Initiate Relative Position Move

Commands

Command Code	Response Code	Data	Resulting SmartMotor Command
0x64		255 (0xff)	ADT=255
0xA3		100000	VT=100000
0x01		0x1D	Change to Mode Position (MP)
	0xA2		RVA (polled motor response)
0x03		10000	PRT=10000 G

PLC Memory

Output to follower motor:
3 words out
0000 0000 0000

Input from follower motor:
7 words in
0000 0000 0000 0080 0000 0000 0000

Set acceleration value, command ADT=255

Begin to set ADT=255 by putting x**00 00 00 FF** in output data.

0000 **0000 00FF** 0000 0000 0000 0080 0000 0000 0000

Insert command code 0x64 and response code 0xA2.

64A2 0000 00FF 0000 0000 0000 0080 0000 0000 0000

Wait for acknowledge in input buffer.

64A2 0000 00FF **64A2** 0000 0000 0080 0000 0000 0000

Now, ADT=255, and the response data value will be velocity. Clear the command code output buffer (handshake) to prepare for the next command.

00A2 0000 00FF 64A2 0000 0000 0080 0000 0000 0000

Wait for acknowledge of command code clear in input buffer.

00A2 0000 00FF **00**A2 0000 0000 0080 0000 0000 0000

Set maximum velocity value, command VT=100000

Insert code commanded velocity of VT=100000 = 0x**0001 86A0**.

00A2 **0001 86A0** 00A2 0000 0000 0080 0000 0000 0000

Insert command code 0x**A3** to set VT=100000.

A3A2 0001 86A0 00A2 0000 0000 0080 0000 0000 0000

Wait for command code acknowledge in the input buffer.

A3A2 0001 86A0 **A3**A2 0000 0000 0080 0000 0000 0000

Insert command code 0x**00**.

00A2 0001 86A0 A3A2 0000 0000 0080 0000 0000 0000

Wait for command code acknowledge in the input buffer.

00A2 0001 86A0 **00**A2 0000 0000 0080 0000 0000 0000

Insert data 0x**0000 001D** for MP when command is 1.

00A2 0000 001D 00A2 0000 0000 0080 0000 0000 0000

Insert command code 0x**01**.

01A2 0001 86A0 00A2 0000 0000 0080 0000 0000 0000

Wait for command code acknowledge in the input buffer.

01A2 0001 86A0 **01**A2 0000 0000 0080 0000 0000 0000

Insert command code 0x**00**.

00A2 0001 86A0 **01**A2 0000 0000 0080 0000 0000 0000

Make a relative position move

Insert data for a relative move of 10,000 counts = 0x**0000 2710**.

00A2 **0000 2710** 00A2 0000 0000 0080 0000 0000 0000

Insert command code value 0x03.

03A2 0000 2710 00A2 0000 0000 0080 0000 0000 0000

Wait for command code acknowledge in the input buffer.

03A2 0000 2710 **03**A2 0000 0000 0080 0000 0000 0000

The motor performs its move. While the trajectory is in the slew phase, you will see something like:

03A2 0000 2710 03A2 0001 86AD 0009 0000 CA23 0011

which is the following input data:

command code acknowledge	03
response code acknowledge	A2
response data current velocity (100,000 in slew)	0001 86AD
status	0009
Bt = 1	
Bi = 1	
measured current position	0000 CA23
measured current position error	0011

User Program Commands

The SmartMotor's EEPROM can store nonvolatile PROFINET information about the network. For proper PROFINET operation, each SmartMotor must have a unique station name set with the SNAME instruction. This is can be accomplished: at the PLC over PROFINET; with SMI and a USB connection over channel 8, or RS-485 on channel 0; with a SmartMotor user program.

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

The following sections list the commands used to operate the motor on a PROFINET network.

SNAME("string")

Set PROFINET Station Name

The SNAME command is used to set a unique PROFINET station name. The setting is nonvolatile. It can use up to 54 characters; the factory default is smc6dev01. It will set the configuration change bit (Bit 1) returned by the ETH/RETH command (see below) if the Station Name has changed from the previous value in EEPROM.

Use the following PROFINET name conventions:

- Characters a-z (lowercase only, uppercase is not permitted)
- Numbers 0-9, but cannot start with a number
- No underscores or other special characters; the hyphen and period are permitted, but not as the first or last character
- No more than 127 characters total or 63 characters as a name component within the device name (e.g., a character string between two periods); may be further limited by your configuration software
- Cannot be formatted as an IP address (dotted-decimal notation)
- Cannot begin with the characters "port-nnn-", where "nnn" are three numeric characters 0-9 (e.g., port-735-)

IPCTL(function,"string")

Sets IP address, Mask, or Gateway

The IPCTL command is used to set the IP address, subnet mask or gateway. The setting is nonvolatile. This command is not usually needed. Typically, the PLC will handle these settings during PROFINET network initialization.

The possible function values are:

0: set IP address

1: set Mask

2: set Gateway

The "string" is formatted as an IP address, e.g., IPCTL(0,"192.168.0.10"). By default, these values are set to 0 (i.e., "0.0.0.0").

=ETH, RETH

Get PROFINET error

The =ETH and RETH commands are used to assign/report errors and certain status information for the PROFINET bus.

- Assigned to a program variable: x=ETH(y)
- As a report: RETH(y)

Refer to the following table for details.

Assignment	Report	Description
=ETH(0)	RETH(0)	Gets the PROFINET status bits: 0 Initialization incomplete Read specific error code from ETH(54); Contact Moog Animatics (Confirm SNAME setting if encountering a problem) 1 Configuration change 2 Reserved 3 Network processor failure Likely due to excessive control power supply noise or ESD event 4 Reserved 5 Reserved 6 I/O Controller is STOP 7 I/O Controller is RUN 8 I/O Controller aborted cyclic communications 9 Network commanded configuration change
=ETH(5)	RETH(5)	LFW firmware version as 32-bit integer; e.g., 3.1.0.1 would be a value 50397185 (0x03010001).
=ETH(6)	RETH(6)	The current Network Lost program label number. For details, see ETHCTL(function, value) on page 38.
=ETH(7)	RETH(7)	Processor type: -1 Failed 0 Unknown 1 netX 10 2 netX 50 3 netX 51/52 4 netX 100
=ETH(8)	RETH(8)	Protocol type after successful initialization (Confirm SNAME setting if encountering a problem) See also RETH(19) 0 Not defined 1 PROFINET 2 EtherCAT 3 EtherNet/IP
=ETH(9)	RETH(9)	The current value assigned to the Network Lost action. For details, see ETHCTL(function, value) on page 38.
	RETH(15)	IP address; value is in dotted-decimal format; report only.
	RETH(16)	Subnet mask; value is in dotted-decimal format; report only.
	RETH(17)	Gateway; value is in dotted-decimal format; report only.
	RETH(18)	MAC ID string formatted; report only; e.g., 00:01:02:a9:ff:00

Assignment	Report	Description
=ETH(19)	RETH(19)	Report the detected LFW Protocol Class. This gives a wider range of values than the known and supported protocols listed in ETH (8). Values designated according to NXF/LFW file loaded into network processor and too numerous to list here. These are the values for the supported protocols: (introduced in firmware 6.0.2.41 and 6.4.2.50 or later) 0 Not Defined 21 PROFINET 9 EtherCAT 10 Ethernet/IP ... ...
=ETH(30)	RETH(30)	Gets the present receive I/O data size in bytes
=ETH(31)	RETH(31)	Gets the present transmit I/O data size in bytes
=ETH(45)	RETH(45)	IP address as integer; e.g., for an IP address of 192.168.1.3 (C0 A8 01 03 hex), this command reports -1062731517 (it reports as a 32-bit signed value).
=ETH(46)	RETH(46)	IP subnet mask as integer; e.g., for an IP netmask of 255.255.0.0 (FF FF 00 00 hex), this command reports -65536 (it reports as a 32-bit signed value).
=ETH(47)	RETH(47)	IP gateway as integer; e.g., for an IP gateway of 192.168.1.1 (C0 A8 01 01 hex), this command reports -1062731519 (it reports as a 32-bit signed value).
=ETH(48)	RETH(48)	Low 3 bytes of MAC ID (device ID) as integer; e.g., for a MACID of 00:01:02:a9:ff:00, this command reports 11140864 (00 a9 ff 00 hex).
=ETH(49)	RETH(49)	High 3 bytes of MAC ID (device ID) as integer; e.g., for a MACID of 00:01:02:a9:ff:00, this command reports 258 (00 00 01 02 hex).
=ETH(50)	RETH(50)	Gets the last internal error code
=ETH(51)	RETH(51)	Gets the last internal error code source
=ETH(54)	RETH(54)	Gets the Initialization error code; for further information, read this error when RETH(0) bits 0 or 1 are indicated, or when RETH(8) returns 0. The value -1070596029 indicates an invalid SNAME format was used.
=ETH(57)	RETH(57)	Gets the real-time Ethernet sync correction
=ETH(58)	RETH(58)	Gets the real-time Ethernet sync count

ETHCTL(function, value)

Control network features

Commands execute based on the function argument, which controls Ethernet functions. After issuing an ETHCTL command the Ethernet error codes will be checked to determine the state of Status Word 2, bit 6 (Ethernet error).

Command	Description
ETHCTL(1,TBD) ... ETHCTL(5,TBD)	Reserved for future use.
ETHCTL(6,<value>)	User program label number. This setting is nonvolatile. Program label to jump to if the NET_LOST_LABEL option is chosen from the NET_LOST_ACTION function. This function has no effect if the NET_LOST_ACTION is anything other than NET_LOST_LABEL.
ETHCTL(7,TBD)	Reserved for future use.
ETHCTL(8,TBD)	Reserved for future use.
ETHCTL(9,<value>)	PROFINET Network Lost Action. This setting is nonvolatile. 0 Ignore, no action (default setting) 1 Send OFF command to motor 2 Send X command to motor (soft stop) 3 Send S command to motor (immediate stop) 4 Send GOSUB(x) command, where x is the value of the user program label. 5 Send GOTO(x) command, where x is the value of the user program label. NOTE: Loss of network is an edge-triggered event if I/O Control goes from RUN to any other state.
ETHCTL(10,x)	Allows the position field of 14 byte (7 word) input module to be reconfigured for alternate data from the motor. See 240, xF0 on page 57.
ETHCTL(11,TBD)	Reserved for future use.
ETHCTL(12,<value>)	Network user bit set or clear. This is a bit in the status word of the 14 byte (7 word) input module. Also visible in response code 164 "legacy status word": 0 Clear Bit 12 of SmartMotor I/O Network Bit 1 Set Bit 12 of SmartMotor I/O Network Bit
ETHCTL(45,x)	Set IP address as integer; e.g., to set for an IP address of 192.168.1.3 (C0 A8 01 03 hex), x=3232235779; non-volatile.
ETHCTL(46,x)	Set IP subnet mask as integer; e.g., to set for an IP netmask of 255.255.0.0 (FF FF 00 00 hex), x=4294901760; non-volatile.
ETHCTL(47,x)	Set IP gateway as integer; e.g., to set for an IP gateway of 192.168.1.1 (C0 A8 01 01 hex), x=3232235777; non-volatile.
ETHCTL(50,<value>)	Resets the internal error register: RETH(50); the value argument is ignored.
ETHCTL(51,<value>)	Resets the internal error register: RETH(51); the value argument is ignored.
ETHCTL(58,<value>)	Clears the real-time Ethernet sync count

Program Example

The following code example sets the nonvolatile station name.

```
SNAME("mymotor1")
a=ETH(0)
IF( a&2 )
  Z           'Execute reset if station name changed
ENDIF

'Add rest of program below
```

Output and Input Packets

This section describes the PROFINET Output and Input packet format. It also provides notes for the Command (Output) packets and Response (Input) Packets.

Output and Input Packet Format

Two options exist for the input/output packet size:

- 3 words (6 bytes) out, 7 words (14 bytes) in
- 12 words (24 bytes) out, 28 words (56 bytes) in
  This option in Class 6M is only available with firmware 6.0.2.41 or later, and requires XML (GSDML) date -20190118 or later. For Class 6D, firmware: 6.4.2.50 with XML (GSDML) date -20220114 or later is required. The I/O controller (PLC) will have an interface for loading the XML file and choosing these options for the input and output packets. Some tools may provide a drag-and-drop interface for selecting the available modules from the XML file and placing them into the 2 available slots in the motor.

NOTE: Only the two combinations of specific in/out sizes are allowed. For example, 3 words out cannot be used with 28 words in.

Output (3 Words) Data Format (I/O Controller Command)

Offset		Description	Notes	Affected by byte / word swap parameter
Word	Byte			
0	0	Command Code		N/A
	1	Response Code		N/A
1	2	Command Data Value (32 bits), big-endian format		Yes
	3			
2	4			
	5			

Input (7 words) Data Format (Motor response)

Offset		Description	Notes	Affected by byte / word swap parameter
Word	Byte			
0	0	Command Code Acknowledge		N/A
	1	Response Code Acknowledge		N/A
1	2	Response Data Value (32 bits), big-endian format		Yes
	3			
2	4			
	5			
3	6	Status Word (16 bits), big-endian format		Yes
	7			

Offset		Description	Notes	Affected by byte / word swap parameter
Word	Byte			
4	8	Measured Position (32 bits), big-endian format NOTE: This field can be configured to report al[0] or af[0].		Yes
	9			
5	10			
	11			
6	12	Position Error (16 bits), big-endian format		Yes
	13			

Command Code: Indicates a command to be issued to the SmartMotor. Also, see Command Data Value.

Response Code: Indicates additional data to be included in the Response Data Value of the Input Data.

Command Data Value: Indicates the 32-bit value to be used in conjunction with the Command Code.

Command Code Acknowledge: Returned in the Input Data to indicate that a Command Code was processed.

Response Code Acknowledge: Returned in the Input Data to indicate that a Response Code was processed and that the current Response Data Value corresponds to that Response Code.

Response Data Value: 32-bit value returned in the Input Data in response to a Response Code.

Status Word: SmartMotor's current status word (16 bit).

Measured Position: SmartMotor's current measured position value (32-bit); result of RPA command.

Position Error: SmartMotor's current commanded trajectory position less the current measured position.

Extended format: 12 words (24 bytes) out, 28 words (56 bytes) in. This format was created for the purpose of easier access to reading data cyclically from the motor. Up to 8 response data items can be read on every cycle, though the first reponse item is required for certain special items, see notes.

There is still only 1 command code item because most commands require a sequence of events to operate correctly, and multiple fields could cause conflict.

The command and response codes have been extended to 16-bit values in this extended format. This allows for a wider set of codes and direct access to variables. See Extended 16-bit command codes on page 58, and Extended 16-bit response codes on page 66.

Several pre-set fields have been removed from the extended format: position, status word, position error. These are still available in the list of response codes (codes 141, 164, 143 respectively), and can be selected by setting those response request codes in the output data. Position error is a full 32-bit when accessed by this method.

NOTE: The PROFINET SmartMotor supports the byte/word swap parameter as of firmware 6.0.2.41 or 6.4.2.50 or later

Output (12 Words) Data Format (I/O Controller Command)

Offset		Description	Notes	Affected by byte / word swap parameter
Word	Byte			
0	0	Reserved (write as 0x00)	4	N/A
	1	Reserved (write as 0x00)	4	N/A
1	2	Command Data Value (32 bits)		Yes
	3			
2	4			
	5			
3	6	Command code request (16 bits)		Yes
	7			
4	8	Response code 0 request (16 bits) See note 1: some codes must use of this section	1	Yes
	9			
5	10	Response code 1 request (16 bits)	2	Yes
	11			
6	12	Response code 2 request (16 bits)	2	Yes
	13			
7	14	Response code 3 request (16 bits)	2	Yes
	15			
8	16	Response code 4 request (16 bits)	2	Yes
	17			
9	18	Response code 5 request (16 bits)	2	Yes
	19			
10	20	Response code 6 request (16 bits)	2	Yes
	21			
11	22	Response code 7 request (16 bits)	2	Yes
	23			

Input (28 words) Data Format (Motor response)

Offset		Description	Notes	Affected by byte / word swap parameter
Word	Byte			
0	0	Reserved (reports as 0xFF)	3	N/A
	1	Reserved (reports as 0xFF)	3	N/A
1	2	Reserved (ignore, reports as 0)		N/A
	3	Reserved (ignore, reports as 0)		N/A

Offset		Description	Notes	Affected by byte / word swap parameter
Word	Byte			
2	4	Reserved (ignore, reports as 0)		N/A
	5	Reserved (ignore, reports as 0)		N/A
3	6	Command code ack (16 bits)		Yes
	7			
4	8	Response code 0 ack (16 bits) See note 1: some codes must use of this section	1	Yes
	9			
5	10	Response code 1 ack (16 bits)	2	Yes
	11			
6	12	Response code 2 ack (16 bits)	2	Yes
	13			
7	14	Response code 3 ack (16 bits)	2	Yes
	15			
8	16	Response code 4 ack (16 bits)	2	Yes
	17			
9	18	Response code 5 ack (16 bits)	2	Yes
	19			
10	20	Response code 6 ack (16 bits)	2	Yes
	21			
11	22	Response code 7 ack (16 bits)	2	Yes
	23			
12	24	Response data 0 (32 bits) See note 1: some codes must use of this section		Yes
	25			
13	26			
	27			
14	28	Response data 1 (32 bits)		Yes
	29			
15	30			
	31			
16	32	Response data 2 (32 bits)		Yes
	33			
17	34			
	35			

Offset		Description	Notes	Affected by byte / word swap parameter
Word	Byte			
18	36	Response data 3 (32 bits)		Yes
	37			
19	38			
	39			
20	40	Response data 4 (32 bits)		Yes
	41			
21	42			
	43			
22	44	Response data 5 (32 bits)		Yes
	45			
23	46			
	47			
24	48	Response data 6 (32 bits)		Yes
	49			
25	50			
	51			
26	52	Response data 7 (32 bits)		Yes
	53			
27	54			
	55			

NOTE: 1) This response request code location is allowed to include attributes (request codes) 214-225 (special access to variables and EEPROM). It is recommended to reserve this slot for this type of access. For constantly read information, like access to variables (using response codes above 255), position, etc., use response code locations 1-7 instead.

NOTE: 2) This response request code location is not allowed to use attributes (request codes) 214-225, an error code (255) will result. These request code locations 1-7 are recommended for information that must be read every cycle, like a variable, position, velocity, current, etc.

NOTE: 3) These fields report 255 as protection so that the data will be interpreted as an error if PLC program / controller reads this and attempts to interpret as 14-byte input format. It is also helpful for the PLC program / controller to read this when the 56 byte input mode is intended because it will provide confirmation by reporting 255. A PLC program could use this as a verification check.

NOTE: 4) You must write 0 to these fields. If any other value is written, then the remainder of the output packet will be ignored. This is for protection in case the PLC/Controller is attempting to write in the 6 byte output format but has the 24-byte format configured.

Command (Output) Packet Notes

The following are notes regarding the Command (Output) Packets:

- A command is issued to the SmartMotor exactly one time after the Command Code or Command Data Value changes in the output data. To issue a command:
    a. Set the Command Code to 0.
    b. Wait for Command Code Acknowledge = 0.
    c. Set the Command Data Value to the desired value.
    d. Set the Command Code to the desired command.
    e. Wait for Command Code Acknowledge = Command Code.
- For <value>, insert the Command Data Value.
- For the variables <a to zzz>:
    - <a to z> u8VarIndexSet (0-25)
    - <aa to zz> u8VarIndexSet (26-51)
    - <aaa to zzz> u8VarIndexSet (52-77)
- For <index>, insert the array index stored in u8ArrIndexSetActual.
- For <length>, insert the length stored in u8VarLenSet or u8ArrLenSet.
- Curly brackets {} indicate binary data rather than ASCII characters.
- The PROFINET interface does not interfere with the SmartMotor's EPTR command for access to EEPROM. Therefore, the user program may use the EPTR command at the same time.

Response (Input) Packet Notes

The following are notes regarding the Command (Output) Packets:

- The requests associated with any Response Codes other than 214-225 are issued to the SmartMotor continuously (or according to the polling rate if set). When the Response Code in the output data transitions to a value in the range of 214-225, the associated request will be issued to the SmartMotor exactly one time after transition to one of those values. To issue a request for data:
    a. Set the Response Code to 0.
    b. Wait for Response Code Acknowledge = 0.
    c. Set the Response Code to the desired value.
    d. Wait for Response Code Acknowledge = Response Code read data from Response Data Value.
    e. Repeat as desired if not Response Codes 214-225.
- For <value>, insert the Response Data Value.
- For the variables <a to zzz>:
    - <a to z> u8VarIndexGet (0-25)
    - <aa to zz> u8VarIndexGet (26-51)
    - <aaa to zzz> u8VarIndexGet (52-77)
- For <index>, insert the array index stored in u8ArrIndexGetActual.
- For <length>, insert the length stored in u8VarLenGet or u8ArrIndexGet.
- Curly brackets {} indicate binary data rather than ASCII characters.
- The Response Data Value for a GET_MODE (SmartMotor RMODE) command will contain the integer code returned by the SmartMotor, which may be unexpected by users familiar with the RMODE command in older Moog Animatics products. For details on the RMODE command, see the *Moog Animatics SmartMotor™ Command Reference Guide*.
- The PROFINET interface does not use the SmartMotor's EPTR command during initialization to read startup parameters from the SmartMotor. Therefore, the user program may use EPTR command at the same time. Also, the SmartMotor variable zzz is not used by the PROFINET interface, which may be unexpected by users familiar with older Moog Animatics products.

Alternate Communications Channel

In addition to communicating over PROFINET, commands in the SmartMotor™ programming language may be sent through an existing communications channel of the SmartMotor. For details, see the *Moog Animatics SmartMotor™ User's Guide*.

Reserved Motor Variables

The PROFINET interface does not:

- Require the reservation of any user variables. Some older Moog Animatics products required the reservation of yyy and zzz. However, this is not the case in the PROFINET interface—these variables are freely available for the user.
- Require the reservation of any serial channels. Therefore, all other ports and associated channels are freely available to the user for the application.
- Interfere with the EPTR variable of the EEPROM command set. When PROFINET accesses the EEPROM, it is done through a private version of EPTR. Therefore, the user no longer has to monitor variable zzz for shared access. The user may access the EEPROM at any time.

  NOTE: EEPROM reads may still cause a user command to wait until the EEPROM is available, but there is no user interaction required.

Command and Response Codes

This section lists the PROFINET packet command and response codes and their corresponding SmartMotor commands.

Command Packet Codes to Motor Commands

This section provides a reference table of PROFINET command packet codes and corresponding SmartMotor commands.

Variables beginning with u8, u16 or u32 are internal to the motor's PROFINET module.

For the variables:

- <a to z> use values (0 to 25)
- <aa to zz> use values (26 to 51)
- <aaa to zzz> use values (52 to 77)

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex	*decimal, hex*			
0, x00	N/A	N/A	NULL / NOP - No command requested Does not perform any action, this command code provided as a way to not initiate a new command, or as a value to alternate to prior to setting a new command.	
1, x01	0, x00	C/D*	Engage brake	BRKENG
1, x01	1, x01	C/D*	Use only internal brake; disable external brake	EOBK(-1)
1, x01	2, x02	C/D*	Direct brake to output number 8	EOBK(8)
1, x01	3, x03	N/A	(Reserved)	
1, x01	4, x04	C/D*	Release brake	BRKRLS
1, x01	5, x05	C/D*	Brake while servo inactive	BRKSRV
1, x01	6, x06	C/D*	Brake while trajectory inactive	BRKTRJ
1, x01	7, x07	N/A	(Reserved)	
1, x01	8, x08	C/D*	Select internal encoder for servo	ENC0
1, x01	9, x09	C/D*	Select external encoder for servo	ENC1
1, x01	10, x0A	C/D*	End user program	END
1, x01	11, x0B	C/D*	Transfer buffered PID tuning to live values	F
1, x01	12, x0C	C/D*	Start motion (GO)	G
1, x01	13, x0D	N/A	(Obsolete) Use KG=0	KGOFF
1, x01	14, x0E	N/A	(Obsolete) Use KG=<value>, command 131	KGON
1, x01	15-18, x80F-x12	N/A	(Obsolete)	
1, x01	19, x13	N/A	(Reserved) not implemented	
1, x01	20-22, x14-x16	N/A	(Obsolete)	
1, x01	23, x17	N/A	(Reserved) not implemented	
1, x01	24, x18	C/D*	Set mode follow and zero out	MF0
1, x01	25-27, x19-x1B	N/A	(Obsolete)	
1, x01	28, x1C	C/D*	Initiate mode follow quadrature	MFR
1, x01	29, x1D	C/D*	Enable position mode	MP
1, x01	30, x1E	N/A	(Obsolete)	

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex	*decimal, hex*			
1, x01	31, x1F	C/D*	Configure step and direction, and zero out	MS0
1, x01	32, x20	C/D*	Initiate mode step ratio calculation	MSR
1, x01	33, x21	C/D*	Enable torque mode	MT
1, x01	34, x22	C/D*	Immediately engage MTB brake	MTB
1, x01	35, x23	C/D*	Enable velocity mode	MV
1, x01	36, x24	C/D*	Stop servoing the motor	OFF
1, x01	37, x25	C/D*	Divide PID sample rate by 1	PID1
1, x01	38-40, x26-x28	N/A	(Reserved)	
1, x01	41, x29	C/D*	Execute stored program	RUN
1, x01	42, x2A	C/D*	End program if RUN has not been commanded yet (since power up)	RUN?
1, x01	43, x2B	C/D*	Abruptly stop move in progress	S
1, x01	44, x2C	C/D*	Make I/O 0 an input	EIGN(0)
1, x01	45, x2D	N/A	(Obsolete) Use CMD_OUT(x)	
1, x01	46, x2E	C/D*	Make I/O 1 an input	EIGN(1)
1, x01	47, x2F	N/A	(Obsolete) Use CMD_OUT(x)	
1, x01	48, x30	C/D*	Make I/O 2 an input; disable right-limit function	EIGN(2)
1, x01	49, x31	N/A	(Obsolete) Use CMD_OUT(x)	
1, x01	50, x32	C/D*	Set I/O C to be a right-limit input	EILP
1, x01	51, x33	C/D*	Make I/O 3 an input; disable left-limit function	EIGN(3)
1, x01	52, x34	N/A	(Obsolete) Use CMD_OUT(x)	
1, x01	53, x35	C/D*	Set I/O 3 to be a left-limit input	EILN
1, x01	54, x36	C/D*	Slow motor motion to stop	X
1, x01	55, x37	C/D*	Total system reset	Z
1, x01	56, x38	C/D*	Reset overcurrent error bit	Za
1, x01	57, x39	C/D*	Reset serial data parity violation latch bit, i.e., clears the parity error bits in RCHN(0) and RCHN(1)	
1, x01	58, x3A	C/D*	Reset communications buffer overflow latch bit, i.e., clears the overflow error bits in RCHN(0) and RCHN(1)	
1, x01	59, x3B	C/D*	Not available in Class 6 PROFINET	
1, x01	60, x3C	C/D*	Reset position error fault	Ze
1, x01	61, x3D	C/D*	Reset serial communication framing error latch bit, i.e., clears the framing error bits in RCHN(0) and RCHN (1)	
1, x01	62, x3E	C/D*	Reset overtemperature fault; requires temperature to fall 5 degrees below limit	Zh
1, x01	63, x3F	C/D*	Reset historical left-limit latch bit	Zl
1, x01	64, x40	C/D*	Reset historical right-limit latch bit	Zr
1, x01	65, x41	C/D*	Reset command scan error latch bit	Zs
1, x01	66, x42	C/D*	Not available in Class 6 PROFINET	
1, x01	67, x43	C/D*	Reset encoder wraparound event latch bit	Zw

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex	*decimal, hex*			
1, x01	68, x44	C/D*	Reset system latches to power-up state	ZS
1, x01	69, x45	C/D*	Disable software limits	SLD
1, x01	70, x46	C/D*	Enable software limits	SLE
1, x01	71, x47	C/D*	Make I/O 6 an input; disable GO synchronization function	EIGN(6)
1, x01	72, x48	C/D*	Enable GO synchronization function	EISM(6)
1, x01	73, x49	C/D*	Make I/O 4 an input. If a brake redirect, this is ignored (supported in Class 6D only, not Class 6M)	EIGN(4)
1, x01	74, x4A	C/D*	Make I/O 5 an input. If a brake redirect, this is ignored (supported in Class 6D only, not Class 6M)	EIGN(5)
1, x01	75, x4B	C/D*	Arm index capture from internal encoder, rising edge	Ai(0)
1, x01	76, x4C	C/D*	Arm index capture from internal encoder, falling edge	Aj(0)
1, x01	77, x4D	C/D*	Arm index capture from internal encoder, rising then falling edge	Aij(0)
1, x01	78, x4E	C/D*	Arm index capture from internal encoder, falling then rising edge	Aji(0)
1, x01	79, x4F	C/D*	Arm index capture from external encoder, rising edge	Ai(1)
1, x01	80, x50	C/D*	Arm index capture from external encoder, falling edge	Aj(1)
1, x01	81, x51	C/D*	Arm index capture from internal encoder, rising then falling edge	Aij(1)
1, x01	82, x52	C/D*	Arm index capture from internal encoder, falling then rising edge	Aji(1)
1, x01	83, x53	N/A	(Reserved) MDT not supported in Class 6.	
1, x01	84, x54	C/D*	Request enhanced trapezoidal commutation mode; entered as soon as angle is satisfied	MDE
1, x01	85, x55	C/D*	Request sine commutation mode (voltage mode); entered as soon as angle is satisfied	MDS
1, x01	86, x56	C/D*	Request current-controlled sine mode; entered as soon as angle is satisfied.	MDC
1, x01	87, x57	C/D*	Turn on Trajectory Overshoot Braking (TOB) feature for trapezoidal mode	MDB
1, x01	88+, x58+	N/A	(Reserved)	
2, x02	<value>	C/D*	Set absolute position and start motor	PT=<value> G
3, x03	<value>	C/D*	Set relative position and start motor	PRT=<value> G
4, x04	<value>	C/D*	Set velocity and start motor	VT=<value> G
5, x05	<value>	C/D*	Call a subroutine	GOSUB(<value>)
6, x06	<value>	C/D*	Branch program execution to a label	GOTO(<value>)
7-89, x07-x59	N/A	N/A	(Reserved)	
90, x5A	<value>	C/D*	Clear mask on user bits, word 0, status word 12	UR(W,0,<value>)
91, x5B	<value>	C/D*	Clear mask on user bits, word 1, status word 13	UR(W,1,<value>)
92, x5C	<value>	C/D*	Set mask on user bits, word 0, status word 12	US(W,0,<value>)
93, x5D	<value>	C/D*	Set mask on user bits, word 1, status word 13	US(W,1,<value>)
94, x5E	<value>	C/D*	Clear specific user bit 0-31	UR(<value>)
95, x5F	<value>	C/D*	Set specific user bit 0-31	US(<value>)

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex	*decimal, hex*			
96, x60	<value>	C/D*	Set output 8 to 0 or 1, ON is 1 sourcing. Requires EOBK command to enable, see developer's guide.	OUT(8)=<value>
97, x61	N/A	N/A	(Reserved)	
98, x62	<value>	C/D*	Set output 9 to 0 or 1, ON is 1 sourcing. Requires EOFT command to enable, see developer's guide. Requires 6.0.2.41 or 6.4.2.50 or later.	OUT(9)=<value>
99, x63	N/A	N/A	(Reserved)	
100, x64	<value>	C/D*	Set acceleration	ADT=<value>
101, x65	<value>	C/D*	Set RS-232/RS-485 address	ADDR=<value>
102, x66	<value>	C/D*	Set PWM drive signal limit	AMPS=<value>
103-123, x67-x7B	N/A	N/A	(Reserved)	
124, x7C	<value>	C/D*	Set relative distance (position)	PRT=<value>
125, x7D	<value>	C/D*	Set allowable position error	EL=<value>
126, x7E	<value>	C/D*	Set special use timer.	
127, x7F	N/A	N/A	(Obsolete)	
128, x80	N/A	N/A	(Reserved)	
129, x81	<value>	C/D*	PID acceleration feed forward	KA=<value>
130, x82	<value>	C/D*	PID derivative compensation	KD=<value>
131, x83	<value>	C/D*	PID gravity compensation; for limits, see the *Moog Animatics SmartMotor™ User's Guide*	KG=<value>
132, x84	<value>	C/D*	PID integral compensation	KI=<value>
133, x85	<value>	C/D*	PID integral limit	KL=<value>
134, x86	<value>	C/D*	PID proportional compensation	KP=<value>
135, x87	<value>	C/D*	PID derivative term sample rate	KS=<value>
136, x88	<value>	C/D*	PID velocity feed forward	KV=<value>
137, x89	<value>	C/D*	Mode follow with ratio divisor	MFDIV=<value>
138, x8A	<value>	C/D*	Mode follow with ratio multiplier	MFMUL=<value>
139, x8B	<value>	C/D*	Set origin	O=<value>
140, x8C	<value>	C/D*	Shift origin	OSH(<value>)
141, x8D	N/A	N/A	(Reserved)	
142, x8E	<value>	C/D*	Set absolute position target	PT=<value>
143-144, x8F-x90	N/A	N/A	(Reserved)	
145, x91	<value>	C/D*	Set RS-232/RS-485 address	SADDR<value>
146-147, x92-x93	N/A	N/A	(Reserved)	
148, x94	<value>	C/D*	Assign torque value in torque mode	T=<value>
149, x95	N/A	N/A	(Reserved)	
150, x96	<value>	C/D*	Set maximum allowable temperature (high limit)	TH=<value>
151-162, x97-xA2	N/A	N/A	(Reserved)	
163, xA3	<value>	C/D*	Set velocity target	VT=<value>

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex	*decimal, hex*			
164, xA4	N/A	N/A	(Reserved)	
165, xA5	<value>	C/D*	Set value of negative software limit	SLN=<value>
166, xA6	<value>	C/D*	Set value of positive software limit	SLP=<value>
167-169, xA7-xA9	N/A	N/A	(Reserved)	
170, xAA	<value>	C/D*	Clear status word 0; bit indicated by value	Z(0,<value>)
171, xAB	<value>	C/D*	Clear status word 1; bit indicated by value	Z(1,<value>)
172, xAC	<value>	C/D*	Clear status word 2; bit indicated by value	Z(2,<value>)
173, xAD	<value>	C/D*	Clear status word 3; bit indicated by value	Z(3,<value>)
174, xAE	<value>	C/D*	Clear status word 4; bit indicated by value	Z(4,<value>)
175, xAF	<value>	C/D*	Clear status word 5; bit indicated by value	Z(5,<value>)
176, xB0	<value>	C/D*	Clear status word 6; bit indicated by value	Z(6,<value>)
177-199, xB1-xC7	N/A	N/A	(Reserved)	
200, C8	<value>	C/D*	u8VarIndexSet = <value> u8VarIndexSetActual = <value> where <value> represents which variable is referred to in the next variable write operation: 'a' is 0, 'b' is 1, ..., 'zzz' is 77. (Range is 0-77)	
201, xC9		N/A	(Reserved)	
202, xCA	<value>	C/D*	u8VarLenSet = <value> Where <value> represents quantity of variables to write in the next variable write operation. Range is 0-78.	
203, xCB	<value>	C/D*	u8ArrIndexSet = <value> u8ArrIndexSetActual = <value> where <value> is the array index to begin the next array write operation at. The ranges of <value> are as follows depending on the type of array: ab[]: 0-203 aw[]: 0-101 al[]: 0-50	
204, xCC		N/A	(Reserved)	
205, xCD	<value>	C/D*	u8ArrLenSet = <value> where <value> represents the quantity of array variables to write in the next array write operation. The ranges of <value> are as follows depending on the type of array: ab[]: 0-204 aw[]: 0-102 al[]: 0-51	
206, xCE	<value>	C/D*	u8AutoIncSet = <value> Enable increment of variable or array index on the next write operation. Where <value> is: 0=NO, 1=YES	
207, xCF	<value>	C/D*	u8VarIndexGet = <value> u8VarIndexGetActual = <value> where <value> represents which variable is referred to in the next variable read operation: 'a' is 0, 'b' is 1, ..., 'zzz' is 77. (Range is 0-77)	
208, xD0		N/A	(Reserved)	

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex	*decimal, hex*			
209, xD1	<value>	C/D*	u8VarLenGet = <value> Where <value> represents quantity of variables to read in the next variable read operation. Range is 0-78.	
210, xD2	<value>	C/D*	u8ArrIndexGet = <value> u8ArrIndexGetActual = <value> where <value> is the array index to begin the next array read operation at. The ranges of <value> are as follows depending on the type of array: ab[]: 0-203 aw[]: 0-101 al[]: 0-50	
211, xD3		N/A	(Reserved)	
212, xD4	<value>	C/D*	u8ArrLenGet = <value> where <value> represents the quantity of array variables to read in the next array read operation. The ranges of <value> are as follows depending on the type of array: ab[]: 0-204 aw[]: 0-102 al[]: 0-51	
213, xD5	<value>	C/D*	u8AutoIncGet = <value> Enable increment of variable or array index on the next read operation. Where value is: 0=NO, 1=YES	
214, xD6	<value>	C/D*	Set variable <a to zzzz> ='a'+u8VarIndexSetActual; if (u8AutoIncSet) then: u8VarIndexSetActual += 1	<a to zzz>=<value>
215, xD7	<value>	C/D*	Set byte array variable <index>=u8ArrIndexSetActual; if (u8AutoIncSet) then: u8ArrIndexSetActual += 1	ab[<index>]=<value>
216, xD8	<value>	C/D*	Set word array variable <index>=u8ArrIndexSetActual; if (u8AutoIncSet) then: u8ArrIndexSetActual += 1	aw[<index>]=<value>
217, xD9	<value>	C/D*	Set long array variable <index>=u8ArrIndexSetActual; if (u8AutoIncSet) then: u8ArrIndexSetActual += 1	al[<index>]=<value>
218, xDA	<value>	C/D*	Store byte to EEPROM u32EptrActual += 1 NOTE: This u32EptrActual is not the same as the program EPTR= command.	VST(<value byte>,1) (But does not affect EPTR or variables.)
219, xDB	<value>	C/D*	Store word to EEPROM u32EptrActual += 2 NOTE: This u32EptrActual is not the same as the program EPTR= command.	VST(<value word16>,1) (But does not affect EPTR or variables.)
220, xDC	<value>	C/D*	Store long to EEPROM u32EptrActual += 4 NOTE: This u32EptrActual is not the same as the program EPTR= command.	VST(<value long>,1) (But does not affect EPTR or variables.)

221, xDD	<value>	C/D*	Set variable and store to EEPROM
			<a to z>='a'+u8VarIndexSetActual
			u32EptrActual += 4;
			if (u8AutoIncSet) then:
			u8VarIndexSetActual += 1
			NOTE: This u32EptrActual is not the same as the program EPTR= command.
				<a to z>=<value>
				VST(<a to z>,1)
				(does not affect EPTR)

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex	*decimal, hex*			

222, xDE	N/A	C/D*	Store variables to EEPROM
			<a to z>='a'+u8VarIndexSetActual
			<length>=u8VarLenSet
			u32EptrActual += (<length>*4);
			if (u8AutoIncSet) then:
			u8VarIndexSetActual += <length>
			NOTE: This u32EptrActual is not the same as the program EPTR= command.
				VST(<a to z>, <length>)
				(does not affect EPTR)

223, xDF	N/A	C/D*	Store byte array variables to EEPROM
			<index>=u8ArrIndexSetActual
			<length>=u8ArrLenSet
			u32EptrActual += (<length>*1);
			if (u8AutoIncSet) then:
			u8ArrIndexSetActual += <length>
			(This u32EptrActual is not the same as the program EPTR= command.)
				VST(ab[<index>], <length>)
				(does not affect EPTR)

224, xE0	N/A	C/D*	Store word array variables to EEPROM
			<index>=u8ArrIndexSetActual
			<length>=u8ArrLenSet
			u32EptrActual += (<length>*2);
			if (u8AutoIncSet) then:
			u8ArrIndexSetActual += <length>
			(This u32EptrActual is not the same as the program EPTR= command.)
				VST(aw[<index>], <length>)
				(does not affect EPTR)

225, xE1	N/A	C/D*	Store long array variables to EEPROM
			<index>=u8ArrIndexSetActual
			<length>=u8ArrLenSet
			u32EptrActual += (<length>*4);
			if (u8AutoIncSet) then:
			u8ArrIndexSetActual += <length>
			(This u32EptrActual is not the same as the program EPTR= command.)
				VST(al[<index>], <length>)
				(does not affect EPTR)

226, xE2	<value>	C/D*	Set the EEPROM address u32EptrSet=<value> u32EptrActual=<value> (doesn't affect EPTR)	
227-239, xE3-xEF	N/A	N/A	(Reserved)	
240, xF0	<value>	C/D*	Configure the PROFINET input packet to use an alternate data source for the 'Measured position' field (words 4,5) <value>: 0 - report actual position in encoder counts (this is the power-up default value) 1 - report al[0] (big-endian format) 2 - report af[0] (IEEE-754 32-bit single precision, big-endian format)	ETHCTL(10,x)
241-254, xF1-xFE	N/A	N/A	(Reserved)	
255, xFF	N/A	N/A	(Error) Not a command. This is what the command ack will return if the command code could not be performed successfully	

C/D* Indicates that a change of command code or a change of the command data will cause this command to occur. Values that are changed locally in a SmartMotor program will not trigger this

update. In other words, the change of data must be a change relative to the previous network output data cycle from the PLC for the command to occur in the motor.

The above codes can be used in the original 3 word out, 7 word in data exchange, or in the extended 12 word out, 28 word in data exchange. The high-order byte should be set to 0 when using these in the extended packet, which has 16-bit fields for the command and reponse codes. For example: command code 124 sets PRT=. As an 8-bit hex value, 124 is x7C; as a 16-bit value, that is x007C. The endian-ness is determined by the byte-swap configuration parameter.

Extended 16-bit command codes

Below are additional 16-bit codes. Therefore, they require the extended data format with its 16-bit fields for command and response codes.

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex				
256, x0100	<value>	C/D*	Set variable a	a=<value>
257, x0101	<value>	C/D*	Set variable b	b=<value>
258, x0102	<value>	C/D*	Set variable c	c=<value>
259, x0103	<value>	C/D*	Set variable d	d=<value>
260, x0104	<value>	C/D*	Set variable e	e=<value>
261, x0105	<value>	C/D*	Set variable f	f=<value>
262, x0106	<value>	C/D*	Set variable g	g=<value>
263, x0107	<value>	C/D*	Set variable h	h=<value>
264, x0108	<value>	C/D*	Set variable i	i=<value>
265, x0109	<value>	C/D*	Set variable j	j=<value>
266, x010A	<value>	C/D*	Set variable k	k=<value>
267, x010B	<value>	C/D*	Set variable l	l=<value>
268, x010C	<value>	C/D*	Set variable m	m=<value>
269, x010D	<value>	C/D*	Set variable n	n=<value>
270, x010E	<value>	C/D*	Set variable o	o=<value>
271, x010F	<value>	C/D*	Set variable p	p=<value>
272, x0110	<value>	C/D*	Set variable q	q=<value>
273, x0111	<value>	C/D*	Set variable r	r=<value>
274, x0112	<value>	C/D*	Set variable s	s=<value>
275, x0113	<value>	C/D*	Set variable t	t=<value>
276, x0114	<value>	C/D*	Set variable u	u=<value>
277, x0115	<value>	C/D*	Set variable v	v=<value>
278, x0116	<value>	C/D*	Set variable w	w=<value>
279, x0117	<value>	C/D*	Set variable x	x=<value>
280, x0118	<value>	C/D*	Set variable y	y=<value>
281, x0119	<value>	C/D*	Set variable z	z=<value>
282, x011A	<value>	C/D*	Set variable aa	aa=<value>

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex				
283, x011B	<value>	C/D*	Set variable bb	bb=<value>
284, x011C	<value>	C/D*	Set variable cc	cc=<value>
285, x011D	<value>	C/D*	Set variable dd	dd=<value>
286, x011E	<value>	C/D*	Set variable ee	ee=<value>
287, x011F	<value>	C/D*	Set variable ff	ff=<value>
288, x0120	<value>	C/D*	Set variable gg	gg=<value>
289, x0121	<value>	C/D*	Set variable hh	hh=<value>
290, x0122	<value>	C/D*	Set variable ii	ii=<value>
291, x0123	<value>	C/D*	Set variable jj	jj=<value>
292, x0124	<value>	C/D*	Set variable kk	kk=<value>
293, x0125	<value>	C/D*	Set variable ll	ll=<value>
294, x0126	<value>	C/D*	Set variable mm	mm=<value>
295, x0127	<value>	C/D*	Set variable nn	nn=<value>
296, x0128	<value>	C/D*	Set variable oo	oo=<value>
297, x0129	<value>	C/D*	Set variable pp	pp=<value>
298, x012A	<value>	C/D*	Set variable qq	qq=<value>
299, x012B	<value>	C/D*	Set variable rr	rr=<value>
300, x012C	<value>	C/D*	Set variable ss	ss=<value>
301, x012D	<value>	C/D*	Set variable tt	tt=<value>
302, x012E	<value>	C/D*	Set variable uu	uu=<value>
303, x012F	<value>	C/D*	Set variable vv	vv=<value>
304, x0130	<value>	C/D*	Set variable ww	ww=<value>
305, x0131	<value>	C/D*	Set variable xx	xx=<value>
306, x0132	<value>	C/D*	Set variable yy	yy=<value>
307, x0133	<value>	C/D*	Set variable zz	zz=<value>
308, x0134	<value>	C/D*	Set variable aaa	aaa=<value>
309, x0135	<value>	C/D*	Set variable bbb	bbb=<value>
310, x0136	<value>	C/D*	Set variable ccc	ccc=<value>
311, x0137	<value>	C/D*	Set variable ddd	ddd=<value>
312, x0138	<value>	C/D*	Set variable eee	eee=<value>
313, x0139	<value>	C/D*	Set variable fff	fff=<value>
314, x013A	<value>	C/D*	Set variable ggg	ggg=<value>
315, x013B	<value>	C/D*	Set variable hhh	hhh=<value>
316, x013C	<value>	C/D*	Set variable iii	iii=<value>
317, x013D	<value>	C/D*	Set variable jjj	jjj=<value>
318, x013E	<value>	C/D*	Set variable kkk	kkk=<value>
319, x013F	<value>	C/D*	Set variable lll	lll=<value>
320, x0140	<value>	C/D*	Set variable mmm	mmm=<value>

Command Code	Command Data Value	Event for update	Command Description	Smart Motor Command(s)
decimal, hex				
321, x0141	<value>	C/D*	Set variable nnn	nnn=<value>
322, x0142	<value>	C/D*	Set variable ooo	ooo=<value>
323, x0143	<value>	C/D*	Set variable ppp	ppp=<value>
324, x0144	<value>	C/D*	Set variable qqq	qqq=<value>
325, x0145	<value>	C/D*	Set variable rrr	rrr=<value>
326, x0146	<value>	C/D*	Set variable sss	sss=<value>
327, x0147	<value>	C/D*	Set variable ttt	ttt=<value>
328, x0148	<value>	C/D*	Set variable uuu	uuu=<value>
329, x0149	<value>	C/D*	Set variable vvv	vvv=<value>
330, x014A	<value>	C/D*	Set variable www	www=<value>
331, x014B	<value>	C/D*	Set variable xxx	xxx=<value>
332, x014C	<value>	C/D*	Set variable yyy	yyy=<value>
333, x014D	<value>	C/D*	Set variable zzz	zzz=<value>
334 - 511, x014E - x01FF	N/A	N/A	(Reserved)	
512, x0200	<value>	C/D*	Set float 0 (32-bit IEEE)	af[0]=<value>
513, x0201	<value>	C/D*	Set float 1 (32-bit IEEE)	af[1]=<value>
514, x0202	<value>	C/D*	Set float 2 (32-bit IEEE)	af[2]=<value>
515, x0203	<value>	C/D*	Set float 3 (32-bit IEEE)	af[3]=<value>
516, x0204	<value>	C/D*	Set float 4 (32-bit IEEE)	af[4]=<value>
517, x0205	<value>	C/D*	Set float 5 (32-bit IEEE)	af[5]=<value>
518, x0206	<value>	C/D*	Set float 6 (32-bit IEEE)	af[6]=<value>
519, x0207	<value>	C/D*	Set float 7 (32-bit IEEE)	af[7]=<value>
520 - 767, x0208 - x02FF	N/A	N/A	(Reserved)	
768, x0300	<value>	C/D*	Set long array element 0	al[0]=<value>
769, x0301	<value>	C/D*	Set long array element 1	al[1]=<value>
...				...
818, x0332	<value>	C/D*	Set long array element 50	al[50]=<value>
819 - 65535, x0333 - xFFFF	N/A	N/A	(Reserved)	

C/D* Indicates that a change of command code or a change of the command data will cause this variable to be written. Variables that are changed locally in a SmartMotor program will not trigger this update. In other words, to set a new value for the variable, the change of data must be a change relative to the previous network output data cycle (not the current state of the variable in the motor) from the PLC.

Response Packet Codes to Motor Commands

This section provides a reference table of PROFINET response packet codes and corresponding SmartMotor commands.

Variables beginning with u8, u16 or u32 are internal to the motor's PROFINET module.

For the variables:

- <a to z> use values (0 to 25)
- <aa to zz> use values (26 to 51)
- <aaa to zzz> use values (52 to 77)

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
0, x00	N/A	0	NULL / NOP - No response requested	
1-95, x01-x5f	N/A	0	(Reserved)	
96, x60	cyclic	<value>=	digital I/O number 4	RIN(4)
97, x61	N/A	0	(Reserved)	
98, x62	cyclic	<value>=	digital I/O number 5	RIN(5)
99, x63	N/A	0	(Reserved)	
100, x64	cyclic	<value>=	acceleration target	RAT
101, x65	cyclic	<value>=	SmartMotor serial address	RADDR
102, x66	cyclic	<value>=	assigned PWM limit	RAMPS
103, x67	cyclic	<value>=	overcurrent status	RBa
104, x68	N/A	0	(Obsolete)	
105, x69	cyclic	<value>=	serial communications error bit	
106, x6A	N/A	0	(Obsolete)	
107, x6B	cyclic	<value>=	position error status	RBe
108, x6C	N/A	0	(Obsolete)	
109, x6D	cyclic	<value>=	overheat status	RBh
110, x6E	cyclic	<value>=	index status	RBi
111, x6F	cyclic	<value>=	program checksum error	RBk
112, x70	cyclic	<value>=	historical left limit status	RBl
113, x71	cyclic	<value>=	negative limit status	RBm
114, x72	cyclic	<value>=	motor off status	RBo
115, x73	cyclic	<value>=	positive limit status	RBp
116, x74	cyclic	<value>=	historical right limit status	RBr
117, x75	cyclic	<value>=	program scan status	RBs
118, x76	cyclic	<value>=	trajectory status	RBt
119, x77	N/A	0	(Obsolete)	
120, x78	cyclic	<value>=	wrapped encoder position	RBw
121, x79	cyclic	<value>=	hardware index input level	RBx

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
122, x7A	cyclic	<value>=	millisecond clock	RCLK
123, x7B	cyclic	<value>=	secondary counter	RCTR(1)
124, x7C	cyclic	<value>=	buffered move distance value	RPRC
125, x7D	cyclic	<value>=	buffered maximum position error	REL
126, x7E	cyclic	<value>=	special use timer	
127, x7F	cyclic	0	(Obsolete)	
128, x80	cyclic	<value>=	index position captured from recent Ai(0) command - object 1, data value 75	RI(0)
129, x81	cyclic	<value>=	buffered acceleration feed forward coefficient	RKA
130, x82	cyclic	<value>=	buffered derivative coefficient	RKD
131, x83	cyclic	<value>=	buffered gravity coefficient	RKG
132, x84	cyclic	<value>=	buffered integral coefficient	RKI
133, x85	cyclic	<value>=	buffered integral limit	RKL
134, x86	cyclic	<value>=	buffered proportional coefficient	RKP
135, x87	cyclic	<value>=	buffered sampling interval	RKS
136, x88	cyclic	<value>=	buffered velocity feed forward coefficient	RKV
137, x89	cyclic	<value>=	follow mode divisor	RMFDIV
138, x8A	cyclic	<value>=	follow mode multiplier	RMFMUL
139, x8B	N/A	0	(Reserved)	
140, x8C	cyclic	<value>=	current mode of operation	RMODE
141, x8D	cyclic	<value>=	present position	RPA
142, x8E	cyclic	<value>=	buffered position setpoint	RPT
143, x8F	cyclic	<value>=	present position error	REA
144, x90	N/A	0	(Reserved)	
145, x91	cyclic	<value>=	motor RMS current Requires firmware 6.0.2.41 or 6.4.2.50 or later	RUIA
146, x92	cyclic	<value>=	servo bus voltage Requires firmware 6.0.2.41 or 6.4.2.50 or later	RUJA
147, x93	N/A	0	(Reserved)	
148, x94	cyclic	<value>=	current requested torque	RT
149, x95	cyclic	<value>=	temperature	RTEMP
150, x96	cyclic	<value>=	temperature shutdown limit	RTH
151, x97	cyclic	<value>=	current algorithm THD time	RTHD
152, x98	cyclic	<value>=	digital I/O number 0	RIN(0)
153, x99	cyclic	<value>=	analog input number 0	RINA(A,0)
154, x9A	cyclic	<value>=	digital I/O number 1	RIN(1)
155, x9B	cyclic	<value>=	analog input number 1	RINA(A,1)
156, x9C	cyclic	<value>=	digital I/O number 2	RIN(2)
157, x9D	N/A	0	(Reserved)	

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
158, x9E	cyclic	<value>=	digital I/O number 3	RIN(3)
159, x9F	N/A	0	(Reserved)	
160, xA0	cyclic	<value>=	digital I/O number 6	RIN(6)
161, xA1	N/A	0	(Reserved)	
162, xA2	cyclic	<value>=	velocity	RVA
163, xA3	cyclic	<value>=	buffered maximum velocity	RVT
164, xA4	cyclic	<value>=	legacy status word	(n/a)
165, xA5	cyclic	<value>=	value of negative software limit	RSLN
166, xA6	cyclic	<value>=	value of positive software limit	RSLP
167, xA7	N/A	0	(Reserved)	
168, xA8	cyclic	<value>=	Inputs 0-7, 16-bit value, right justified	RIN(W,0)
169, xA9	N/A	0	(Reserved)	
170, xAA	cyclic	<value>=	status word 0	RW(0)
171, xAB	cyclic	<value>=	status word 1	RW(1)
172, xAC	cyclic	<value>=	status word 2	RW(2)
173, xAD	cyclic	<value>=	status word 3	RW(3)
174, xAE	cyclic	<value>=	status word 4	RW(4)
175, xAF	cyclic	<value>=	status word 5	RW(5)
176, xB0	cyclic	<value>=	status word 6	RW(6)
177, xB1	cyclic	<value>=	status word 7	RW(7)
178, xB2	cyclic	<value>=	status word 8	RW(8)
179, xB3	cyclic	<value>=	status word 9	RW(9)
180-181, xB4-xB5	N/A	0	(Reserved)	
182, xB6	cyclic	<value>=	user bits 0-15 (status word 12)	RW(12)
183, xB7	cyclic	<value>=	user bits 16-31 (status word 13)	RW(13)
184-185, xB8-xB9	N/A	0	(Reserved)	
186, xBA	cyclic	<value>=	I/O 0-7 (status word 16)	RW(16)
187-199, xBB-xC7	N/A	0	(Reserved)	
200, xC8	cyclic	<value>=	u8VarIndexSet	
201, xC9	cyclic	<value>=	u8VarIndexSetActual	
202, xCA	cyclic	<value>=	u8VarLenSet	
203, xCB	cyclic	<value>=	u8ArrIndexSet	
204, xCC	cyclic	<value>=	u8ArrIndexSetActual	
205, xCD	cyclic	<value>=	u8ArrLenSet	
206, xCE	cyclic	<value>=	u8AutoIncSet	
207, xCF	cyclic	<value>=	u8VarIndexGet	

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
208, xD0	cyclic	<value>=	u8VarIndexGetActual	
209, xD1	cyclic	<value>=	u8VarLenGet	
210, xD2	cyclic	<value>=	u8ArrIndexGet	
211, xD3	cyclic	<value>=	u8ArrIndexGetActual	
212, xD4	cyclic	<value>=	u8ArrLenGet	
213, xD5	cyclic	<value>=	u8AutoIncGet	
214, xD6 Response 0 only	RC*	<value>	Get 1 variable: a to zzz <var a-zzz> is: 'a'+u8VarIndexGetActual <value> = value of <var a-zzz> if (u8AutoIncGet) then: u8VarIndexGetActual += 1	R<var a to zzz>
215, xD7 Response 0 only	RC*	<value>	Get 1 byte array variable <index>=u8ArrIndexGetActual <value>=ab[<index>] if (u8AutoIncGet) then: u8ArrIndexGetActual += 1	Rab[<index>]
216, xD8 Response 0 only	RC*	<value>	Get 1 word array variable <index>=u8ArrIndexGetActual <value>=aw[<index>] if (u8AutoIncGet) then: u8ArrIndexGetActual += 1	Raw[<index>]
217, xD9 Response 0 only	RC*	<value>	Get 1 long array variable <index>=u8ArrIndexGetActual <value>=al[<index>] if (u8AutoIncGet) then: u8ArrIndexGetActual += 1	Ral[<index>]
218, xDA Response 0 only	RC*	<value>	Get **byte** from EEPROM <value>=EE byte at u32EptrActual u32EptrActual += 1 NOTE: This u32EptrActual is not the same as the program EPTR= command.	(VLD, but does not affect EPTR or variables.)
219, xDB Response 0 only	RC*	<value>	Get **word** from EEPROM <value>=EE 2 bytes at u32EptrActual u32EptrActual += 2 NOTE: This u32EptrActual is not the same as the program EPTR= command.	(VLD, but does not affect EPTR or variables.)
220, xDC Response 0 only	RC*	<value>	Get **long** from EEPROM <value>=EE 4 bytes at u32EptrActual u32EptrActual += 4 NOTE: This u32EptrActual is not the same as the program EPTR= command.	(VLD, but does not affect EPTR or variables.)

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
221, xDD Response 0 only	RC*	<value>	Get 4 bytes from EEPROM, store in 1 var a to zzz, and return that value. <var a-zzz> is: 'a'+u8VarIndexGetActual <value> = value of <var a-zzz> after VLD. u32EptrActual += 4 if (u8AutoIncGet) then: u8VarIndexGetActual += 1 NOTE: This u32EptrActual is not the same as the program EPTR= command.	VLD(<var a to zzz>,1) R<var a to zzz> (does not affect EPTR)

222, xDE
Response 0 only
	RC*	0	Load data from EEPROM into multiple variables
			<var a-zzz> is: 'a'+u8VarIndexGetActual
			<length>=u8VarLenGet
			u32EptrActual += (<length>*4);
			if (u8AutoIncGet) then:
			u8VarIndexGetActual += <length>
			NOTE: This u32EptrActual is not the same as the program EPTR= command.
				VLD(<var a to zzz>,<length>)
				
				(does not affect EPTR)

223, xDF
Response 0 only
	RC*	0	Load data from EEPROM into multiple byte array variables
			<index>=u8ArrIndexGetActual
			<length>=u8ArrLenGet
			u32EptrActual += (<length>*1);
			if (u8AutoIncGet) then:
			u8ArrIndexGetActual += <length>
			NOTE: This u32EptrActual is not the same as the program EPTR= command.
				VLD(ab[<index>], <length>)
				
				(does not affect EPTR)

224, xE0
Response 0 only
	RC*	0	Load data from EEPROM into multiple word array variables
			<index>=u8ArrIndexGetActual
			<length>=u8ArrLenGet
			u32EptrActual += (<length>*2);
			if (u8AutoIncGet) then:
			u8ArrIndexGetActual += <length>
			NOTE: This u32EptrActual is not the same as the program EPTR= command.
				VLD(aw[<index>], <length>)
				
				(does not affect EPTR)

225, xE1
Response 0 only
	RC*	0	Load data from EEPROM into multiple long array variables
			<index>=u8ArrIndexGetActual
			<length>=u8ArrLenGet
			u32EptrActual += (<length>*4);
			if (u8AutoIncGet) then:
			u8ArrIndexGetActual += <length>
			NOTE: This u32EptrActual is not the same as the program EPTR= command.
				VLD(al[<index>], <length>)
				
				(does not affect EPTR)

226, xE2	cyclic	<value>=	u32EptrSet (last set EEPROM address) NOTE: This u32EptrActual is not the same as the program EPTR= command.	
227, xE3	cyclic	<value>=	u32EptrActual (actual EEPROM address currently in PROFINET interface) NOTE: This u32EptrActual is not the same as the program EPTR= command.	

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
228, xE4	cyclic	<value>=	u16NetLostLabel (initialized to the value of u16NetLostLabelDefault during power-up); see ETHCTL(...)	
229, xE5	cyclic	<value>=	u8NetLostAction (initialized to the value of u8NetLostActionDefault during power-up) See ETHCTL(...)	On loss of communication with PROFINET host, command is based on <value>: 0=IGNORE (No Command), 1=OFF (Motor Off), 2=X (Soft Stop), 3=S (Immediate Stop), 4=GOSUB, 5=GOTO
230-234, xE6-xEA	N/A	0	(Reserved)	
235, xEB	cyclic	<value>=	encoder resolution	RRES
236, xEC	cyclic	<value>=	firmware version	RFW
237, xED	N/A	0	(Obsolete)	
238, xEE	cyclic	<value>=	sample period as RSP command reports it (microseconds * 100), so 8kHz reports as 12500.	RSP
239-254, xF0-xFE	N/A	0	(Reserved)	
255, xFF	N/A	0	(Reserved)	

RC* indicates that a change of response request code is required to begin or repeat this event. For repeated events, that means that the code should be changed to 0, then back to the desired code per event. If using the extended packet which allows for multiple requests, then only the first request area (0) is allowed to make this request. The reason is that the global state of the motor is affected and multiple requests concurrently would be a problem.

The above codes can be used in the original 3 word out, 7 word in data exchange, or in the extended 12 word out, 28 word in data exchange. The high-order byte should be set to 0 when using these in the extended packet, which has 16-bit fields for the command and reponse codes. For example: reponse code 122 returns CLK (clock). As an 8-bit hex value, 122 is x7A; as a 16-bit value, that is x007A. The endian-ness is determined by the byte-swap configuration parameter.

Extended 16-bit response codes

Below are additional 16-bit codes. Therefore, they require the extended data format with its 16-bit fields for command and response codes.

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
256, x0100	cyclic	<value>=	variable a	Ra
257, x0101	cyclic	<value>=	variable b	Rb

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
258, x0102	cyclic	<value>=	variable c	Rc
259, x0103	cyclic	<value>=	variable d	Rd
260, x0104	cyclic	<value>=	variable e	Re
261, x0105	cyclic	<value>=	variable f	Rf
262, x0106	cyclic	<value>=	variable g	Rg
263, x0107	cyclic	<value>=	variable h	Rh
264, x0108	cyclic	<value>=	variable i	Ri
265, x0109	cyclic	<value>=	variable j	Rj
266, x010A	cyclic	<value>=	variable k	Rk
267, x010B	cyclic	<value>=	variable l	Rl
268, x010C	cyclic	<value>=	variable m	Rm
269, x010D	cyclic	<value>=	variable n	Rn
270, x010E	cyclic	<value>=	variable o	Ro
271, x010F	cyclic	<value>=	variable p	Rp
272, x0110	cyclic	<value>=	variable q	Rq
273, x0111	cyclic	<value>=	variable r	Rr
274, x0112	cyclic	<value>=	variable s	Rs
275, x0113	cyclic	<value>=	variable t	Rt
276, x0114	cyclic	<value>=	variable u	Ru
277, x0115	cyclic	<value>=	variable v	Rv
278, x0116	cyclic	<value>=	variable w	Rw
279, x0117	cyclic	<value>=	variable x	Rx
280, x0118	cyclic	<value>=	variable y	Ry
281, x0119	cyclic	<value>=	variable z	Rz
282, x011A	cyclic	<value>=	variable aa	Raa
283, x011B	cyclic	<value>=	variable bb	Rbb
284, x011C	cyclic	<value>=	variable cc	Rcc
285, x011D	cyclic	<value>=	variable dd	Rdd
286, x011E	cyclic	<value>=	variable ee	Ree
287, x011F	cyclic	<value>=	variable ff	Rff
288, x0120	cyclic	<value>=	variable gg	Rgg
289, x0121	cyclic	<value>=	variable hh	Rhh
290, x0122	cyclic	<value>=	variable ii	Rii
291, x0123	cyclic	<value>=	variable jj	Rjj
292, x0124	cyclic	<value>=	variable kk	Rkk
293, x0125	cyclic	<value>=	variable ll	Rll
294, x0126	cyclic	<value>=	variable mm	Rmm
295, x0127	cyclic	<value>=	variable nn	Rnn
296, x0128	cyclic	<value>=	variable oo	Roo

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
297, x0129	cyclic	<value>=	variable pp	Rpp
298, x012A	cyclic	<value>=	variable qq	Rqq
299, x012B	cyclic	<value>=	variable rr	Rrr
300, x012C	cyclic	<value>=	variable ss	Rss
301, x012D	cyclic	<value>=	variable tt	Rtt
302, x012E	cyclic	<value>=	variable uu	Ruu
303, x012F	cyclic	<value>=	variable vv	Rvv
304, x0130	cyclic	<value>=	variable ww	Rww
305, x0131	cyclic	<value>=	variable xx	Rxx
306, x0132	cyclic	<value>=	variable yy	Ryy
307, x0133	cyclic	<value>=	variable zz	Rzz
308, x0134	cyclic	<value>=	variable aaa	Raaa
309, x0135	cyclic	<value>=	variable bbb	Rbbb
310, x0136	cyclic	<value>=	variable ccc	Rccc
311, x0137	cyclic	<value>=	variable ddd	Rddd
312, x0138	cyclic	<value>=	variable eee	Reee
313, x0139	cyclic	<value>=	variable fff	Rfff
314, x013A	cyclic	<value>=	variable ggg	Rggg
315, x013B	cyclic	<value>=	variable hhh	Rhhh
316, x013C	cyclic	<value>=	variable iii	Riii
317, x013D	cyclic	<value>=	variable jjj	Rjjj
318, x013E	cyclic	<value>=	variable kkk	Rkkk
319, x013F	cyclic	<value>=	variable lll	Rlll
320, x0140	cyclic	<value>=	variable mmm	Rmmm
321, x0141	cyclic	<value>=	variable nnn	Rnnn
322, x0142	cyclic	<value>=	variable ooo	Rooo
323, x0143	cyclic	<value>=	variable ppp	Rppp
324, x0144	cyclic	<value>=	variable qqq	Rqqq
325, x0145	cyclic	<value>=	variable rrr	Rrrr
326, x0146	cyclic	<value>=	variable sss	Rsss
327, x0147	cyclic	<value>=	variable ttt	Rttt
328, x0148	cyclic	<value>=	variable uuu	Ruuu
329, x0149	cyclic	<value>=	variable vvv	Rvvv
330, x014A	cyclic	<value>=	variable www	Rwww
331, x014B	cyclic	<value>=	variable xxx	Rxxx
332, x014C	cyclic	<value>=	variable yyy	Ryyy
333, x014D	cyclic	<value>=	variable zzz	Rzzz
334 - 511, x014E - x01FF	N/A	0	(Reserved)	

Response Code	Event for update	Response Data Value	Response Description	Smart Motor Command(s)
decimal, hex				
512, x0200	cyclic	<value>=	float 0 (32-bit IEEE)	Raf[0]
513, x0201	cyclic	<value>=	float 1 (32-bit IEEE)	Raf[1]
514, x0202	cyclic	<value>=	float 2 (32-bit IEEE)	Raf[2]
515, x0203	cyclic	<value>=	float 3 (32-bit IEEE)	Raf[3]
516, x0204	cyclic	<value>=	float 4 (32-bit IEEE)	Raf[4]
517, x0205	cyclic	<value>=	float 5 (32-bit IEEE)	Raf[5]
518, x0206	cyclic	<value>=	float 6 (32-bit IEEE)	Raf[6]
519, x0207	cyclic	<value>=	float 7 (32-bit IEEE)	Raf[7]
520 - 767, x0208 - x02FF	N/A	0	(Reserved)	
768, x0300	cyclic	<value>=	long array element 0	Ral[0]
769, x0301	cyclic	<value>=	long array element 1	Ral[1]
...	cyclic	<value>=	long array element ...	Ral[...]
818, x0332	cyclic	<value>=	long array element 50	Ral[50]
819 - 65535, x0333 - xFFFF	cyclic	0	(Reserved)	

Troubleshooting

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

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

Issue	Cause	Solution
PROFINET Communication Issues		
NOTE: Station Name, IP Address, Subnet Mask, and Gateway must be correct at the PROFINET I/O controller.		
No PROFINET connection.	Motor not powered.	Check Drive Status LED. If LED is not lit, check wiring.
	Disconnected or miswired connector, or broken wiring between follower and controller.	Check that connectors are correctly wired and connected to motor. For details, see Motor Connectors and Pinouts on page 1.
	Motor nonvolatile settings.	Check that motor PROFINET Station name is set, and that all motors have been programmed with a unique station name.
	Wrong type of cable.	Check that cable is a PROFINET cable. For details, see Cables and Diagram on page 1.
	Wrong GSDML file.	Verify that the correct GSDML file was used to configure the controller and connect the follower motor as part of the PROFINET network.
Command code Ack and/or Response code Ack is returning as 255	Unknown command or response code	Check if command/response code is supported in this version of firmware
	Mismatch of the original vs. extended packet size	Verify that the controller/PLC has the correct input/output data size set. Not all possible combinations are supported. Both input and output size must be the original (14 bytes in and 6 bytes out), or both must be the extended size (56 bytes in and 24 bytes out.)
	Byte order of command / response code or data is wrong.	Check that the byte-order parameter is set as intended.
	Request in the incorrect response-request area.	Certain responses (response codes 214-225) are only allowed in the first response request section (0) of the extended packet and not in responses 1-7.
	Value out of range	Check the data value, or related commands such as EE address or variable index for appropriate range of values.

Issue	Cause	Solution
Other Communication and Control Issues		
Motor does not communicate with SMI.	Transmit, receive, or ground pins are not connected correctly.	Ensure that transmit, receive and ground are all connected properly to the host PC.
	Motor program is stuck in a continuous loop or is disabling communications.	To prevent the program from running on power up, use the Communications Lockup Wizard located on the SMI software Communications menu.
Motor disconnects from SMI sporadically.	COM port buffer settings are too high.	Adjust the COM port buffer settings to their lowest values.
	Poor connection on serial cable.	Check the serial cable connections and/or replace it.
	Power supply unit (PSU) brownout.	PSU may be too high-precision and/or undersized for the application, which causes it to brown-out during motion. Make moves less aggressive, increase PSU size, or change to a linear unregulated power supply.
After power reset, motor stops communicating over USB or serial port, requires re-detection.	Motor does not have its address set in the user program. NOTE: Serial addresses are lost when motor power is off or reset.	Use the SADDR or ADDR= command within the program to set the motor address.
Red PWR SERVO light illuminated.	Critical fault.	To discover the source of the fault, use the Motor View tool located on the SMI software Tools menu.
Common Faults		
Bus voltage fault.	Bus voltage is either too high or too low for operation.	Check servo bus voltage.
Overcurrent occurred.	Motor intermittently drew more than its rated level of current. Does not cease motion	Consider making motion less abrupt with softer tuning parameters or acceleration profiles.
Excessive temperature fault.	Motor has exceeded temperature limit of 85°C. Motor will remain unresponsive until it cools down below 80°C.	Motor may be undersized or ambient temperature is too high. Consider adding heat sinks or forced air cooling to the system.
Excessive position error.	The motor's commanded position and actual position differ by more than the user-supplied error limit.	Increase error limit, decrease load, or make movement less aggressive.
Historical positive/negative hardware limit faults.	A limit switch was tripped in the past.	Clear errors with the ZS command.
	Motor does not have limit switches attached.	Configure the motor to be used without limit switches by setting their inputs as general use.

Issue	Cause	Solution
Programming and SMI Issues		
Several commands not recognized during compiling.	Compiler default firmware version set incorrectly.	Use the "Compiler default firmware version option" in the SMI software Compile menu to select the default firmware version closest to the motor firmware version. In the SMI software, view the motor firmware version by right-clicking the motor and selecting Properties.
	Unsupported commands used in program.	Check the unrecognized commands against those listed in the section "Commands Not Currently Supported" in the *Class 6Moog Animatics SmartMotor™ User's Guide*

NOTES

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

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

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

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

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

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

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**

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