WOODWARD

Product Manual 26578
(Revision D, 6/2016)
Original Instructions

ProAct™ P-Series Position Controller

Actuator Models II through IV

Installation, Programming, and Troubleshooting Manual

General Precautions	**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.** **Practice all plant and safety instructions and precautions.** **Failure to follow instructions can cause personal injury and/or property damage.**

Revisions	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:** **www.woodward.com/publications** **The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

Proper Use	**Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.**

Translated Publications	**If the cover of this publication states "Translation of the Original Instructions" please note:** **The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.**

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

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Illustrations and Tables

The following are trademarks of Woodward, Inc.:
ProAct
TecJet

The following are trademarks of their respective companies:
Windows, Windows Vista (Microsoft Corporation)

Warnings and Notices

Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE **Battery Charging Device**	**To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.**

Electrostatic Discharge Awareness

Prior to making any connections to the product, personnel should ensure that they are free of electrostatic build-up in order to protect the integrity of the device's circuitry. The simplest method for dissipating electrostatic build-up is to contact an adjacent, grounded metal object before contacting the product.

NOTICE	**The product circuit boards should only be removed or repaired by authorized Woodward personnel. In the event this is required, authorized personnel must follow the ESD mitigation procedures described in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*, to ensure circuit board integrity is maintained during repair or replacement.**

Regulatory Compliance

European Compliance for CE Mark:
These listings are limited only to those units bearing the CE Marking.

EMC Directive:	Declared to Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)

Other European Compliance:

Machinery Directive:	Compliant as partly completed machinery with Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery.

North American Compliance:

CSA:	CSA Certified for Class I, Division 2, Groups A, B, C, & D, T3 at 85 °C Ambient for use in Canada and the United States. Certificate 1167451 Type 3R Enclosure Rainproof This product is certified as a component for use in other equipment. The final combination is subject to acceptance by CSA International (or UL) or local inspection.

The ProAct P-Series is suitable for use in Class I, Division 2, Groups A, B, C, D per CSA for Canada and U.S. or non-hazardous locations only.

Wiring must be in accordance with North American Class I, Division 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field wiring must be suitable for at least 85 °C.

Compliance with the Machinery Directive 2006/42/EC noise measurement and mitigation requirements is the responsibility of the manufacturer of the machinery into which this product is incorporated.

⚠WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division or Zone applications.

⚠AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division ou Zone.

Acronyms/Abbreviations

ACK	Acknowledgment
AUX	Auxiliary
CAN	Controller Area Network
CAN ID	CAN Identifier. Used to define and select multiple product applications within a single device.
CW	Clockwise
CCW	Counterclockwise
DA	Destination Address
ECU	Electronic Control Unit
EEPROM	Electrically-Erasable Programmable Read-Only Memory
EMC	Electromagnetic Compatibility
FL or FLEX	ProAct P-Series version with customer I/O terminated on terminal blocks as opposed to a 24-pin circular connector on the standard version
GUI	Graphic User Interface
J1939	CAN high-level protocol format defined by SAE
I/O	Inputs/Outputs
ID	Identifier
ISC	Integrated Speed Control. ProAct version capable of speed control
ITB	Integrated Throttle Body
LSB	Least Significant Bit or Least Significant Byte
MPU	Magnetic Pickup
NACK	Negative Acknowledgment
OEM	Original Equipment Manufacturer
P-Series	Woodward electronic engine governor that contains both a rotary actuator and a controller circuit board
PDU	Protocol Data Unit
PGN	Programmable Group Number
PWM	Pulse-Width Modulated
RPM or rpm	Revolutions per Minute
RS-232	a communications standard
SA	Source Address
SPN	Suspect Parameter Number
TPS	Throttle Position Sensor

Chapter 1.
General Information

Purpose and Scope

The purpose of this manual is to provide the necessary background information for applying the ProAct P-Series control to gaseous and diesel fueled reciprocating engines. Topics covered include mechanical installation, electrical wiring, software programming, and troubleshooting. While this manual is primarily targeted at OEM customers, OEMs themselves may find it useful to copy some of the information from this manual into their application user manuals.

This manual does not contain instructions for the operation of the complete engine system. For engine or plant operating instructions, contact the plant-equipment manufacturer.

This revision of the manual has been modified to include a Run/Stop feature update available in firmware version 5418-6507. When a shutdown is detected or STOP is selected, the option was added to drive the shaft position to min (or max) for 10 seconds and subsequently enter 'Low Power Standby' mode.

This version of the manual applies to all ProAct P-Series Position Control models with software 5418-3759, 5418-6133, 5418-6507, or newer. The software version can be identified on the Identification tab of the Service Tool.

How to Use This Manual

The following summarizes how to install a P-Series actuator into a new or existing system:

- Unbox and inspect the hardware.
- Mount and wire the hardware following the procedures and recommendations in Chapter 2.
- Optionally configure the control using the Service Tool (Chapter 4).
- Optionally stroke the valve and verify dynamics and functionality (Chapter 6).
- Troubleshooting guidelines are provided in Chapter 8.
- Specifications are provided in the Appendix.

Intended Applications

The ProAct control is designed for various industrial applications, including but not limited to generator sets, mechanical drives, pumps and compressors. The ProAct is generally applicable to engines in the 300 kW to 3000 kW output range. Key environmental characteristics of these applications include extended industrial operating temperatures (–40 °C to +85 °C / –40 °F to +185 °F), Industrial EMC Requirements, and electrical transients.

Introduction

The ProAct provides a building block approach to total engine management. The modular bi-directional actuator design easily attaches to fuel pumps, fuel valves, or throttle bodies. There are three ProAct models (II, III, IV) that provide a wide range of work outputs. Available ITBs (integrated throttle bodies) include 85, 95, 105, 120, 135, 160, and 180 mm versions (see product manual 26265 for details).

Two similar variations of the ProAct P-Series are available: the standard version and the FL version. The standard ProAct P-Series, covered by this manual, utilizes a 24-pin circular connector for customer I/O, whereas the FL version has terminal block connections. The FL (flex) version can be adapted into a variety of existing systems by adding a connector kit or by directly landing wires to terminal blocks. The P-Series FL also provides additional options of (0 to 200) mA Analog Input range and (0 to 5) V (dc) Analog Output range. Refer to manual 26659 for FL version details.

Woodward also offers a ProAct version for speed control applications. Refer to manual 26246, ProAct ISC—Integrated Speed Control. The ProAct ISC is a microprocessor-based speed control incorporated into the actuator, creating a single integrated actuator/speed control. This eliminates the need for an additional driver box and speed control box.

The ProAct P-Series actuator accepts a position command and drives the 0 to 75 degree output shaft to the commanded position based on an internal shaft position sensor. The high-efficiency torque motor delivers up to 10.4 N·m (92 lb-in), for a Model IV, nominally over 75° travel range to operate fuel or air control devices. See specifications in the Appendix for torque performance of all actuator model sizes over the full product temperature range.

The device accepts either a PWM command, a CAN command, or an analog (voltage or milliamp) command for output positioning. The position command input can also be set up with a primary and a backup input, providing redundancy. Automatic failover and fallback logic is provided when using redundant position commands.

For status purposes, a relay driver output is available that changes state whenever a fault or error condition is experienced by the ProAct P-Series controller.

A (4 to 20) mA position output signal provides an external position indication after installation and while the unit is operating.

Input power is nominally 24 V (18 V to 32 V) but the device is functional in the range of (8 to 40) V (dc) for short periods (e.g. starting or transients), however accuracy and/or torque can be diminished at the extreme ends of this range.

Product configuration and tuning is performed using a PC-based Service Tool.

More detail on the features of the ProAct P-Series can be found later in this manual.

Programmable Features

Control setup and tuning is accomplished through the use of a PC (personal computer), Woodward Service Tool software, and a programming harness. The features identified below are described in Chapters 2 and 4. Briefly, the programmable features include:

- General Setup
  - Direction (CCW or CW)
  - Fail Position
- Position Controller
  - Dynamics (friction & inertia)
  - Position Error magnitude & delay
  - Non-Linear actuator settings
- Position Demand
  - Position Demand Select (Primary/Backup; CAN, PWM or Analog)
  - Tracking options
- PWM Input scaling, failure levels, offset
- Analog Input scaling and failure levels
- Analog Output selection & scaling
- Discrete Output Settings
  - Output's Non-Fault Condition (ON or OFF)
  - Fault Selections as Discrete Output Indications
- Fault Settings
  - Latching or Non-Latching Fault Indications
  - Fault Selections as Alarms or Shutdowns
  - Shutdown actions
- CAN (J1939)
  - CAN Data Rate
  - CAN ID input selections
  - Demand Failure Timeout
  - Data PGN, Command PGN, Source address, Function Field

Service Tool Software

The ProAct Service Tool software is a Microsoft Windows based GUI (graphic user interface). The Service Tool Software is compatible with Windows 2000, XP, Vista, 7 (32- and 64-bit) or greater and provides the ability to:

- Configure product settings based on application requirements
- Tune the control with the engine running during application development
- Create configuration files for downloading into multiple controls
- Download configuration files
- Extract and view fault codes for field diagnosis
- Update control dynamics during field service
- Calibrate the control for user stops

Detailed descriptions of software installation are available in Chapter 4.

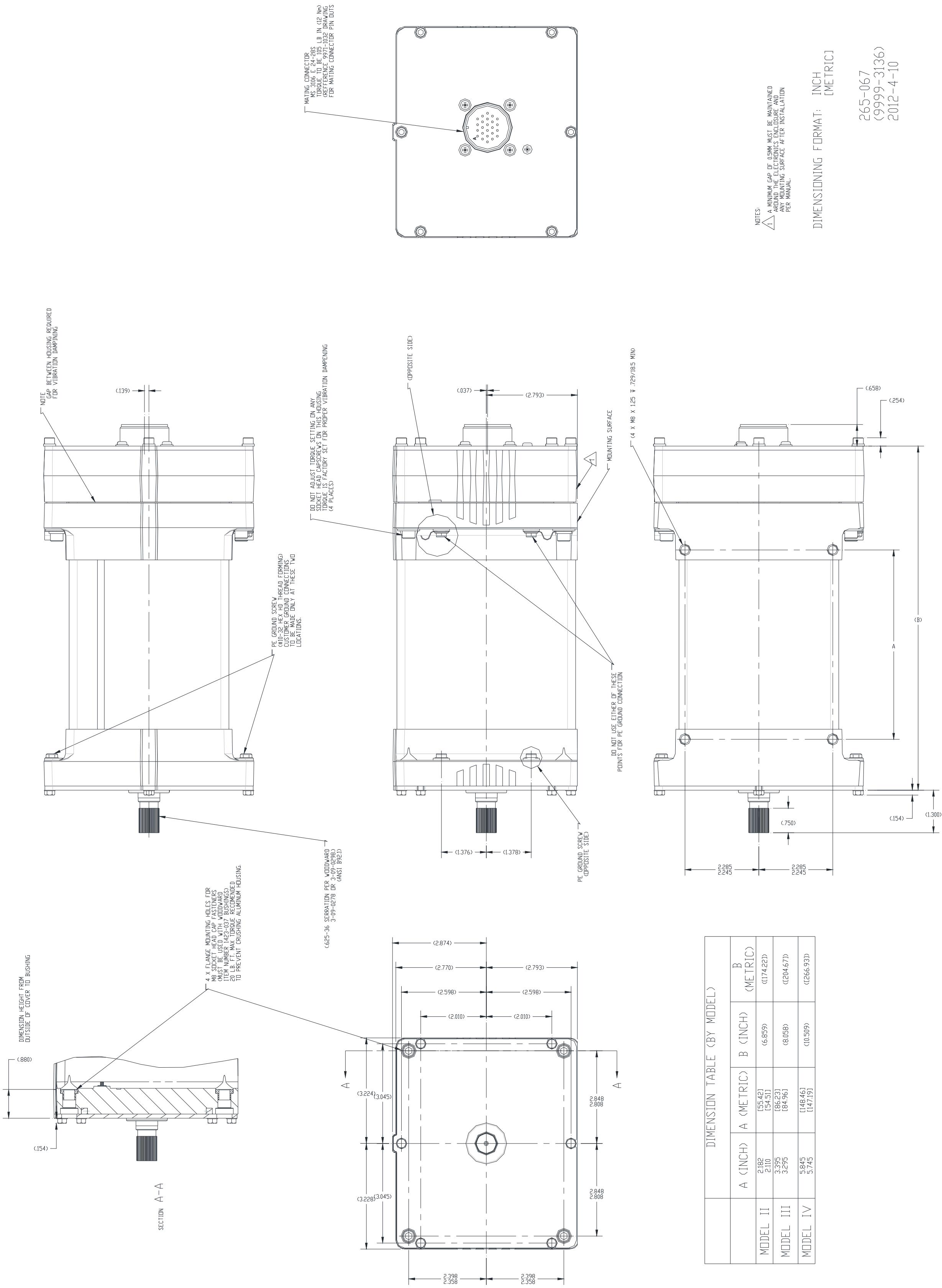
WARNING — **The actuator must be properly set up using the Service Tool prior to starting the prime mover.**

WARNING — **The inertia setting and friction setting must be properly adjusted using the Service Tool prior to engine operation. Improper inertia or friction settings can result in unpredictable actuator movement and possible personal injury or damage to equipment.**

IMPORTANT — **The Service Tool is not included, but can be downloaded from the Woodward Internet website (www.woodward.com/software).**

References

The outline drawing is Figure 1-1 below, and the control wiring diagram is Figure 2-2 in Chapter 2.



DIMENSION TABLE (BY MODEL)

	A (INCH)	A (METRIC)	B (INCH)	B (METRIC)
MODEL II	2.182 2.110	[55.42] [54.51]	(6.859)	([174.22])
MODEL III	3.395 3.295	[86.23] [84.96]	(8.058)	([204.67])
MODEL IV	5.845 5.745	[148.46] [147.19]	(10.509)	([266.93])

Figure 1-1. ProAct Outline Drawing

Chapter 2. Installation

Introduction

This chapter provides instructions on how to mount and connect the ProAct P-Series controller into a system. Hardware dimensions are provided for mounting the device to a specific application.

⚠WARNING	**EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.** **Substitution of components may impair suitability for Class I, Division or Zone applications.**

⚠WARNING	**External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.**

⚠WARNING	**Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.**

⚠WARNING	**Due to typical noise levels in turbine or engine environments, hearing protection should be worn when working on or around the P-Series.**

⚠WARNING	**The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.**

NOTICE	**Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Figure 2-2).**

General Installation, Operation Notes and Requirements

⚠WARNING	**Do not lift or handle the P-Series by any conduit. Lift or handle the actuator only by following proper procedures.**

⚠WARNING	**Use an independent device for positive shutdown, such as a fuel shut-off valve is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.** **Use of an external spring to return to minimum fuel is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.** **Use of a predicted min fuel shutdown procedure is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.**

Unpacking and Handling

Before handling the actuator, read the Electrostatic Discharge Awareness information on page iv. Be careful when unpacking the actuator. Check the unit for signs of damage, such as bent or dented panels, scratches, and loose or broken parts. If any damage is found, immediately notify the shipper.

⚠CAUTION	**Use both hands to pick up the ProAct P-Series. Do NOT pick up by the connectors or by the terminal shaft, which could damage the actuator or allow it to fall, with the possibility of personal injury.**

Mechanical Installation

Mounting Location

The ProAct is designed for installation on the engine. The mounting location on the engine has to provide suitable access to the air throttle, fuel gas control valve, or the diesel control shaft. The ProAct must be able to change the throttle, valve, or shaft position to control engine speed. Secondary mounting location considerations are temperature, heat sink capability, vibration, and wire length.

NOTICE	**A minimum gap of 0.5 mm must be maintained between the support bracket and electronics enclosure (see Figure 1-1). This is necessary because the enclosure is supported on vibration isolators to filter out high-frequency vibrations from reaching the electronics. If the enclosure contacts the bracket, the isolation is defeated and may reduce the electronics operating life.** **If spacers are used to achieve the necessary gap, Woodward recommends maximizing the surface contact area of the spacers to maximize heat transfer between the ProAct and mounting bracket.**

Temperature

The ProAct is designed to operate within a temperature range of –40 °C to +85 °C (–40 °F to +185 °F). However, maintaining the actuator operating temperature near normal ambient temperatures (~20 °C) reduces the input and output temperature drift and improves actuator life (MTTF).

Heat Sink Capability

The ProAct generates heat, especially when stalled or during other conditions requiring maximum torque output. The installer must consider the heat conductivity of the installation bracket, and the operating temperature of the ultimate heat sink to which the bracket will be attached.

The thermal design of the ProAct is based on the cooling of critical electrical components coupled to the aluminum frame of the actuator. If a temperature of 90 °C is maintained at the mounting surfaces, the temperature of the electronics will remain within acceptable limits. Therefore, when applying the ProAct, the temperature at the mounting bracket must not exceed 90 °C regardless of the surrounding thermal conditions. If the temperature of this zone exceeds 90 °C, the actuator will limit the available torque to compensate.

IMPORTANT **The CSA hazardous location listing is not applicable if the surrounding air ambient temperature exceeds 85 °C.**

Mounting the ProAct

Models II through IV actuators may be installed on a bracket in either base or flange mount configuration with the exception of the model IV. The mass of the model IV requires that it be mounted only in the base mount configuration.

The base mount configuration requires the use of four M8x1.25 screws with a minimum engagement of 16 mm. The flange mount configuration requires the use of four M8 screws through the flange. Whether base mounting or flange mounting the actuator, torque the four M8 screws to 22.6 N-m (200 lb-in). Both mounting features are shown in Figure 1-1. The unit can be mounted in any attitude. All exterior and mounting dimensions and exterior fasteners are metric.

The brackets and attaching hardware must be designed to hold the weight and to withstand the vibration associated with engine mounting.

The ProAct weighs approximately:

Model II	11 kg (25 lb)
Model III	15 kg (32 lb)
Model IV	24 kg (52 lb)

As shown in Specifications, the ProAct actuators have been designed for and verified to a given accelerated life vibration test level at the mounting surface of the actuator. The user should be aware that in any application, bracket design can significantly change the vibration levels at the actuator. Therefore, every effort should be made to make the bracket as stiff as possible so that engine vibrations are not amplified, creating an even more severe environment at the actuator. Additionally, when possible, orienting the actuator shaft parallel to the crankshaft of the engine will often reduce the vibration load on the actuator's rotor system in reciprocating engine applications.

Mounting the ProAct with an ITB

The ProAct ITBs with model II actuators are designed to be mounted on the valve flange. However, the end-user may also want to support the actuator to minimize the loads on their piping. The ProAct ITBs with model III and model IV actuators are designed to be base-mounted due to the higher mass of the actuator and the increased lever arm between the center of the bore and the center of gravity. Flange mounting of model III may be allowed, but the vibration level must be assessed in order to ensure a low level of stress on the component.

Refer to the ITB manual for mounting details.

ProAct Grounding

The ProAct must be grounded to the engine structure through a low-impedance connection in order to ensure proper EMC performance. This may be accomplished through the mechanical mounting of the actuator/throttle itself (preferred), or through a wired connection to a designated ground screw on the unit. If a wired connection is used as the primary EMC ground, it must be through a low-impedance wire or strap < 30 cm (12 inches) in length, 3 mm² (12 AWG) minimum. See Figure 1-1 for the ground screw location on each model.

Output Shaft

The ProAct has 73° to 77° of available travel. The max fuel direction of this travel is software configurable in the clockwise or counterclockwise direction through the Service Tool.

Mechanical Stops

Internal mechanical actuator stops will only survive a maximum kinetic energy of 0.011 J (0.097 in-lb). If the actuator internal stops are used, the load inertia should not exceed 4.25E-4 kg-m² (3.76E-3 in-lb-s²). In service, electrical and engine stops should be set inside the actuator stops. Electrical stops are set via the Service Tool.

Fuel Position Stops
Diesel Stops—Diesel installations generally use the fuel system minimum and maximum position stops. Diesel engine racks are normally designed to provide the minimum and maximum stops without binding. The actuator's stops must not prevent the actuator from driving the fuel linkage to the minimum and maximum positions. The linkage should be designed to use as much actuator travel as possible, without preventing minimum and maximum fuel positions (see Figure 2-1).

Gas Engine Stops—Fuel gas valves and butterfly valves in carburetors often bind if rotated too far toward minimum or maximum. For this reason, the stops in the ProAct actuator should be used at both minimum and maximum positions. Note that the actuator internal stops allow up to 1.5 degrees of additional rotation in both directions during impact (see Figure 2-1). The engine must always shut down when the actuator is at the minimum stop.

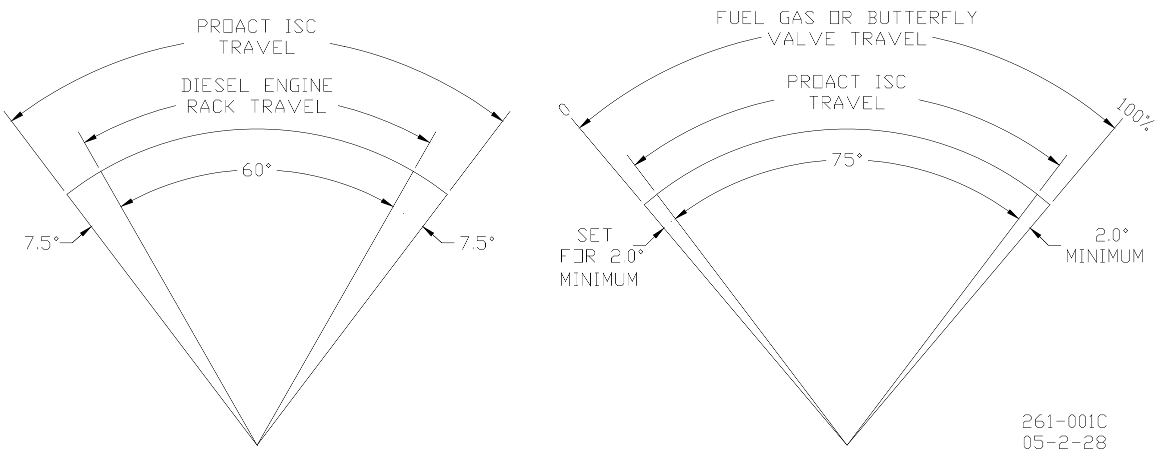


Figure 2-1. Fuel Stops

Linkage

Proper design and installation of the actuator linkage is necessary for the ProAct actuator to provide the best possible speed control. Certain applications with low inertia may be unstable with high impulse loads and may require additional system inertia. See troubleshooting guidelines or contact Woodward for more information. Ensure the actuator has ample work capacity to control the fuel supply under maximum load conditions.

Manually stroke the fuel-control linkage from stop to stop as if the actuator were moving it. The linkage must move freely, without friction and backlash. Lubricate or replace worn linkage or fuel control parts as required.

⚠WARNING	**The actuator contains no internal return spring; therefore an external positive shutdown is necessary in the event of a loss of power to the actuator.**

NOTICE	**The actuator's maximum slew rate can place stress on the fuel system stops and on the linkage between the actuator and the fuel system. The maximum actuator speed is 1000 degrees per second in both increase and decrease fuel directions.**

The Mass Moment of Inertia (MMOI) for the ProAct actuators:

- Model II is 5.5E-4 kg-m² (4.9E-3 lb-in-s²)
- Model III is 6.4E-4 kg-m² (5.6E-3 lb-in-s²)
- Model IV is 8.2E-4 kg-m² (7.2E-3 lb-in-s²)

The fuel system stops must be adequate to absorb the actuator MMOI in addition to the linkage inertia without damage. ProAct actuator internal stops are designed to absorb 0.011 J (0.097 in-lb) of kinetic energy with 1.5 degrees of over travel. If the actuator stops are used, the load inertia must not exceed 4.25E-4 kg-m² (3.76E-3 in-lb-s²), and the linkage must be designed to allow the 1.5 degrees of over travel on each end. Use of good rod-end connectors with as little free play as possible is essential. Select rod ends that will remain tight and wear well during the nearly constant movement associated with precise speed control. Low-friction, long-wearing rod ends are available from Woodward. The link connecting the actuator lever to the fuel-control lever must be short and stiff enough to prevent flexing while the engine is running.

Typically, in a linkage system, there are links and levers that are supported by customer-supplied bearings. However, there is often a section of the linkage where the mass is supported fully by the actuator output shaft. When designing linkage systems, please note that each ProAct actuator output shaft accepts 1.2 kg (2.6 lb) of additional mass at a maximum vibration level of 10 G's. Exceeding the allowable mass or vibration level may damage the actuator rotor system and shorten actuator life.

Actuator levers are available from Woodward, which allow adjustment of the rod end locations with respect to the center of the actuator shaft. The lever used must have a 0.625-36 serration.

Adjust the location of the rod end on the lever to achieve the desired actuator rotation between minimum and maximum positions. The linkage should be set to use as much of the 75 degrees as possible (60 degrees minimum). To increase the amount of actuator rotation, move the rod end closer to the actuator shaft or farther away from the shaft controlling the fuel flow. To decrease the amount of actuator rotation, move the rod end farther from the actuator shaft or closer to the shaft controlling the fuel flow.

⚠WARNING	**GAS ENGINE STOPS—Fuel gas valves and butterfly valves in carburetors often bind if rotated too far toward minimum or maximum. For this reason, the stops in the ProAct actuator should be used at both minimum and maximum positions. Note that the actuator internal stops allow up to 1.5 degrees of additional rotation in both directions during impact (see Figure 2-1). The engine must always shut down when the actuator is at the minimum stop.**

Electrical Installation

A wiring pin-out of the ProAct P-Series control, as viewed by looking into the control’s connector feature, is shown in Figure 2-2. Typical connections to external devices are also shown. Prior to installation, refer to the wiring diagram and the representative I/O interfaces schematic in this chapter. Also, review the hardware I/O specifications in the Appendix.

All input and output signals run through a 24-pin connector. The following section provides a description for every pin and the electrical requirements. For functional descriptions see Chapter 3, Description of Operation.

Shielded Wiring

The use of cable with individually shielded-twisted pairs is required where indicated by the control wiring diagram (Figure 2-2). Cable shields must be terminated as indicated in the control wiring diagram, and following the installation notes below. DO NOT attempt to directly ground the shield at both ends since an undesired ground loop condition may occur. **NOTE**—The P-Series actuator CAN shield connection pin is through a high-frequency capacitor only (not directly grounded), therefore it may be grounded directly at the opposite end.

Installation Notes

- Wires exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches).
- The shield termination wire (or drain wire) should be kept as short as possible, not exceeding 50 mm (2 inches), and where possible the diameter should be maximized.
- Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information. Failure to provide shielding can produce future conditions which are difficult to diagnose. Proper shielding, when provided, at the time of installation is required to ensure satisfactory operation of the product.

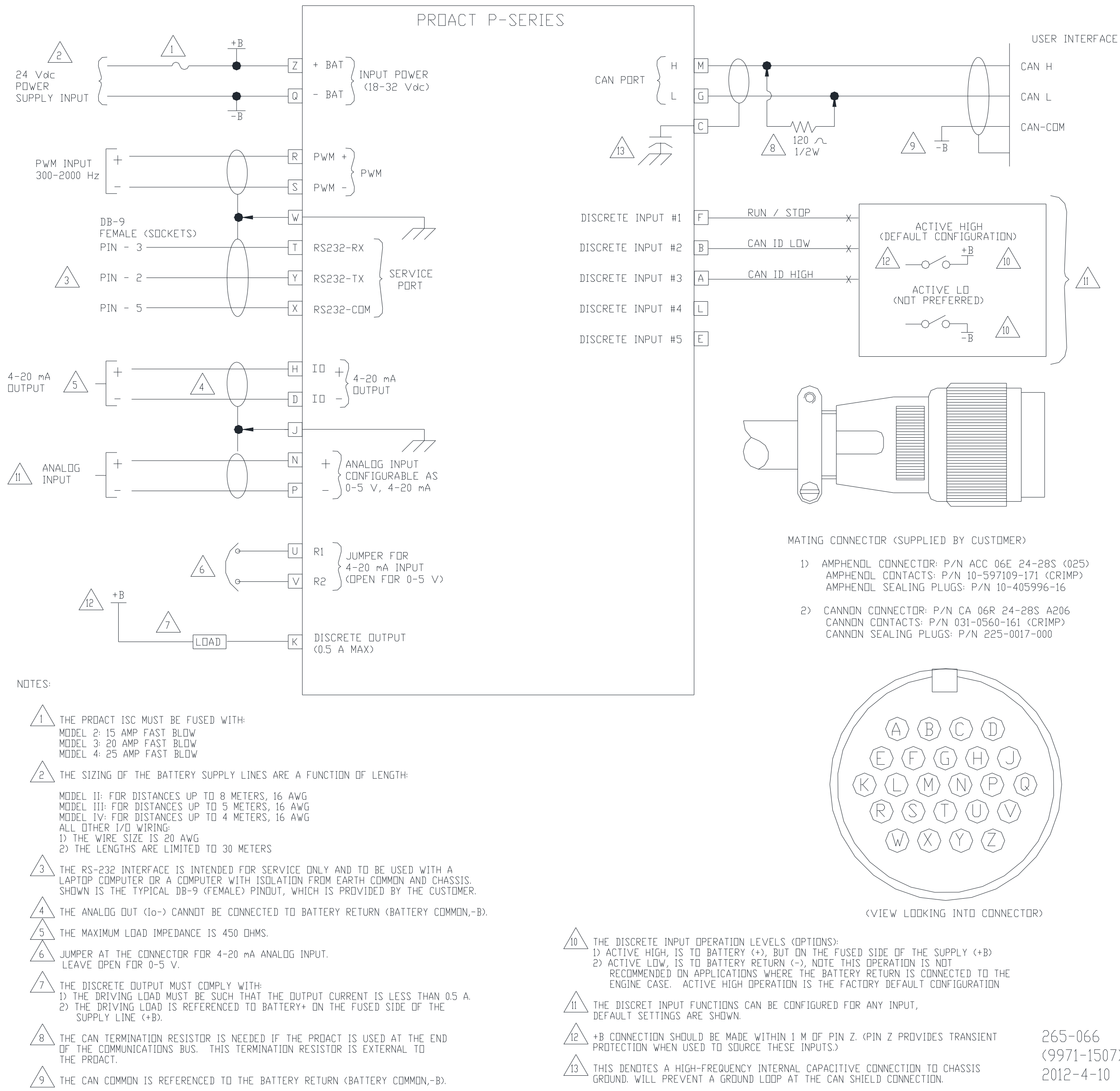


Figure 2-2. Control Wiring Diagram

Electrical Connections

The ProAct P-Series is not supplied with the prime mover harness connector. The following connectors are compatible with the ProAct P-Series.

Amphenol

Amphenol Connector:	P/N ACC 06E 24-28S (025)
Amphenol Contacts:	P/N 10-597109-171 (CRIMP)
Amphenol Sealing Plugs	P/N 10-405996-16

Cannon

Cannon Connector:	P/N CA 06R 24-28S A206
Cannon Contacts:	P/N 031-0560-161 (CRIMP)
Cannon Sealing Plugs:	P/N 225-0017-000

As an option, a connector can be ordered from Woodward, part number 1635-1113, kit 6995-1021.

The correct size for all I/O wiring to the ProAct is 0.5 mm² (20 AWG).

I/O cabling for the ProAct is limited to 30 m (100 ft) for surge compliance.

Exceptions:
For specifics on power supply and the CAN wiring, see the Supply Power and CAN Port Specification Summary sections later in this chapter.

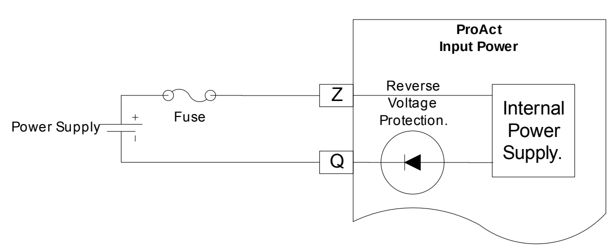
⚠WARNING — **Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.**

NOTICE — **Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Figure 2-2).**

Description of Electrical I/O

This section provides a schematic representation of each input/output. Additional information can be found in the I/O specifications of the Appendix.

Supply Power (Pins: Z, Q)



Pin Z = Supply Power Plus
Pin Q = Supply Power Minus

The ProAct requires a voltage source of (18 to 32) V (dc), with a current capacity of at least:

15 A for the Model II
15 A for the Model III
20 A for the model IV

If a battery is used for operating power, an alternator or other battery-charging device is necessary to maintain a stable supply voltage.

Special care must be taken when wiring the ProAct P-Series.

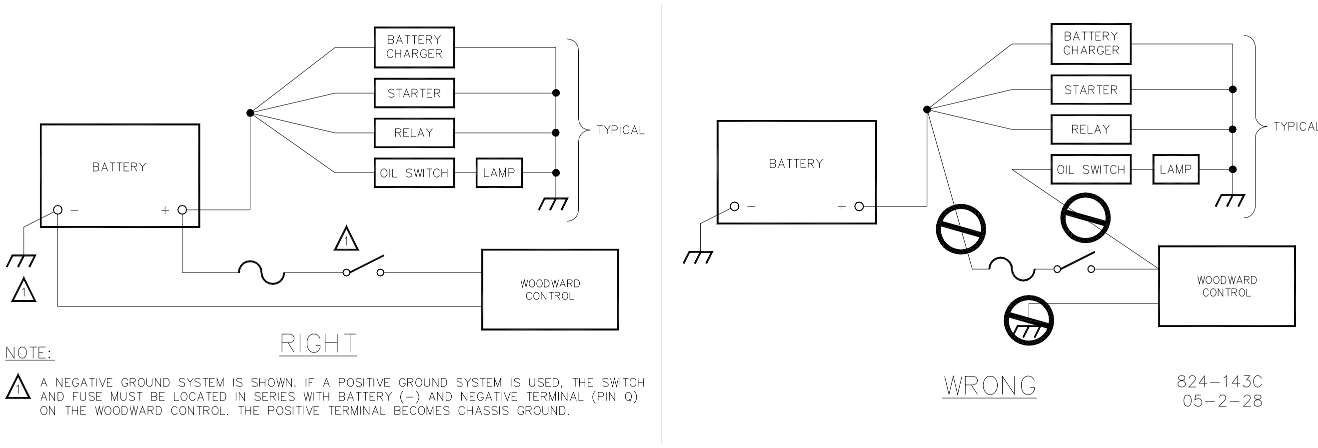


Figure 2-3. Correct and Incorrect Wiring to Power Supply

To withstand an engine start when actuator power is from the starting batteries, the actuator will work with a supply voltage as low as 8 V. However, the actuator will not function completely within specifications. During the low voltage, the ProAct will NOT meet the transient response times or the maximum torque output.

Voltage range

- Normal operation: (18 to 32) V
- Transient/starting: (8 to 40) V for 1 minute

The ProAct must be fused:

- Model II: 15 A fast blow
- Model III: 20 A fast blow
- Model IV: 25 A fast blow

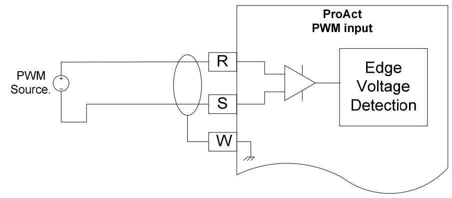
⚠WARNING **The input power must be fused. Failure to fuse the ProAct could, under exceptional circumstances, lead to personal injury, damage to the control valve, or explosion.**

Wire Requirements:

For battery connections (+Bat and –Bat):

- Model II: 1.0 mm²/16 AWG for distances up to 8 meters
- Models III and IV: 1.5 mm²/14 AWG for distances up to 8 meters

PWM Input (Pins: R, S, W)



Pin R = PWM + signal
Pin S = PWM - signal
Pin W = Shield (shared)

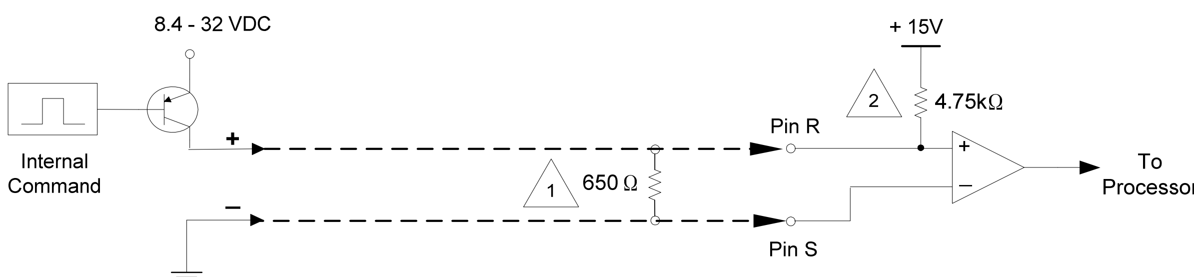
This input is optional and is used when a PWM position command is required. The PWM input is a differential type capable of handling low-side and push-pull style PWM sources. Pull-up level is 15 V through 4.75 kς. A high-side source is possible but requires customer-supplied wiring and a resistor (see suggested wiring option below).

This input will handle a PWM frequency range from 300 Hz to 2000 Hz at amplitudes ranging from 8.4 V to 32 V. Normal operating range is from 10 % to 90 % duty cycle; however these settings are configurable using the service tool.

PWM input duty cycle failure diagnostics are provided based on software configuration.

High-Side PWM Source
(suggested wiring option)

Customer PWM Source — P-Series PWM Input Circuit

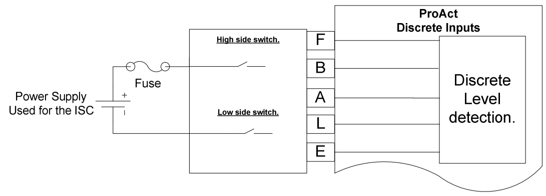


NOTES:

1 — This resistor is supplied by the customer. It is NOT internal to the P-Series actuator. A 650 ohm 3W resistor is a suggested value to ensure a 1.8V detection threshold over the entire temperature range.

2 — This resistor is present in all P-Series versions. It must be taken into consideration when selecting an external resistor to ensure that the PWM signal passes through the detection threshold.

Discrete Inputs (Pins: F, B, A)



Pin F = DI#1 (default function: Run Enable)
Pin B = DI#2 (default function: CAN ID Low Input)
Pin A = DI#3 (default function: CAN ID High Input)

The Discrete inputs are used to control the behavior of the ProAct P-Series. The input functions (below) are mapped to discrete inputs. All discrete inputs are the same electrical circuits. All can be configured in the software for high side switch or low side switch and for an active closed contact or an active open contact.

High Side Switch: (default)
If used as a high side switch, the switch contact must be connected to the discrete input pin and to the supply plus of the ProAct P-Series. The high side switch configuration is preferred.

Low Side Switch:
If used as a low side switch, the contact must be connected to the discrete input pin and to the power supply minus of the ProAct P-Series.

Active Closed: (default)
Active closed can be used for situations where it is safer to make the function inactive if the wire is broken or disconnected.

Active Open:
Active open contact can be used for situations where it is safer to make the function active if the wire is broken or disconnected.

The fuse shown in the diagram can be the same fuse that is used for the power supply of the actuator—there is no need for an additional fuse.

Run Input

The Run Input is a configurable discrete input that causes the actuator to run normally when active and will force the actuator current to zero (actuator goes limp) when not active. The low power mode provides for minimal power consumption of the device.

The Run Input can be configured as ‘Not Used’, which sets the software to always run. With a ‘Not Used’ configuration, the Run Input wiring is not needed. If configured for use, the Run Input must be active to run the actuator.

CAN ID Inputs

The CAN ID inputs are used to select which CAN identifiers will be used on the CANbus. With no programming tools, the customer can select from the four pre-programmed CAN IDs through a hard-wired code in the engine harness. This is especially important where more than one ProAct is used on an engine. If one ProAct P-Series actuator is replaced with another, the new actuator will read the correct ID number from the engine harness connector upon power-up.

Up to four ProAct actuators with the same configuration can be on the same CANbus, however, each must have a different device address. The CAN device source address is determined by using the CAN ID HI and LO discrete inputs upon power-up of the actuator (see Table 2-1). The TRUE/FALSE state is based on the actuator's configuration settings (see Table 2-2).

ProAct ID Number	**1**	**2**	**3**	**4**
CAN ID HI	FALSE state	FALSE state	TRUE state	TRUE state
CAN ID LO	FALSE state	TRUE state	FALSE state	TRUE state

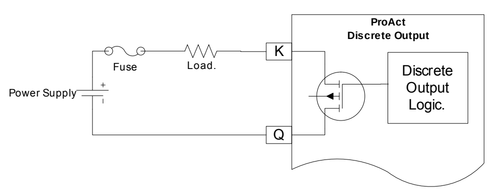
Table 2-1. ProAct CAN ID Number

ProAct Configuration	**High Side Switch, Active Closed**	**High Side Switch, Active Open**	**Low Side Switch, Active Closed**	**Low Side Switch, Active Open**
TRUE state	Closed / High (+V)	Open/ Low (Gnd)	Closed/ Low (Gnd)	Open/ High (+V)
FALSE state	Open/ Low (Gnd)	Closed/ High (+V)	Open/ High (+V)	Closed/ Low (Gnd)

Table 2-2. Discrete In Configuration Logic

IMPORTANT **The CAN address high and low discrete inputs must be wired prior to power-up to be registered.**

Discrete Output (Pin: K)



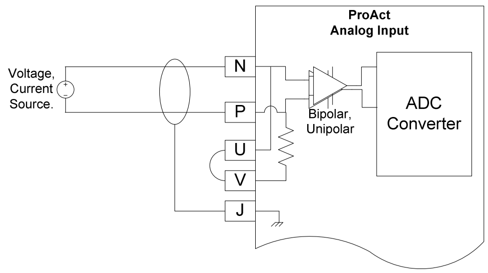
Pin K = Discrete output

The discrete output is used to give a signal to a control system or an operator panel. The output is software configurable and can be either turned on or off by the use of a number of flags such as shutdown, alarm, etc.

The electrical circuit is a low-side switch with the return current going to supply minus, pin Q. It is possible to drive a relay if more current is needed for the load. If the load is below 0.5 A, the load can be driven directly from the output.

The output is current protected and shuts down if driven above 0.5 A. If the short is removed, the output returns to normal operation automatically.

Analog Input (Pins: N, P, U, V, J)



Pin N = Analog Input Plus Signal
Pin P = Analog Input Minus Signal
Pin U = 4 to 20 mA Select 1
Pin V = 4 to 20 mA Select 2
Pin J = Shield (shared)

The Analog input is used when an analog position command is required. The input can be either (4 to 20) mA or (0 to 5) V and is configured by the wiring harness and software.

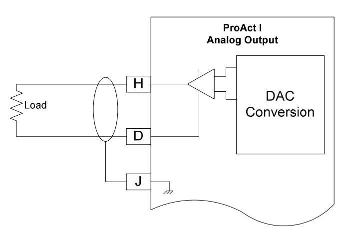
Connect the Analog Input sensor between pins N and P. Pin N is the positive input signal and pin P is for the negative input signal. The conductor shield must be connected to pin J and the other end of the Analog Input sensor cable shield is not connected and is isolated. The Analog Input and the Analog Output cables share pin J.

Mode: 0 to 5 V
If the input is used for (0 to 5) V, connect a voltage source between pins N and P. Make sure that there is no connection between pins U and V. The signal at pin N must be more positive then the signal at pin P.

Mode: 4 to 20 mA
If the input is used for (4 to 20) mA, connect a current source between pins N and P. Make sure that pins U and V are connected together as close as possible to the connector. The signal at pin N must be more positive then the signal at pin P.

Analog Input scaling and failure diagnostics are provided based on software configuration.

Analog Output (Pins: H, D, J)



Pin H = Analog Output Plus Signal
Pin D = Analog Output Minus Signal
Pin J = Shield (shared)

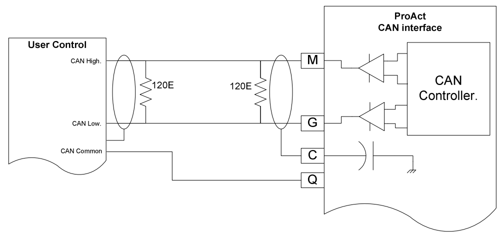
An analog output provides a (4 to 20) mA output signal representing the actual shaft rotational position where 4 mA indicates 0 % position and 20 mA is 100 %. Optionally it can be configured to represent the position setpoint.

The (4 to 20) mA analog output drives a (0 to 450) Ω load. The high side (pin H) drives current from the internal 15 V (dc) power supply to the load. Connect the return current to pin D. Pin D is internally connected to the power supply ground.

A shielded twisted-pair cable is recommended for the analog output. The output can be setup in the software for scaling and output type.

It is possible to use the analog output with more than one load if the **total** load resistance is not greater than 450 Ω.

CAN Port (Pins: M, G, C)



Pin M = CAN High
Pin G = CAN Low
Pin C = Shield

The CAN (Control Area Network) communication link is used for supervisory control and monitoring of the actuator position using a J1939 protocol. The CANbus is available for monitoring at any time independent of software configuration. However, control functions over CAN are only permitted when a CAN position command is configured.

The use of CANbus cable that meets SAE J1939-11 specifications for impedance and shielding properties is required for the CAN communication. The battery minus signal and the shield signal are not connected and therefore the shield cannot be used as a common signal between the controls.

To prevent ground loops, the shield connection is not hard wired to the chassis. The shield is terminated in the ProAct control through a high-frequency capacitor. The shield must be connected to the earth ground in the wiring harness to improve EMC performance. See Figure 2-4.

CAN Port Specification Summary:

Name	**Value**
Wiring Specification	ISO-11898, SAE J1939-11
Max Wire Length	30 m
CAN Port Isolated	No
Baud Rate	125 kbps, 250 kbps, 500 kbps, and 1 Mbps

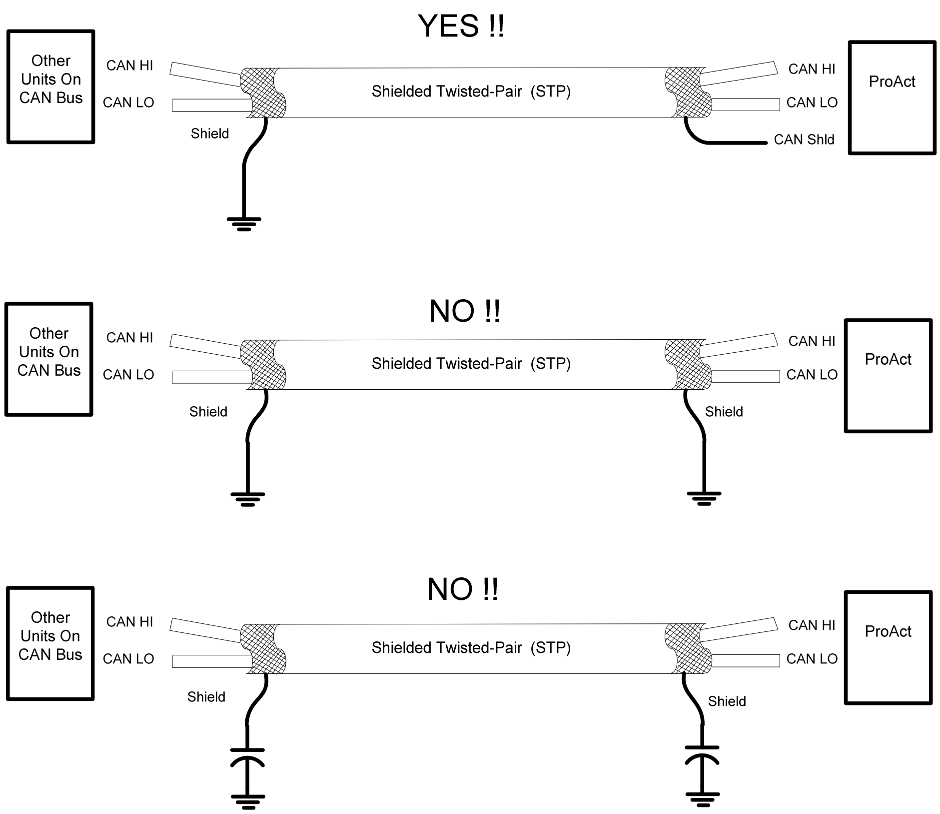
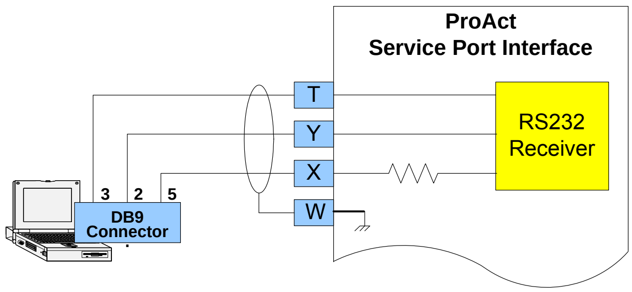


Figure 2-4. CAN Shielding

RS-232 Service port (Pins: Y, T, X, W)



Pin Y = RS-232 TX
Pin T = RS-232 RX
Pin X = RS-232 Common
Pin W = RS-232 Shield (shared)

The RS-232 service port is used to monitor, configure, and troubleshoot the ProAct P-Series. Use a Windows operating system PC to perform these typical functions:

- Monitor operations
- Calibration or tuning
- Load or retrieve configuration settings from the control or a file
- Change a parameter or configuration setting

For details, refer to Chapter 4 (Service Tool).

The ProAct Service Tool can be downloaded from the Internet at **www.woodward.com/software**.

It is recommended that the OEM or packager provide a breakout cable that is connected to the ProAct service port and run to an easily accessible area on the engine. The service port is absolutely necessary to set up and troubleshoot the ProAct P-Series.

Any RS-232 wiring must meet the requirements in the EIA RS-232 Standard document. The RS-232 standard states that the length of the RS-232 cable between the driver and the PC must be less than 50 ft (15 m) with a total capacitance less than 2500 pF. The RS-232 data rate is fixed at 38.4 kbps. The communication port is non-isolated and susceptible to both EMI noise and ground loops related to PC connections and typical industrial environments.

IMPORTANT **The service port is not isolated and is not intended to function continuously while the prime mover is in normal operation. The service port is provided for configuration and setup only.**

Chapter 3. Description of Operation

Overview

The ProAct P-Series is an electric actuator with internal position feedback. The ProAct actuator accepts a PWM, (4 to 20) mA analog, (0 to 5) V analog, or a CAN position command input signal. Typically the actuator output shaft connects to the fuel gas valve, intake throttle, or fuel oil pump rack shaft of a reciprocating engine. The output shaft maximum rotation is 75 degrees and is configurable for CW or CCW rotation. A manual mode is provided to facilitate setting up the actuator system.

Control adjustments are made using the Service Tool. The Service Tool is a Windows based software tool provided at no charge to configure, monitor, adjust, and troubleshoot a ProAct actuator. It runs on a personal computer and communicates with the ProAct actuator through a serial connection. The Service Tool is disconnected from the control when not in service.

The actuator has a switching power supply with excellent spike, ripple, and EMI (electromagnetic interference) rejection. Discrete inputs are capable of rejecting EMI and variable resistance in switch or relay contacts. Analog inputs are differential type with extra filtering for common-mode noise rejection.

Optionally, a Run Enable input can be used to activate or de-activate the ProAct output. It can also be used to reset shutdown fault conditions. The actuator has one discrete output, which changes state based on configurable alarms and status conditions. A (4 to 20) mA analog output is available, providing a position feedback indication.

The control provides one RS-232 serial interface and one CAN communication connection. The RS-232 port is the service port used by the ProAct Service Tool to configure and tune the ProAct actuator. The CAN communication port is used to connect to an engine control system. The protocol provided is J1939. Two discrete inputs (CAN ID High and Low) are provided to support multiple CAN identifications within a single device configuration using harness coding.

System Operation

The ProAct actuator is ready for operation immediately (< 1 second) when the power supply is connected. Power may be connected to the actuator at the same time the engine starter motor is engaged.

On an engine shutdown command, the independent engine shutdown solenoid or solenoid valve in the fuel supply should be de-activated and the power supply disconnected from the speed control. This shutdown signal should be sent directly from the engine control panel and should be independent and separate from the ProAct actuator.

⚠WARNING	**The ProAct actuator should not be used as the primary means of shutting down the engine.**

Controller Features Description

As you review the following features, keep in mind that most applications only require a few of the functions to be activated. The choices are made available to provide maximum flexibility in a single package. The user must set up the actuator direction, min and max position calibration, position command input, and desired I/O. The user can choose all or none of the CAN settings, alarm/shutdown functions and logic functions depending on the application.

The controller I/O consists of input power, a PWM input, one configurable analog input, 3 discrete inputs, one analog (4 to 20) mA output, one status discrete output and a CAN communication port. The analog input can be either (4 to 20) mA or (0 to 5) V.

The actuator maintains the position commanded by the supervisory control, as determined by the input redundancy manager. Internal position feedback is used to assure positive positioning. The actuator output shaft rotation is software configured for either a clockwise (CW) or counter-clockwise (CCW) output shaft rotation. An actuator correction curve is provided to configure a demanded position versus actual position for non-linear systems.

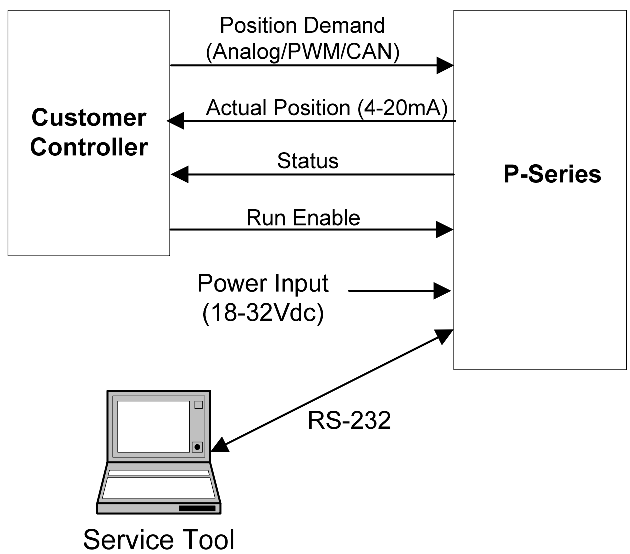


Figure 3-1. System Overview

Driver Input Power

The ProAct will handle a voltage range of (18 to 32) V (dc) at full specified torque. The actuator is functional in the range of (8 to 40) V (dc), but accuracy and/or torque can be diminished at the extreme ends of this range.

The supply voltage failure levels are below 17 V (dc) and above 33 V (dc) with a timeout to avoid nuisance alarms. The unit can be configured to either alarm or shutdown upon detection of a supply voltage fault.

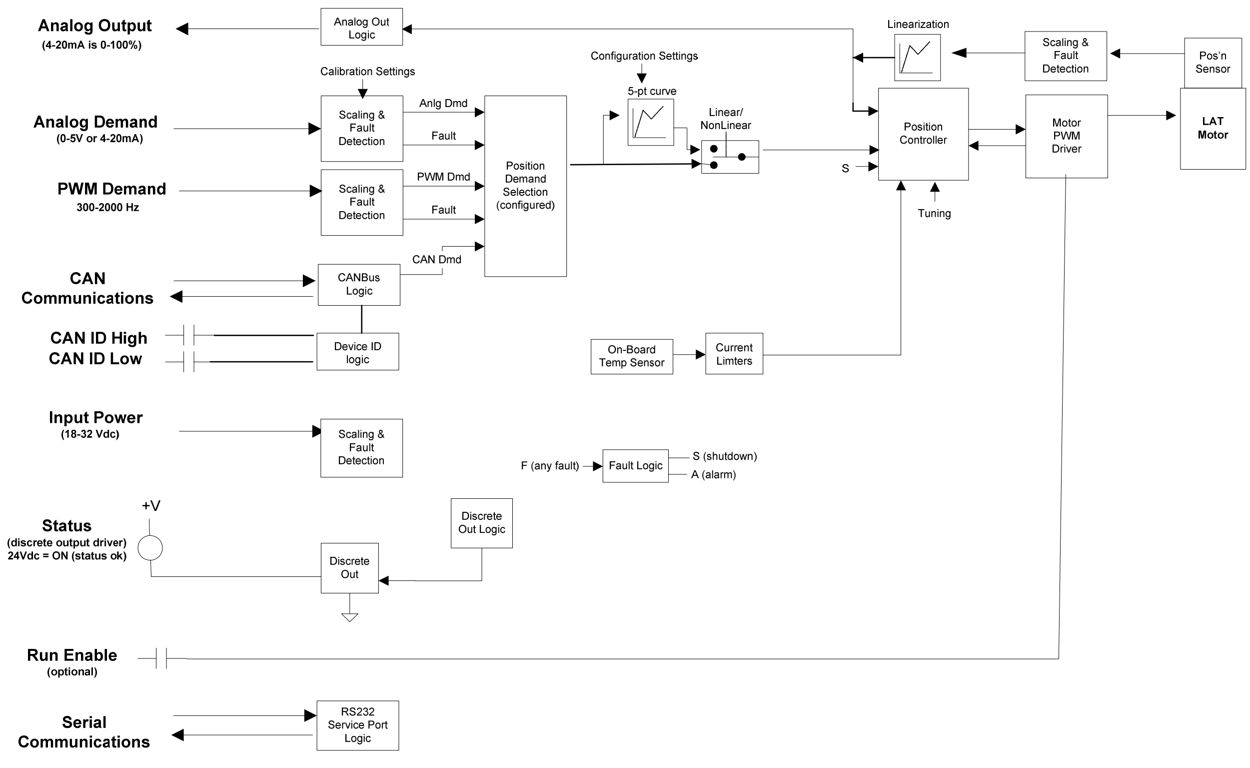


Figure 3-2. Functional Overview

Position Command Signal

The ProAct can accept either a single position command or a redundant position command. A redundant command uses two position commands, one as the primary command and one as a backup. If the primary should fail, the unit could continue to run using the backup command. The command source can be sent over CAN, as a PWM command signal input, or an analog [(4 to 20) mA or (0 to 5) V] command signal input, depending on how the software application is configured.

The position demand input can be optionally set to use a non-linear mode which provides a 5-point curve relationship between position signal and desired position. The same curve relationship will be used for any demand input type.

The unit can be configured to either alarm or shut down on detection of a position command failure (loss of all position command inputs). Failure of one command source, when redundant commands are used, will result in an alarm and the unit will continue to operate using the remaining healthy command signal.

PWM Position Command

The PWM position command input will function with either a low-side open collector or push-pull driver. It will handle a PWM frequency range from 300 Hz to 2000 Hz at amplitudes ranging from 8.4 V up to battery voltage. The scaling from duty cycle to commanded position is user-configurable.

The input failure levels are below 3 % and above 97 % duty cycle by default but are user-configurable.

A user-configurable offset is available to adjust the input duty-cycle reading, as needed. This feature is used to compensate duty cycle measurement error resulting from slow signal edge transitions.

Analog Position Command

The analog input operates from 4 mA to 20 mA or 0 V to 5 V (jumper configured). The scaling of the input to position command is user selectable but defaults as (4 to 20) mA and (0.5 to 4.5) V to command the throttle from minimum to maximum position. The input is monitored for out of range condition and the failure levels are user configurable.

CAN Position Command

CANbus can be used to monitor unit status and/or control the commanded position. The CAN protocol provided is SAE J1939. CAN details are provided in Chapter 7.

When used as a position command, a minimum update rate is expected or a CAN fault will be issued. This update rate is user-configurable.

Position Command Redundancy

The position command redundancy determines a commanded position based on the two possible configured inputs - the primary or backup command selection of CAN, PWM, or Analog. It provides failover (primary-to-backup) and fallback (backup-to-primary) logic. Indications are provided for monitoring of the operating status. These two inputs are expected to track each other such that failure of one signal will not disrupt overall system operation.

The command redundancy utilizes two command inputs; a primary command and a backup command (see Figure 3-3). When both inputs are within normal ranges, as determined by user-configurable failure settings, the primary command shall be selected and used. If the input position commanded varies by more than the configured maximum difference, then one will be flagged as failed and the other command will be used. The selected (primary or backup) command is user-configurable. In addition, a tracking error can be utilized to ensure the inputs are tracking each other.

The following operating status indication is provided on the Service Tool and over CAN.
Primary Demand Used—Indicates the primary demand is selected and the backup demand is either not used or not failed.

Primary Demand Used, Backup Failed—Indicates the primary demand is selected and the backup demand is failed, indicating the backup signal is out of range or exceeds the demand difference from the primary.
Backup Demand Used, Primary Failed—Indicates the backup demand is selected and the primary demand is failed. The failed may indicate the signal is out of range or exceeds demand difference from the backup. Note that the chosen input when the difference is exceeded is configurable.
Primary Enabled but not active—Indicates the backup demand is selected but the primary demand will become active after a 10 second signal healthy delay.
All Demands Failed—Indicates both the primary and backup (if used) demands are failed (out of range).

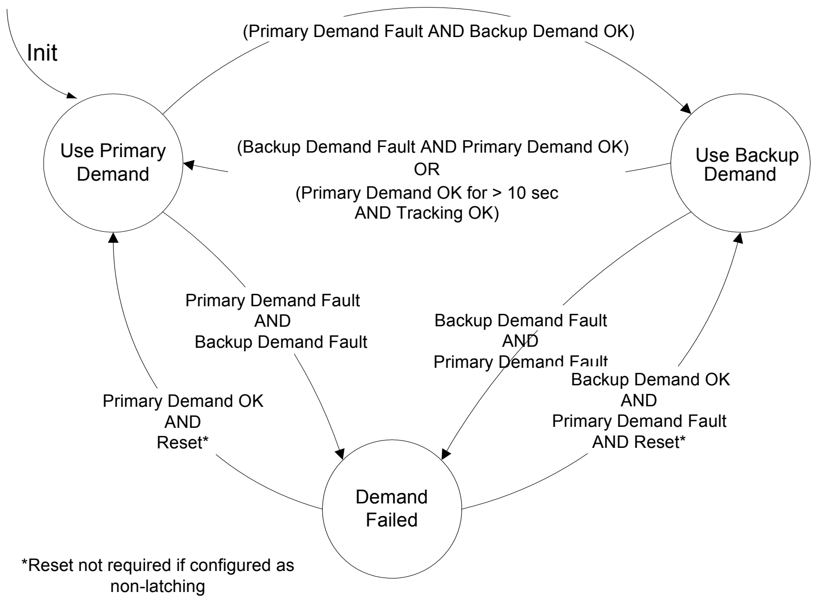


Figure 3-3. Position Demand Logic

Status (Discrete) Output

A discrete output is provided to serve as a status indicator. This output can be configured to be either normally on/open (preferred failsafe setting) or normally off/closed. In addition, the faults that drive the relay status can be configured individually. For details refer to Chapter 4 (Service Tool).

Run Enable Discrete Input

An optional Run Enable discrete input can be configured for use. The Run Enable operation provides a closed-to-run and an open to force the shaft controller into a low-current "limp" mode. The Run Enable can also be used to clear a latching shutdown condition since a closure of the input will issue a reset command.

Analog Output

The analog output provides a (4 to 20) mA signal representing either actual shaft rotational position or position setpoint. The output is 4 mA at 0 % and 20 mA at 100 % by default, but is user-configurable.

Temperature Sensing

The ProAct has an on-board temperature sensor to monitor board temperatures and protect the unit from over temperature as well as detect under temperature. This temperature is monitored and a fault is annunciated if temperature increases above 140 °C or falls below –45 °C. Internal monitoring also provides temperature level indications for temperatures exceeding 100 °C and 120 °C.

Current Limiting based on Temperature

The control provides actuator current limiting based on the electronics temperature. Depending on board temperature and actuator thermal models, the software reduces current as necessary to avoid conditions that would damage the device due to extreme temperatures.

Current limiting based on temperature begins when the combined current and temperature environment causes board temperatures greater than 100 °C. The steady-state limit curve is a linear derate from full current at 100 °C down to zero current at 140 °C. Depending on the current needed (actuator torque) and ambient operating temperatures, the unit may never reach a reduced current limiting condition. See Figure 3-4.

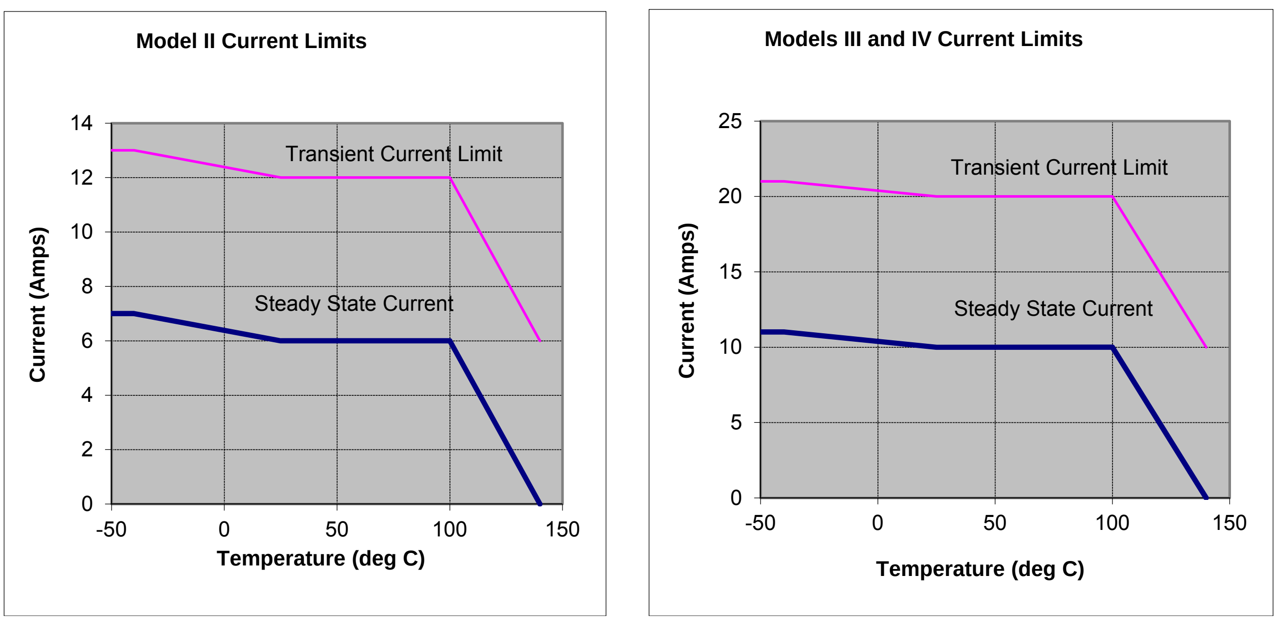


Figure 3-4. Example Temperature vs. Current Limit Curves

Alarms and Shutdowns

Power-up Diagnostics

The ProAct provides power up self-test diagnostics. The power-up diagnostics takes less than one second to complete. This means that the actuator is active within one second of power-up. A diagnostics error found during power-up will shut down the actuator. There are a limited number of power-up diagnostics, as most of the diagnostics are done during run time.

Run-time Diagnostics

Once power-up tests are completed, the unit starts controlling and provides continuous indication of alarms and shutdowns. The Service Tool can be used to monitor the alarm and shutdown conditions. Also, the discrete output can be configured to reflect internal shutdowns, overall alarm or shutdown status, or individual alarms and shutdowns.

Alarm and Shutdown Actions

An alarm is intended to indicate a condition that an operator should be aware of during operation or troubleshooting, but does not require the engine to be shut down. Alarms are indicated on the Service Tool, and can be configured to annunciate on the discrete output.

When a shutdown diagnostic is detected, the ProAct will follow the configured shutdown action (Go to Min, Go to Max, or Go Limp). Firmware 5418-6507 provides two additional options, Min then Limp and Max then Limp. These two modes will position at min (or max) for 10 seconds prior to transitioning to a low-power (limp) mode.

Alarm and Shutdown Indications on the Service Tool

Alarms and shutdowns are indicated on separate tabbed pages in the main Service Tool screen. The alarm and shutdown symbols on the status bar indicate the alarm and shutdown state of the control. For example, if any alarms on the Alarm page are active, the alarm symbol on the status bar is active.

Logged Alarms and Shutdowns

The occurrence of an alarm or shutdown is saved in non-volatile memory. If power to the ProAct is turned off, then turned on, the logged alarm and shutdown indications can still be seen on the Service Tool.

Resetting Alarms and Shutdowns

Alarm and shutdown faults can be globally set as either latching or non-latching. When set to latching, either a reset command or a power-cycle is required to clear the fault and allow the unit to start again. If non-latching, the fault is automatically cleared without any reset once the fault condition returns to normal.

Alarms and shutdowns can be reset using the Service Tool, or by toggling the Run Enable discrete input (if connected) Off for greater than 1 second, then back to Run.

If a shutdown diagnostic occurs when the actuator is in a state other than the Shutdown state or Powered Down state, and then is immediately reset, the actuator remains shut down until the Shutdown state is reached.

⚠WARNING **It is recommended that all faults be configured as shutdowns to ensure maximum fault protection.**

Faults

This section identifies the diagnostic faults detected in this product. Each of these faults can be configured to activate the discrete output. In addition, many of them can be configured to be alarm or shut down conditions. If configured as an alarm, the control will log the condition and attempt to continue normal operation. If configured as an shutdown, it will follow the shutdown action which can be set to go to min (0 %), go to max (100 %), or go limp (zero drive current).

Some faults are dedicated shutdowns and cannot be configured or have dedicated actions—they are identified below. Faults with special actions, like go limp, will have priority.

IMPORTANT	**Selection of either Alarm or Shutdown is recommended for each individual fault below (as opposed to Off). An alarm selection will provide a historical event occurrence information and a shutdown selection would also enforce a shutdown action (min/max/limp).**

Supply Voltage Fail

This diagnostic indicates an out-of-range signal on the input power. It could indicate that the input power is out of range or there is a fault in the supply voltage sense circuitry. The input supply voltage went above 33 V (dc) or below 17 V (dc) for longer than the allowed low voltage time. There is a delay time provided to ensure that the control does not flag a supply voltage low error during the standard engine start cycle.

Failure levels: >33 V for 500 ms; <9 V for 500 ms, and <17 V for 70 seconds
Configuration options: Off, Alarm, Shutdown

If configured as an alarm, the control will internally default to an assumed 32 V (dc) power supply voltage (decreased torque at lower actual voltages) and attempt to continue normal operation if this fault is detected. The value displayed on the Service Tool will show the sensed value, not default.

Temperature Sensor Failed

This diagnostic indicates a failure of the internal on-board Temperature Sensor.

Failure levels: >140 °C and <–45 °C
Persistence: 100 ms
Configuration options: Off, Alarm, Shutdown

If configured as an alarm, the control will attempt to continue normal operation with a default value of 20 °C used internally.

Temperature > 100 ºC (derated)

If the on-board temperature sensor reads above 100 °C this diagnostic will be set, which is the temperature where current limiting begins. This diagnostic, when used, provides an indication of this event occurrence.

Failure levels: >100 °C
Persistence: 100 ms
Configuration options: Off, Alarm, Shutdown

Temperature > 120 ºC

If the on-board temperature sensor reads above 120 °C this diagnostic will be set. Operation above this temperature is not recommended and may exceed the temperature rating of the internal electronic components. This diagnostic, when used, provides an indication of this event occurrence.

Failure levels: >120 °C
Persistence: 100 ms
Configuration options: Off, Alarm, Shutdown

Position Error

Position Error detection logic will indicate a difference between actual position and demanded position was detected. The magnitude and duration values are customer-configurable parameters (see Configuration, Position tab). This indication goes true when the low-pass error delay filter on the 'expected position minus actual position' is greater than the Error Maximum threshold setting. The filter time constant is set by the Error Delay setting. The 'expected position' is internally determined as the demanded position filtered by the expected dynamics.

Failure levels: Set by customer variable, Error > |Position Error Maximum|
Persistence: Time constant set by customer variable, Position Error Delay.
Configuration options: Off, Alarm, Shutdown

Loss of All Position Demands

The configured position demand(s) are determined to be out of range or failed. When redundant inputs are configured, it indicates that both inputs are failed.

Configuration options: Off, Alarm, Shutdown

PWM Demand Failed

The PWM input went above the PWM input diagnostic maximum threshold or below the PWM input diagnostic minimum threshold. PWM Demand Failed is only active when the position demand is configured for 'PWM'.

Failure levels: >97 % Duty for and < 3 % Duty, set by customer variable
Persistence: 200 ms when not configured for redundant demands
Persistence: 10 ms when configured for redundant demands
Configuration options: Off, Alarm, Shutdown

Analog Demand Failed

The analog input went above the analog input diagnostic maximum threshold or below the analog input diagnostic minimum threshold. Analog Demand Failed is only active when the position demand is configured for 'Analog'.

Failure levels (0 V to 5 V mode): >4.8 V and < 0.2 V, set by customer variable
Failure levels (4 mA to 20 mA mode): >22 mA and <2 mA, set by customer variable

Persistence: 100 ms when not configured for redundant demands
Persistence: 10 ms when configured for redundant demands
Configuration options: Off, Alarm, Shutdown

CAN Demand Fault

This is an indication that CAN messages are not valid, not received, or received at a rate slower than the configured minimum update rate (CAN Fail Timeout). A CAN signal in the “Error” or “Not Supported” range is considered not valid (0xFAFF-0xFFFF). This diagnostic fault only applies to commands configured to be received over CAN (i.e. CAN Demand configured).

Configuration options: Off, Alarm, Shutdown

CAN Communications Fault

Unable to communicate with the CAN bus. Could indicate a bus problem or an address contention.

Configuration options: Off, Alarm, Shutdown

CAN Stop Command

Indicates a STOP command was received over the CAN Command message. CAN demand must be configured for this feature to be enabled. Not available in Legacy mode.

Configuration options: none - dedicated Shutdown

This is a hard-coded shutdown. The control will go limp if this condition is detected.

Run Enable Shutdown

Indicates the Run Enable discrete input is opened. The shutdown is only active when Run Enable is configured for use.

Configuration options: Not Used or Shutdown

When configured for use, this is a hard-coded shutdown. The control will go limp if this condition is detected.

Demand Tracking Fault

Indicates the backup position command does not match the primary position command.

Failure levels: Set by customer variable, |Error| > Tracking Error Max
Persistence: Set by customer variable, Tracking Error Delay
Configuration options: Off, Alarm, Shutdown

If configured as an alarm, the control will attempt to continue normal operation using the trusted input. The trusted input is configurable and is based on the 'Switch control to Backup demand on track error' selection.

Internal Fault

Indicates that an internal failure has occurred. The Internal Shutdowns page of the Service Tool indicates the exact cause.

Configuration options: none - dedicated Shutdown

If detected, the control will use current control to execute the shutdown action (min, max, limp).

Chapter 4.
Service Tool

Introduction

This chapter covers the process of tuning, configuring, calibrating, and servicing the actuator via the ProAct Service Tool. It is assumed that the actuator has already been installed on the engine.

IMPORTANT **Many applications are delivered pre-configured, calibrated, and tuned. These units do not require the use of the Service Tool.**

Description

The Service Tool software is used to configure, tune, and troubleshoot the ProAct actuator. This chapter describes installation and use of the Service Tool. It identifies the parameters available that can be viewed.

Refer to Chapter 5 for comprehensive configuration instructions to set up the ProAct actuator for customer specific applications.

The Service Tool software resides on a PC (personal computer) and communicates to the ProAct through connector pins T, Y, X and W (see Figure 4-3 and the wiring instructions in Chapter 3). An RS-232 breakout cable is available for purchase from Woodward, part number 1249-1147.

It is highly recommended that the OEM or packager provide a breakout cable for the ProAct service port that is routed to a readily accessible area on the engine. The service port is absolutely needed to set up and troubleshoot the actuator.

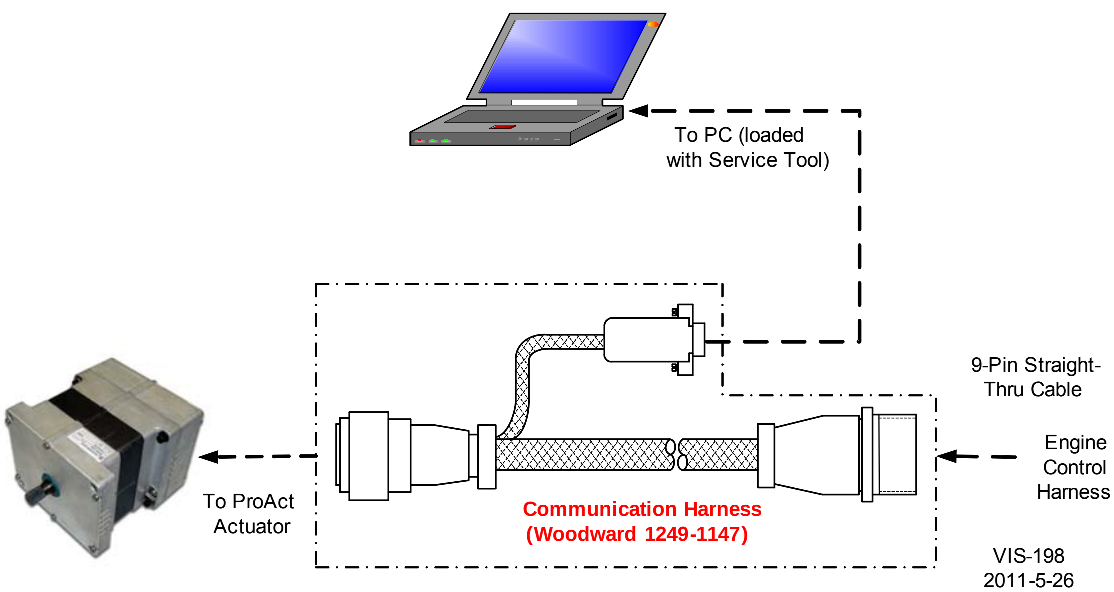


Figure 4-1. Communication Harness Connections

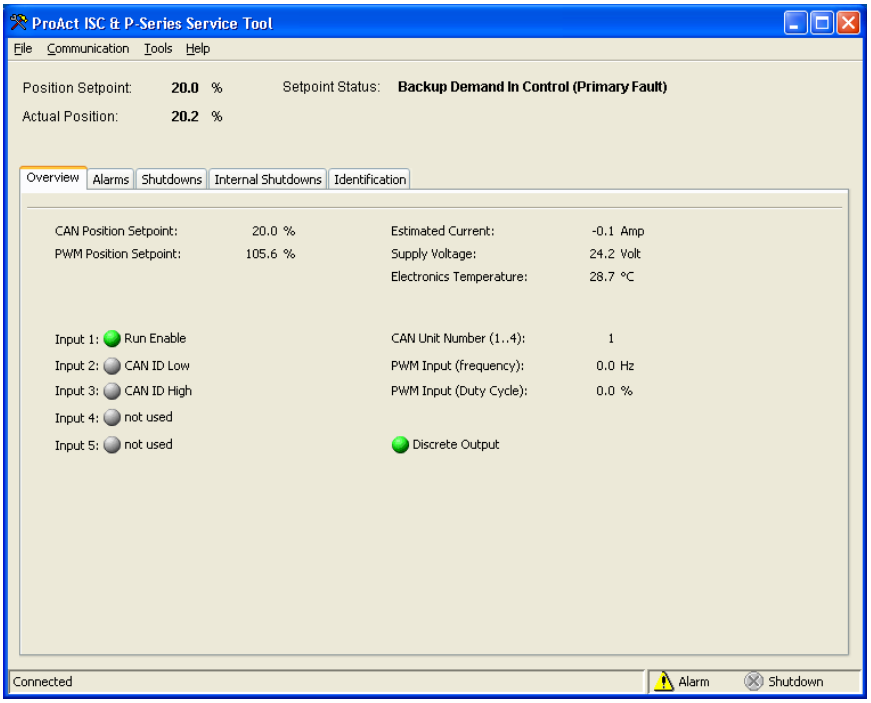


Figure 4-2. Example Service Tool Screen

The following hardware is required to work with the ProAct actuator:

- PC-compatible laptop or desktop computer* with at least one available serial communications port, and Windows 2000, XP, Vista, 7 (32- and 64-bit) or greater as the operating system.
- Programming/datalink harness as shown in Figure 4-3.

In addition to the hardware, the following are the distributions of tool software needed to communicate with the control:

- Woodward part number 9927-1187, ProAct Service Tool

NOTICE	**There is a potential for serial port damage when communicating with the ProAct actuator. This is caused by a difference in ac voltage between neutral and earth ground. If the PC RS-232 port ground is referenced to ac neutral, and the ProAct control is referenced to battery ground (ac earth ground), a large amount of current can be experienced. To avoid this situation, we strongly recommend placing an isolation transformer between the ac outlet and the PC or use an isolated serial adaptor.**

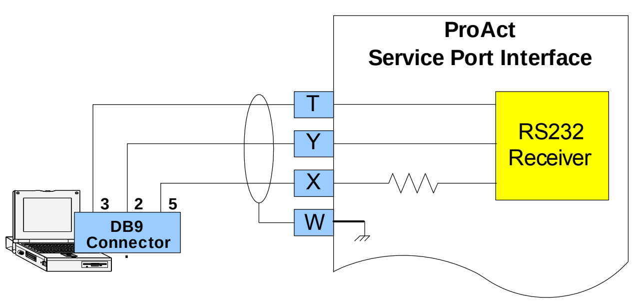


Figure 4-3. Typical Programming Datalink Harness Wiring

Getting Started

Installation Procedure

The Service Tool software can be downloaded and installed from the Woodward internet site (**www.woodward.com/software**).

What to do next

After the software is installed, connect a serial communications cable between the RS-232 connections on the ProAct actuator and an unused serial port on your computer. Run the Service Tool program and select the appropriate comm port. Once connected to the control, the status bar will display 'connected' and the Service Tool screen will populate with monitor parameters.

⚠WARNING **An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.**

Service Tool Help

More help on using Service Tool is available and included with the installation of the Service Tool product. Service Tool Help can be accessed from the Service Tool 'Contents' drop-down window selection under the Help menu located on the Main Window.

Software Version Identification

The Service Tool software version can found by selecting 'About' under the Help menu. The ProAct software version can be found on the right-most tab sheet (Identification tab) of the Service Tool screen. The Service Tool and Control must be connected to view this information. Refer to this version information in any correspondence with Woodward.

Monitoring the Driver

General

The Service Tool has five different tabbed screens to monitor driver parameters. These are:
- Overview, (see Figure 4-4)
- Alarms, (see Figure 4-5)
- Shutdowns, (see Figure 4-6)
- Internal Shutdowns, (see Figure 4-7)
- Identification, (see Figure 4-8)

Displayed in an area above these screens are values showing:
- Position Setpoint
- Actual Position
- Setpoint Status

Position Setpoint
Displayed value of the position demand - in percent.

Actual Position
Displayed value of the actual position - in percent.

Setpoint Status (conditionally displayed)
Indication of the position command redundancy status. Displayed only if the unit is configured for redundant commands.

The following operating status indication is provided on the Service Tool and over CAN.
Primary Demand Used—indicates the primary demand is selected and the backup demand is either not used or not failed.
Primary Demand Used, Backup Failed—indicates the primary demand is selected and the backup demand is failed, indicating the backup signal is out of range or exceeds the demand difference from the primary.
Backup Demand Used, Primary Failed—indicates the backup demand is selected and the primary demand is failed. The failed may indicate the signal is out of range or exceeds demand difference from the backup. Note that the chosen input when the difference is exceeded is configurable.
Primary Enabled but not active—indicates the backup demand is selected but the primary demand will become active after a 10 second signal healthy delay.
All Demands Failed—indicates both the primary and backup (if used) demands are failed (out of range).

Status Bar Indications

At the bottom of the Service Tool window is a status bar. The status bar has two sections. The bottom left section displays communication status and bottom right section displays alarm & shutdown status.

Communication Status
This section of the status bar shows the status of communication between the Service Tool and the ProAct actuator.

- **Connected**—The Service Tool is connected to and communicating with the actuator.
- **Not Connected**—The Service Tool is not connected to the actuator.
- **Connecting**—The Service Tool is attempting to connect to the actuator. This message is displayed when Connect is selected from the Communications menu or when attempting to re-establish communication to the control. If the connection is lost, it will continuously attempt to re-connect.

Alarms and Shutdowns

- Alarm Status
  One or more alarms on the Alarms screen are active.
- Shutdown Status
  One or more shutdowns on the Shutdowns or Internal Shutdowns screen are active.

Overview Screen

To monitor the control parameters, go to the Overview page on the main window. This screen dynamically populates based on the ProAct configuration. If a function is not programmed, it will not appear or may appear grayed out.

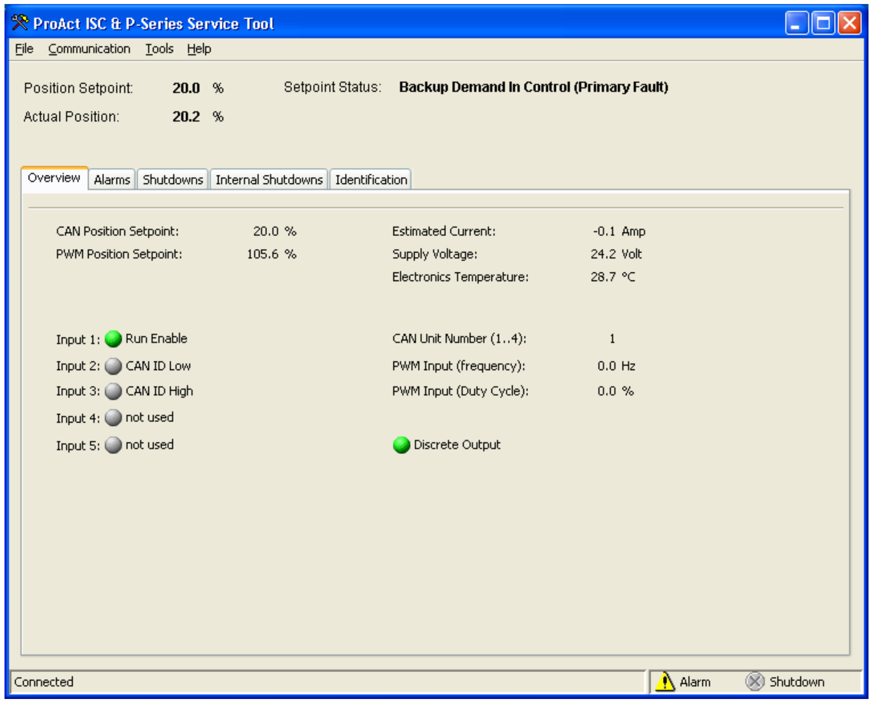


Figure 4-4 Service Tool—Overview Tab

CAN Position Setpoint (conditionally displayed)
Displayed value of the position setpoint commanded via CAN, in percent. Displayed when configured for redundant commands and CAN demand is used.

PWM Position Setpoint (conditionally displayed)
Displayed value of the position setpoint commanded by the PWM input, in percent (if applicable). Displayed when configured for redundant commands and PWM demand is used.

Analog Position Setpoint (conditionally displayed)
Displayed value of the position setpoint commanded by the analog input, in percent (if applicable). Displayed when configured for redundant commands and analog demand is used.

Discrete Inputs
The overview screen displays the status and configuration of all discrete inputs. When the indication is "on" then the input is active.

Estimated Current
Displayed value of the estimated current drive into the actuator coil, in amps.

Supply Voltage
Displayed value of the input power, in volts, as read by the processor.

Electronics Temperature
Displayed value of the electronics temperature sensor, in degrees Celsius, as read by the processor. The temperature sensor is physically located on the printed circuit board.

CAN Unit Number (1..4)
Indication of the harness-code selected CAN unit number. This value is determined on power-up and ranges from 1 to 4.

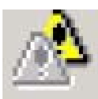
PWM Input Frequency (conditionally displayed)
Displayed value of the PWM input, in Hertz, as read by the processor.

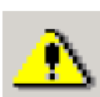
PWM Input Duty Cycle (conditionally displayed)
Displayed value of the PWM input, in % duty cycle, as read by the processor. The duty cycle is calculated as high time / period.

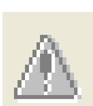
Discrete Output
On/Off status of the discrete output command. The indicator is illuminated when the channel is commanded to ON and grayed-out when the command signal is OFF.

Shutdown and Alarm Indications

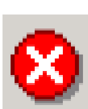
The Shutdown and Alarm screens display the status of both active and logged fault conditions. The logged indications provide a history of events even after the unit has been power-cycled or run again. A complete listing and detailed description of all faults can be found in Chapter 3.

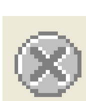
 Indicates a logged alarm condition.

 Indicates an active alarm condition.

 Indicates no active or logged alarm condition

 Indicates a logged shutdown condition.

 Indicates an active shutdown condition.

 Indicates no active or logged shutdown condition.

An active fault is one that is currently active or latched in the control. The latching/non-latching fault configuration setting factors into this indication. If the fault is latching, then an active fault could either be one that is still present or one that has occurred but has not been reset. Latched faults can be cleared by cycling control power, toggling the Run Enable input or by selecting the 'Reset Alarms and Shutdowns' button on either the Alarm or Shutdown Service Tool screens.

A logged fault is one that has occurred but is no longer active or latched in the actuator. Selecting the 'Reset Logged Alarms and Shutdowns' button on either the Alarm or Shutdown screens permanently clears the logged faults.

Alarms Screen

To monitor the alarm conditions, go to the Alarms page on the main window. The values displayed on this screen dynamically change with the fault configuration.

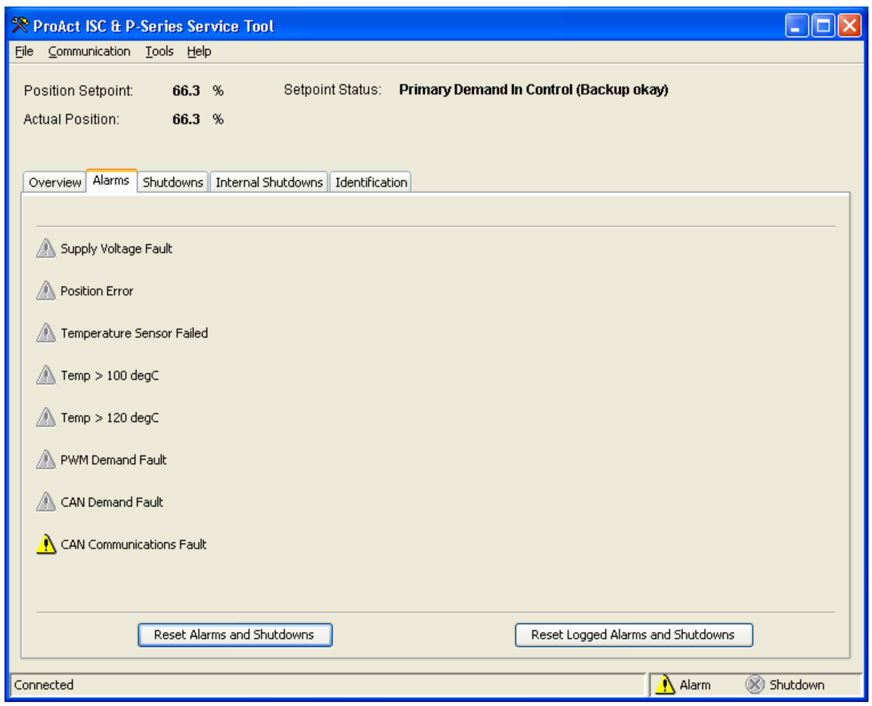


Figure 4-5. Service Tool—Alarms Tab

Shutdowns and Internal Shutdowns Screens

To monitor the shutdown conditions, go to the Shutdowns and the Internal Shutdowns pages (Figures 4-5 and 4-6) on the main window. The values displayed on the Shutdowns screen dynamically change with the fault configuration.

A Reset Alarms and Shutdowns command is available on the alarm and shutdown screens to clear any faults that are currently latched on. If a fault condition has occurred but is no longer present, it will remain as a logged fault until cleared. The 'Reset Logged Alarms and Shutdowns' command clears all logged faults.

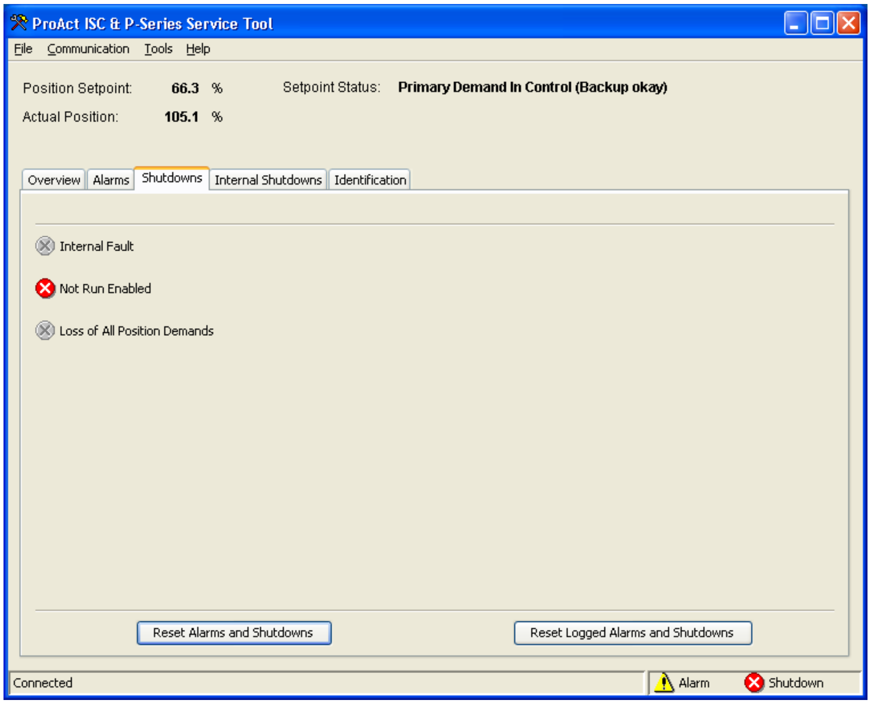


Figure 4-6. Service Tool—Shutdowns Tab

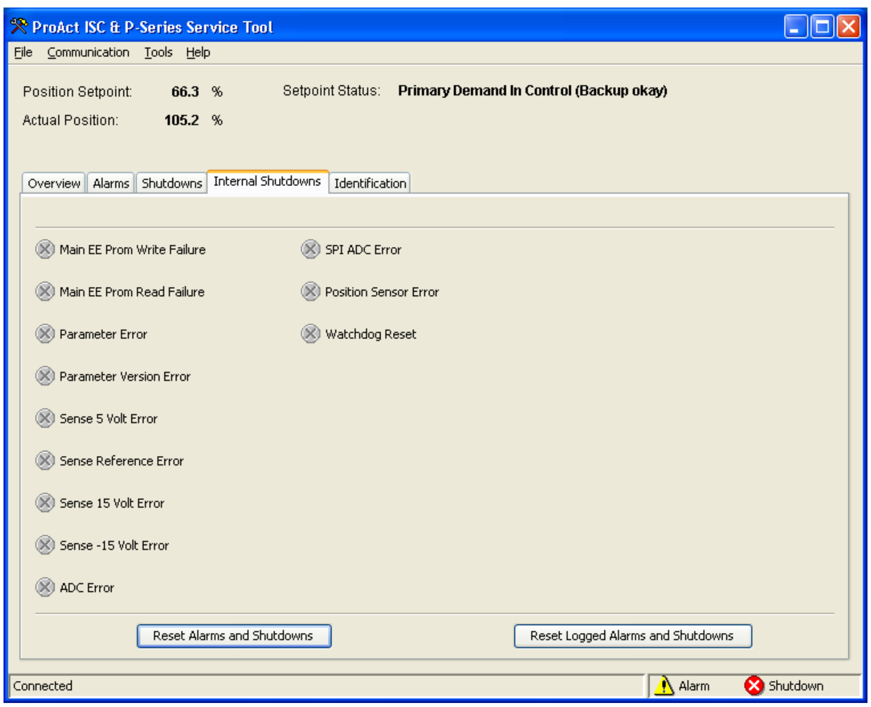


Figure 4-7. Service Tool—Internal Shutdowns Tab

Identification Screen

To check the ProAct product identification, go to the Identification screen. Displayed information includes the ProAct software part number and serial number.

The Software Part Number identifies the embedded firmware part number and revision level. The Serial Number is a Woodward tracking tool set at the factory.

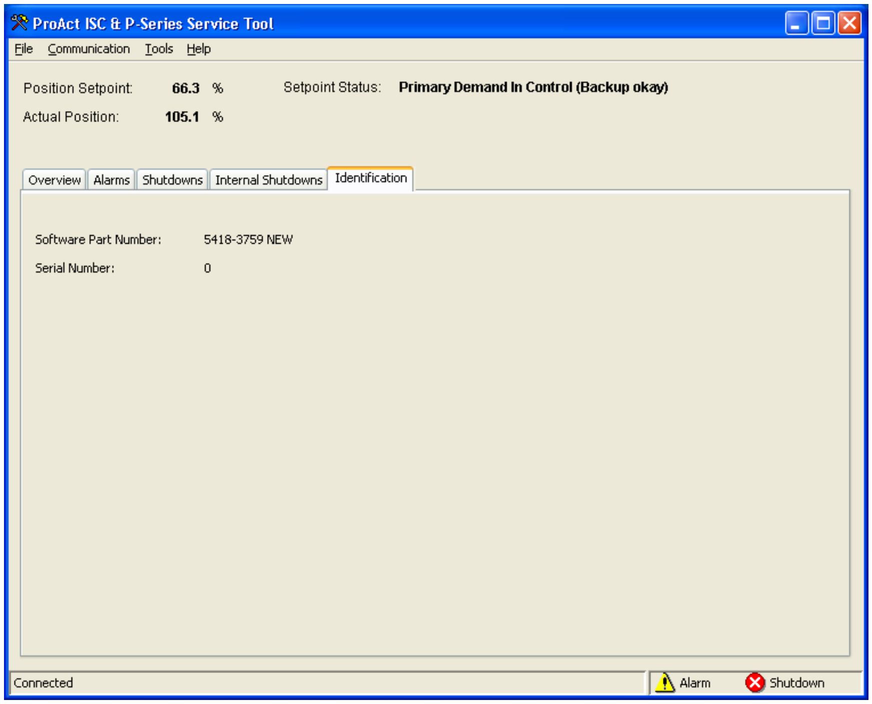


Figure 4-8. Service Tool—Identification Tab

Chapter 5. Configuration

Introduction

This chapter describes the general steps required to configure the device. The Service Tool guides the user in calibrating and verifying the actuator stroke limits.

Overview

The ProAct Service Tool is used to configure and adjust the settings within the actuator. Refer to Chapter 4 for Service Tool installation and connection instructions. The existing actuator configuration settings can be viewed at any time when connected to the actuator by opening the Configuration Editor (File/Open Control Configuration).

The ProAct can be configured either on-line or off-line. On-line configuration can only be performed when the Service Tool is connected to and communicating with the ProAct actuator. Off-line configuration can be done at any time; however, settings do not take effect until they are loaded into the actuator.

⚠WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An over temperature or over pressure shutdown device may also be needed for safety, as appropriate.

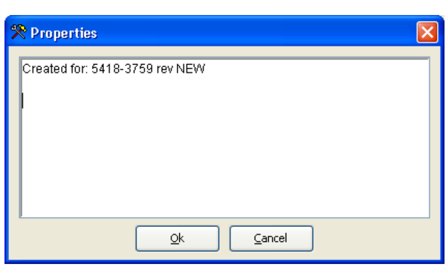
⚠WARNING

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

Custom Configuration File Data

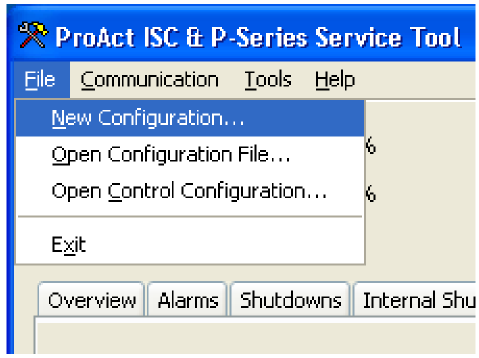
Data identifying the configuration can be added by selecting Properties under the File menu pull down. This is a text field that can be used to store data such as:

- Customer
- Engine Type
- Application Type
- Notes



Configuring the Unit—On-Line

Unit On-Line configuration is summarized as follows:
1. Open the Configuration Editor Dialog by selecting 'File/Open Control Configuration'.
2. Edit the configuration settings.
3. Load the configuration to the control.



IMPORTANT — **As changes are made to Configuration parameters, the driver does not use them until a 'load' command is issued. Selecting the 'Cancel' button closes the Configuration Editor and does not make any changes to the driver.**

Configuring the Unit—Off-Line

Unit Off-Line configuration is summarized as follows:
1. Open the Configuration Editor Dialog using the 'File/New Configuration' or 'File/Open Configuration File'
2. Edit the configuration settings.
3. Save the configuration to a file. At a later date simply open the configuration and load it into the control.

Configuration Parameters

There are 5 different screens that display the configuration settings in the ProAct actuator: Setup, CAN, Analog I/O, Discrete I/O, Alarm/Shutdown, and Position.

Setup Tab

The Setup tab (Figure 5-1) provides all the position demand settings for the application including PWM, analog and CAN setup parameters. Changing the Demand Input Source will modify the parameter settings available as well as the displayed indications within the Service Tool.

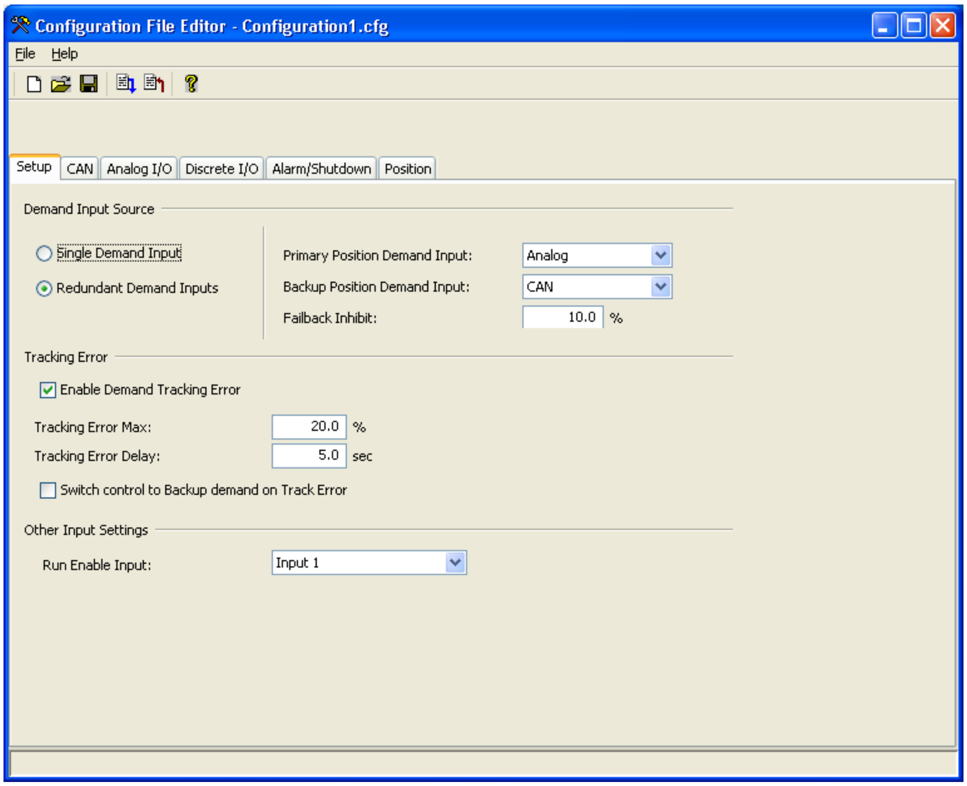


Figure 5-1. Configuration Editor—Setup Tab

Demand Input Source
The Position Demand Source can be set to one of the following:

Single	Selects a single, non-redundant position demand input.
Redundant	Selects a redundant (primary/backup) position demand input.

Allowed values: Single, Redundant. Default: Single

Primary Position Demand Input
The Primary Position Demand source can be set to one of the following:

PWM	Selects a PWM position demand input.
Analog	Selects an analog (0 V to 5 V or 4 mA to 20 mA) position demand input.
CAN	Selects a CAN position demand input.

Allowed values: PWM, Analog, CAN. Default: Analog

Backup Position Demand Input
The Backup Position Demand source can be set to one of the following:

PWM	Selects a PWM position demand input.
Analog	Selects an analog (0 V to 5 V or 4 mA to 20 mA) position demand input.
CAN	Selects a CAN position demand input.
Not Used	No input selected.

Allowed values: PWM, Analog, CAN, Not Used. Default: PWM

Failback Inhibit - *(only displayed if configured for Redundant Demand Inputs)*
When the backup demand is in control, this setting determines the max difference between the primary and the backup demands before transferring back into primary demand control.
Allowed values: 0.0 to 100 %. Default: 5 %

Tracking Error Section

Provides settings used to monitor how tightly redundant demand shall track and determine which to use should they differ.

Enable Demand Tracking Fault - *(only displayed if configured for Redundant Demand Inputs)*
When selected, activates the Demand Tracking Fault logic. Default: unchecked

Tracking Error Maximum (%)—*(only displayed if Tracking Error is used)*
Maximum deviation between the primary position demand and the backup position demand. If the Error is exceeded for longer than the Tracking Error Delay, then the Tracking Error Fault is annunciated.
Allowed values: (0 to 100) % but must be greater than the Failback Inhibit setting. Default: 10 %

Tracking Error Delay (seconds)—*(only displayed if Tracking Error is used)*
Delay for tracking error fault.
Allowed values: (0 to 10) seconds. Default: 1 second

Switch control to Backup demand on Track Error– *(only displayed if Tracking Error is used)*
Determines which demand input to select when a tracking error is detected, primary or backup. When checked and a tracking error is detected, selects the backup demand input for positioning and sets the primary demand as failed. When unchecked, selects the primary demand and sets the backup demand as failed.
Default: unchecked

Other Input Settings Section

Run Enable Input
Select the desired discrete input for the Run Enable function. A selection of 'Always Enabled' sets the software to always run, and acts like a 'function not used'. Additional input settings are provided on the Discrete I/O tab.
Options are: Always Enabled, Input 1, Input 2, Input 3, Input 4, Input 5. Default: Always Enabled

CAN Tab

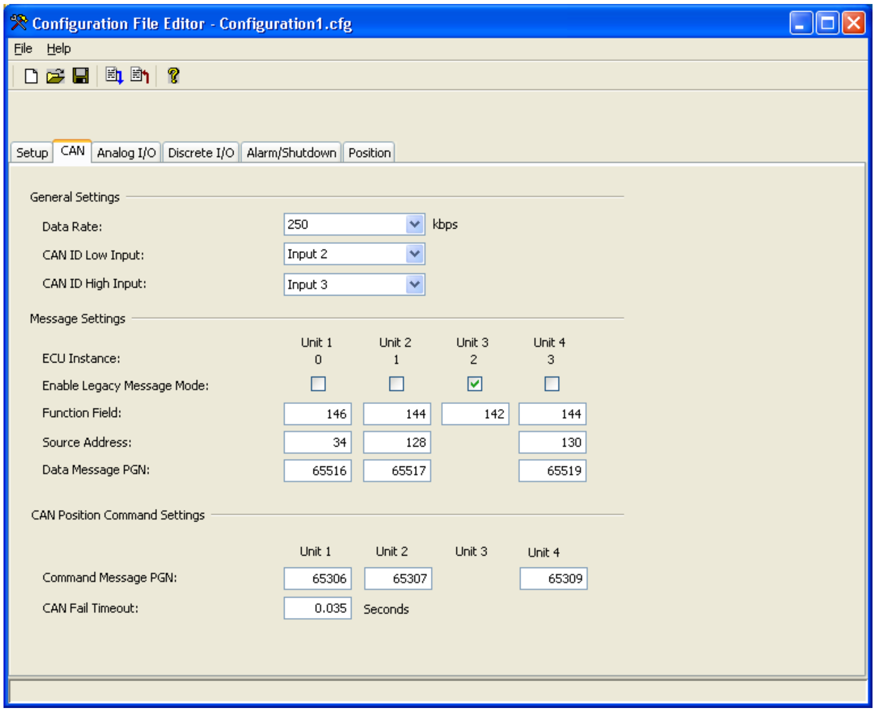


Figure 5-2. Configuration Editor—CAN Tab

General Settings Section

CAN Data Rate
Selects the desired CAN data rate.
Options are: 125, 250, 500, or 1000 kbits/s
Default: 250 kbps

CAN ID Low Input
Select the desired discrete input for the CAN ID Low function.
Options are: Input 1, Input 2, Input 3, Input 4, Input 5. Default: Input 2

CAN ID High Input
Select the desired discrete input for the CAN ID High function. Options are: Input 1, Input 2, Input 3, Input 4, Input 5. Default: Input 3

Message Settings Section

ECU Instance
Displays the value of the ECU Instance in the J1939 Name. This is displayed for informational purposes only.

Enable Legacy Message Mode
Selects either Legacy messages (checked) or configurable PGN messages (unchecked), for each harness code address (Unit 1-4).
Default: checked

Function Field
Sets the J1939 Name function field for each harness code address (Unit 1-4).
Allowed values: 0 to 255. Defaults: 146, 144, 142, 144

Source Address
Sets the J1939 source address for each harness code address (Unit 1-4).
Allowed values: 0-253. Defaults: 34, 128, 129, 130

CAN Position Command Settings Section

(only displayed if CAN demand is configured)

This section provides settings related to a J1939 CAN commanded position setpoint.

Data Message PGN *(only displayed if Legacy Mode is not selected)*
PGN for the data message transmission for each harness code address (Unit 1-4). Only used when configurable PGN messaging is used.
Allowed values: 0-65535. Defaults: 65516, 65517, 65518, 65519

Command Message PGN *(only displayed if Legacy Mode is not selected)*
PGN for the expected incoming command message for each harness code address (Unit 1-4). Only used when configurable PGN message is used and CAN position demand is configured.
Allowed values: 0-65535. Defaults: 65306, 65307, 65308, 65309

CAN Fail Timeout *(only displayed if CAN demand is configured)*
Sets the maximum allowed delay between CAN receive / inputs (Rx), in seconds, before a CAN Fault is annunciated.
Allowed values: 0.010-10 seconds. Default: 0.035 seconds

Analog I/O Tab

The Analog I/O tab provides analog input, analog output, and PWM input configuration settings.

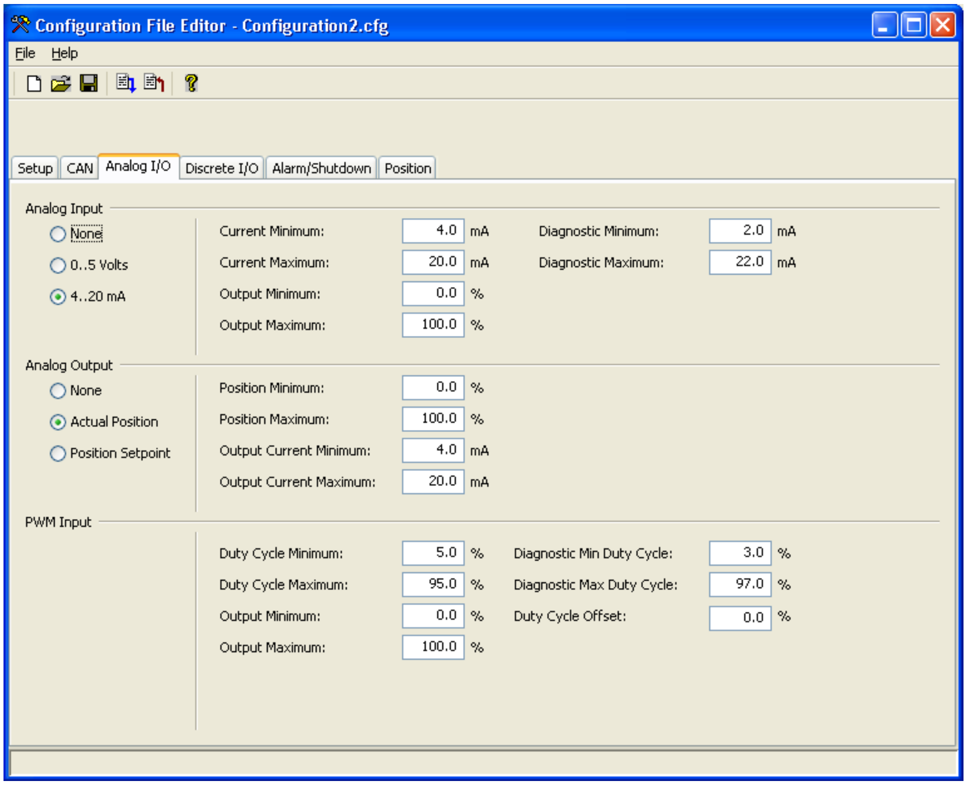


Figure 5-3. Configuration Editor—Analog I/O Tab

Analog Input Section

A scaling of the analog input to position command is provided in this section. Additional settings include diagnostic failure settings.

Analog Input Selection
The analog input is scaled from input volts or mA to output %. It can be configured as follows:

None—The analog input is ignored.
0–5 V—Selects a (0 to 5) V analog input.
4–20 mA—Selects a (4 to 20) mA analog input.
Default: 4–20 mA

Voltage Minimum
The value of the input at the output minimum setting. Setting the minimum higher than the maximum is allowed to provide for a reverse acting signal as needed.
Allowed values: (0 to 5) V (dc). Default: 0.5 V

Voltage Maximum
The value of the input at the output minimum setting, used for the analog input voltage to position command scaling.
Allowed values: (0 to 5) V (dc). Default: 4.5 V

Current Minimum
The value of the input at the output minimum setting. Setting the minimum higher than the maximum is allowed to provide for a reverse acting signal as needed.
Allowed values: (0 to 25) mA. Default: 4 mA

Current Maximum
The value of the input at the output maximum setting, used for the analog input current to position command scaling.
Allowed values: (0 to 25) mA. Default: 20 mA

Output Minimum
The position command value corresponding to the input minimum setting.
Allowed values: (0 to 100) %. Default: 0 %

Output Maximum
The position command value corresponding to the input maximum setting.
Allowed values: (0 to 100) %. Default: 100 %

Diagnostic Minimum
Specifies the minimum normal value for the analog input. When configured, an Analog Input Low alarm or shutdown fault is triggered when the input falls below this setting.

Allowed values: (–1 to +6) V or (0 to 25) mA. Default: 0.2 V or 2 mA

Diagnostic Maximum
Specifies the maximum normal value for the analog input. When configured, an Analog Input High alarm or shutdown fault is triggered when the input increases above this setting.

Allowed values: (–1 to +6) V or (0 to 25) mA. Default: 4.8 V or 22 mA

IMPORTANT

The user should ensure that the Diagnostic Minimum and Diagnostic Maximum fields are set to values that will trigger an alarm or shutdown when reasonable faults such as open or shorted wires occur.

Analog Output Section

An output selection and scaling of position to milliamps is provided in this section.

Analog Output Selection
The analog output is scaled from the position percent to a (0 to 20) mA current output signal. It can be configured as follows:
- **None** —The analog output is turned off.
- **Actual Position**—Selects an actual position analog output signal.
- **Position Setpoint**—Selects a position setpoint analog output signal.
- Default: Actual Position

Position Minimum
Specifies the value of the selected position (actual or setpoint) at the output current minimum setting. Setting the position minimum higher than the position maximum is allowed to provide for a reverse acting signal as needed.
Allowed values: (0 to 100) %. Default: 0 %

Position Maximum
The position value at the output current maximum setting.
Allowed values: (0 to 100) %. Default: 100 %

Output Current Minimum
Specifies the analog output current at the position minimum setting.
Allowed values: (0 to 25) mA. Default: 4 mA

Output Current Maximum
Specifies the analog output current at the position maximum setting
Allowed values: (0 to 25) mA. Default: 20 mA

PWM Input Section

A scaling of PWM duty cycle to position command is provided in this section. Additional settings include diagnostic failure settings and a duty cycle offset.

Duty Cycle Minimum
The value of the PWM input duty cycle at the output minimum setting. Setting the minimum duty cycle higher than the maximum is allowed to provide for a reverse acting signal as needed.
Allowed values: (0 to 100) % duty cycle. Default: 5 % duty cycle

Duty Cycle Maximum
The value of the PWM input duty cycle at the output maximum setting.
Allowed values: (0 to 100) % duty cycle. Default: 95 % duty cycle

Output Minimum
The output position command value corresponding to the duty cycle minimum setting. Allowed values: (0 to 100) %. Default: 0 %

Output Maximum
The output position command value corresponding to the duty cycle maximum setting. Allowed values: (0 to 100) %. Default: 100 %

Diagnostic Min Duty Cycle
Specifies the duty cycle below which a PWM input failed diagnostic is set.
Allowed values: (0 to 50) %. Default: 3 %

Diagnostic Max Duty Cycle
Specifies the duty cycle above which a PWM input failed diagnostic is set.
Allowed values: (50 to 100) %. Default: 97 %

Duty Cycle Offset
Sets the PWM duty cycle offset. This setting is provided to compensate for duty cycle variations in PWM input frequencies, voltages, and types.
Allowed values: (–20 to +20) %. Default: 0 %

Discrete I/O Tab

The Discrete I/O tab provides discrete input and discrete output configuration settings.

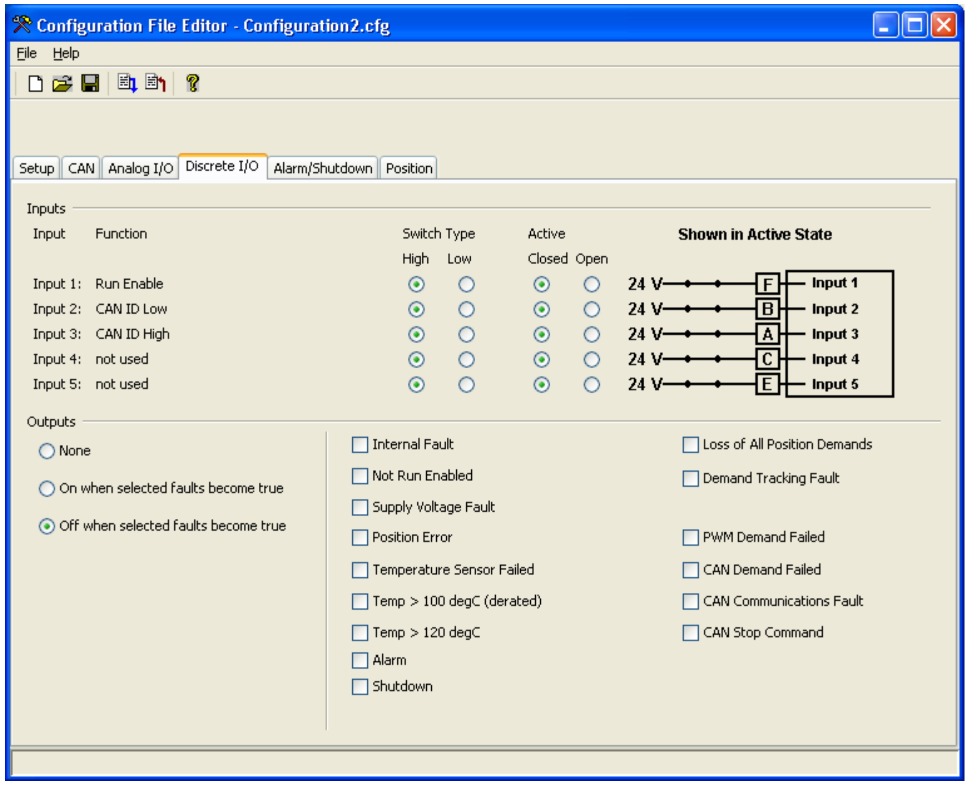


Figure 5-4. Configuration Editor—Discrete I/O Tab

Input Settings

Discrete Input function assignments are configurable. Each function can be configured for activation by any of the five (5) discrete inputs. To make discrete input assignments, see the Setup and CAN tabs. The Discrete I/O tab shows the actual input assignments. All discrete inputs can be configured for high side, low side, active closed, and active open contact types.

In a typical engine harness, there is a higher likelihood of unintentional shorts to battery minus than to battery plus. In such cases, using a high side setting reduces the chance of a short causing unintended operation. The active open or active closed setting for each input should be configured for safest operation. If the most likely failure mode is an open wire, then configure the input to select the safer engine operation should the wire break.

⚠WARNING

It is recommended that an engine system Failure Modes and Effects Analysis (FMEA) be used to determine the discrete input configuration that provides the lowest probability of unintended operation in the presence of faults, such as a broken wire.

High
If “High” input type is selected, the switch must provide a high voltage on the input, typically a switch to battery plus.

Low
If “Low” input type is selected, the switch must provide a low voltage on the input, typically a switch to battery minus.

Closed
If “Closed” active switch is selected, the function is active when the contact is closed.

Open
If “Open” active switch is selected, the function is active when the contact is open.

Defaults: Active High, Active Closed

Output Settings

Relay Output Configuration
The relay output can be configured to one of the following:

> **None**—The relay output is turned off.
> **On when selected faults become true—**Sets the relay driver to turn on when the selected fault becomes true and turns off when no fault conditions exist.
> **Off when selected faults become true—**Sets the relay driver to turn off when the selected fault becomes true and turns on when no fault conditions exist. This is the preferred, failsafe output configuration.

Default: None

⚠WARNING

It is recommended that the Relay Output be configured for the failsafe ‘Off when selected faults become true’ mode, to ensure maximum fault protection and annunciation. Failure to follow these guidelines could, under exceptional circumstances, lead to personal injury and/or property damage.

Relay Output Fault Selections
The list of faults displayed can be individually selected to activate the relay output. A common selection is also provided to activate the relay output with any configured Alarm or Shutdown fault.

Any of the selected faults will either turn the output off if configured for 'Off when selected faults become true' or turn the output on if configured for 'On when selected faults become true'.
Default: not selected

A full description of each fault condition is listed in Chapter 3, Description of Operation.

- Internal Fault
- Not Run Enabled
- Supply Voltage Fault
- Position Error
- Temperature Sensor Failed (internal electronics)
- Temp > 100 °C (derated)
- Temp > 120 °C
- Alarm
- Shutdown
- Loss of All Position Demands
- Demand Tracking Fault
- Analog Demand Failed
- PWM Demand Failed
- CAN Demand Failed
- CAN Communications Fault
- CAN Stop Command

⚠WARNING	**It is recommended that all faults be configured to activate the relay output, this ensures maximum fault annunciation.**

Alarm / Shutdown Tab

The Alarm/Shutdown tab provides alarm and shutdown configuration settings.

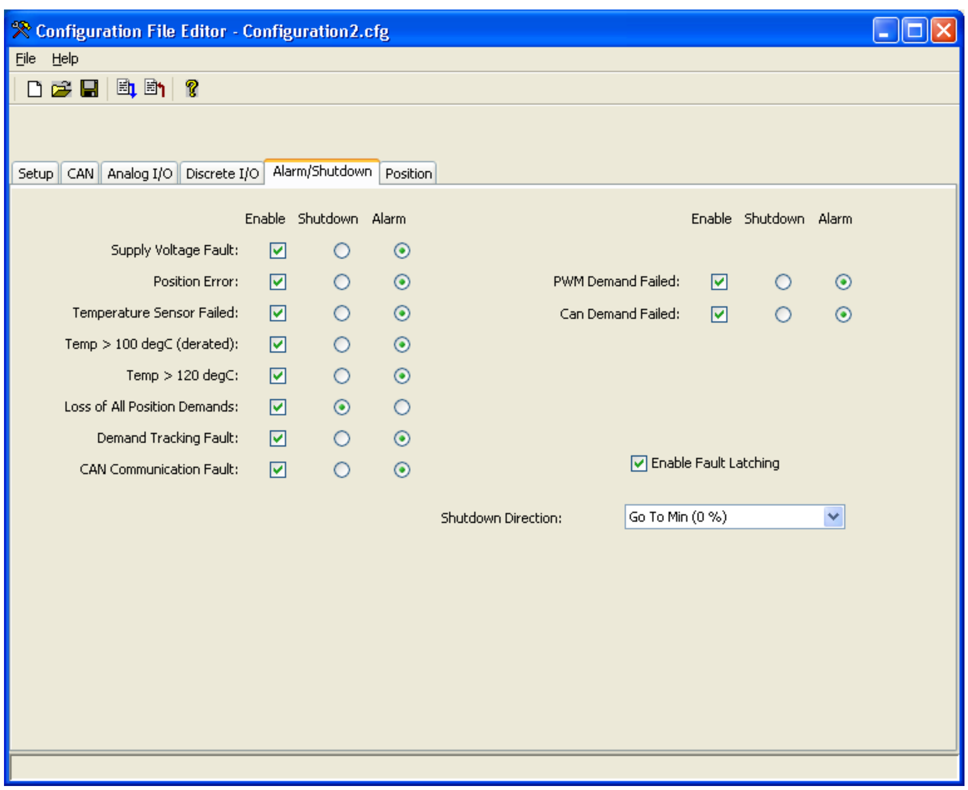


Figure 5-5. Configuration Editor—Alarm/Shutdown Tab

Alarm / Shutdown Fault Settings

Fault Selection (Shutdown or Alarm)
Set the desired action for each of the faults from the list. Enable the faults that are to be detected. Setting the selection to a Shutdown positions the output to the Shutdown Direction setting when a fault occurs. Setting the selection to an Alarm allows the unit to attempt continued running but provides an indication that the condition was detected (logged fault).
Default: unchecked (disabled)

Fault Description
See Chapter 3 for detailed descriptions for the following fault conditions.
- Supply Voltage Fault
- Position Error
- Temperature Sensor Failed (internal electronics)
- Temp > 100 °C (derated)
- Temp > 120 °C
- Loss of All Position Demands
- Demand Tracking Fault
- CAN Communication Fault
- Analog Demand Failed
- PWM Demand Failed
- CAN Demand Failed

The following are dedicated shutdown conditions.
- Internal Shutdown
- Run Enable Shutdown (Run/Stop)
- CAN Stop Command

WARNING	**It is recommended that all faults be configured as shutdowns and that 'Enable Fault Latching' be selected. This ensures maximum fault protection and prevents erratic on/off fault behavior.**

Enable Fault Latching
Set to either latching (checked) or non-latching. When set to latching, a reset command or a power cycle must be issued to clear the fault. When non-latching is configured, normal control operation is restored once the fault condition ceases to exist. The fault log continues to indicate any faults that have occurred, but are no longer active, until the logged alarms and shutdowns are reset.
Default: checked

Shutdown Direction (firmware 5418-6133 and older)
Specifies the action when a shutdown condition is detected and active.
Options are: Go to Min (0 %), Go to Max (100 %), or Go Limp (no drive current).
Default: Go To Min (0 %)

Shutdown Action (firmware 5418-6507 and newer)
Specifies the action when a shutdown condition is detected and active.
Options are: Go to Min (0 %), Go to Max (100 %), Go Limp (no drive current), Min then Limp, or Max then Limp.
Default: Go To Min (0 %)

Position Tab

This tab provides position configuration settings.

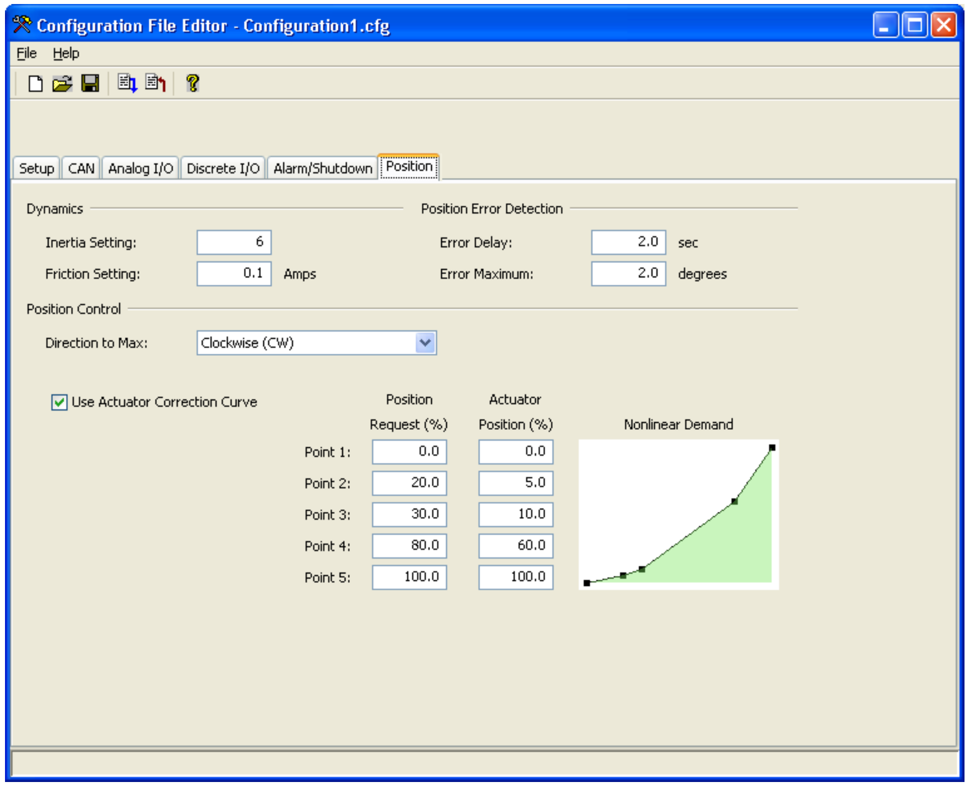


Figure 5-6. Configuration Editor—Position Tab

Dynamics Settings

Inertia Setting

The inertia setting calibrates the position controller to the load inertia. A setting of zero represents the actuator shaft with no load attached. Higher load inertia requires a higher inertia setting.

If the inertia setting is too low, there may be a slow oscillation when the actuator should be steady, or the step response may show excessive overshoot and ringing. If the inertia setting is too high, a high frequency oscillation or limit cycle may be seen. If a range of values is seen to provide adequate response, the lowest value that does not produce overshoot should be chosen.

Allowed values: 0 to 20. Default: 0

See Position Calibration and Verification in Chapter 6 for more details and a tuning procedure.

Friction Setting

The friction setting represents the actuator current required to overcome static load friction.
Allowed values: (0 to 4) A. Default: 0.1 A

See Position Calibration and Verification in Chapter 6 for more details and a tuning procedure.

Position Error Detection Section

Magnitude and delay settings for the position error fault. A position error may be configured as an alarm, shutdown or neither.

Error Delay—Delay time setting before triggering a position error. Sets the time constant of the single-pole low-pass which is filtering the difference between the model-expected response and the actual sensed position.

Error Maximum - Sets the maximum difference between the demanded position and the actual position needed to trigger a position error.
Allowed values: 1-50 degrees. Default: 2 degrees

Position Control Settings

Direction to Max
Sets the position controller direction.
Allowed values: CW and CCW. Default: CW

Use Actuator Correction Curve
Check to use an Actuator Correction Curve. Leave unchecked for a linear relationship between the position demand and actuator position.
Default: unchecked

Position Request (%)
Allowed values: Each breakpoint [5] must be larger than the previous and less than the next value.
Allowed values: (0 to 100) % but must be monotonically increasing
Defaults: 0, 25, 50, 75, 100 %

Actuator Position (%)
Sets the actuator positions for each breakpoint [5] based on the position request.
Allowed values: (0 to 100) %. Defaults: 0, 25, 50, 75, 100 %

Loading the Configuration (Save)

To load a configuration into the control, select the 'File/Load to Control' option from the menu, the blue load to control arrow icon or hot keys 'Ctrl+L' on the Configuration Editor.

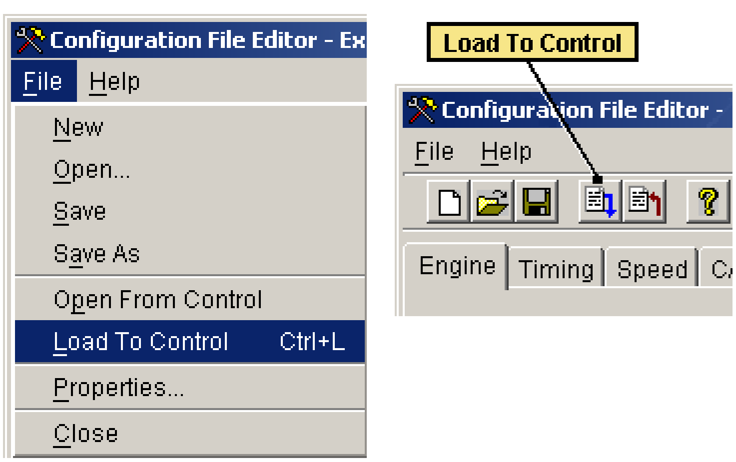


Figure 5-7. Loading Configuration

See Chapter 4 for information on monitoring the ProAct P-Series.

Chapter 6.
Setup, Calibration, and Tuning

Introduction

This chapter describes how to setup, calibrate and tune the ProAct P-Series. The Service Tool is used to configure, calibrate and tune the ProAct P-Series. See Chapter 4 for Service Tool installation and connection instructions. The actuator must be configured before it can be calibrated and tuned. The instructions in this chapter assume the actuator has already been configured and installed on the engine. See Chapter 5 for configuration instructions.

The following setup steps are required.

- Configure the ProAct actuator.
- Calibrate the Position.
- Calibrate the Position Feedback range.

These following optional setup features are also available:

- Verify Position calibration.
- Tune the Position control loop inertia setting and friction setting

IMPORTANT	**Some applications are delivered pre-configured, calibrated, and tuned. For these applications, the configured gains rarely need to be changed. Min Position and Fail Direction should be checked and verified.**

⚠WARNING	**An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.**

Control Setup

Use the Service Tool to set up the direction of rotation, either clockwise or counterclockwise (CW or CCW), the 0 % and 100 % position feedback calibration, and the dynamics. Ensure that the actuator linkage is set up to maximize the actuator degrees of rotation. This results in better control resolution.

Make sure that the actuator output shaft moves freely from the 0 % to 100 % positions and is not blocked by any linkage, mechanical stops, etc.

IMPORTANT	**It is highly recommended that the minimum fuel position setting stop the engine. This is essential for any configured shutdowns in the ProAct to be directly effective. If this is not possible, the discrete output should be configured to actuate an external shutdown device as needed.**

Position Calibration and Verification

To perform calibration and/or verification, the ProAct must be connected to the driven device. The actuator stroke and direction must set the 0 % and 100 % positions of the driven device to achieve the intended control function.

The position calibration maps the position command input (%) to the actual output shaft rotation (degrees). It also sets the direction of rotation (CW or CCW).

There are two methods available to perform a position calibration:

Automatic—The actuator strokes itself to find the 0 % and 100 % positions and saves these calibration points to the control.

Manual—The actuator shaft is manually positioned to the 0 % and 100 % positions and these calibration points are manually saved to the control.

If the application has hard stops that correspond to the actual min/max travel, then either the automatic or manual calibration method can be used—although automatic is easier. If hard stops are not available, then the manual method must be followed since the automatic method will yield invalid results.

Position Calibration and Verification Procedure

The Service Tool is used to calibrate end-user stops (physical or soft) and to verify the position calibration.

Opening the Position Calibration Screen

Select 'Position Calibration' from the 'Tools' menu to open the 'Position Calibration' screen.

Position Calibration

To calibrate the position, select either 'Manual' or 'Automatic'. A "wizard" is launched to guide the user through the calibration process. Click 'Cancel' at any step to abort the calibration procedure without saving any new values in the ProAct P-Series.

Position Verification

Two means are provided to perform position verification without actually re-calibrating the position. Selecting 'Verify Position' under the Position Calibration sub-menu will launch a "wizard" to guide the user through the verification process. Selecting 'Position Verification' from the Tools menu will open a window that allows test mode selection for manually positioning the device.

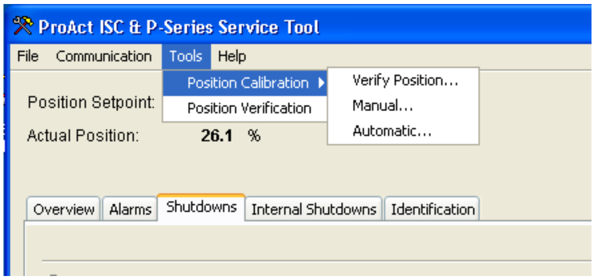


Figure 6-1. Tools Menu Options

Manual Calibration Summary

1. Safety warnings are read, followed, and acknowledged.
2. The direction is set to CW or CCW rotation.
3. The actuator shaft is positioned to the desired 0 % position point.
4. The actuator shaft is positioned to the desired 100 % position point.
5. The inertia and friction values are set. See the instructions below on "Adjusting the Inertia Settings" and "Adjusting the Friction Settings".
6. To check the position calibration, change the position setpoint and verify that the actual position is correct. The endpoints of travel can be adjusted if needed.

Automatic Calibration

1. Safety warnings are read, followed, and acknowledged.
2. The direction is set to CW or CCW rotation.
3. The actuator strokes itself in the minimum direction, then in the maximum direction.
4. The inertia and friction values are set. See the instructions below on "Adjusting the Inertia Settings" and "Adjusting the Friction Settings".
5. To check the position calibration, change the position setpoint and verify that the actual position is correct. The endpoints of travel can be adjusted if needed.

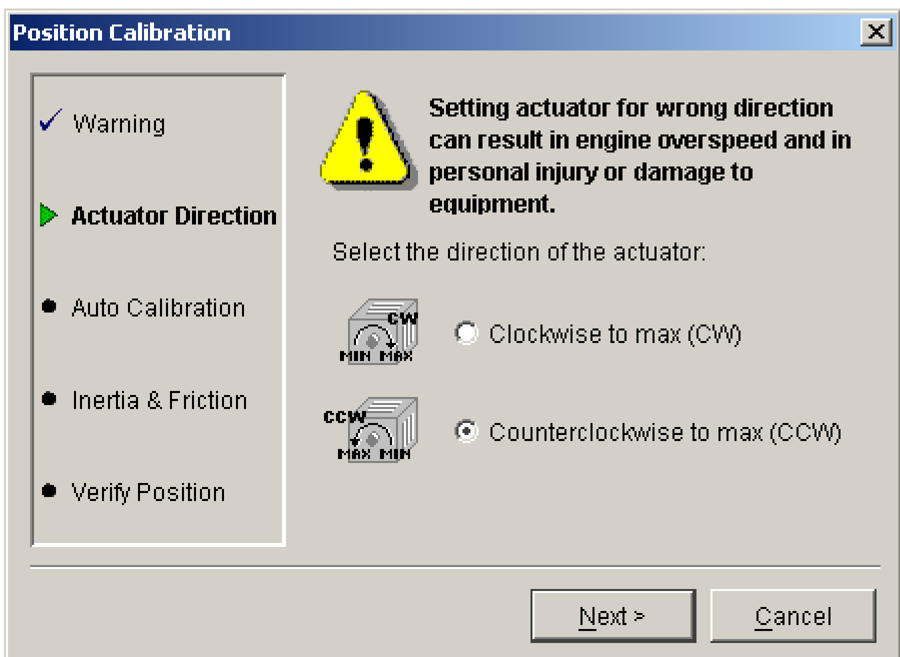


Figure 6-2. Auto Cal Direction Screen

Click Next or Cancel.

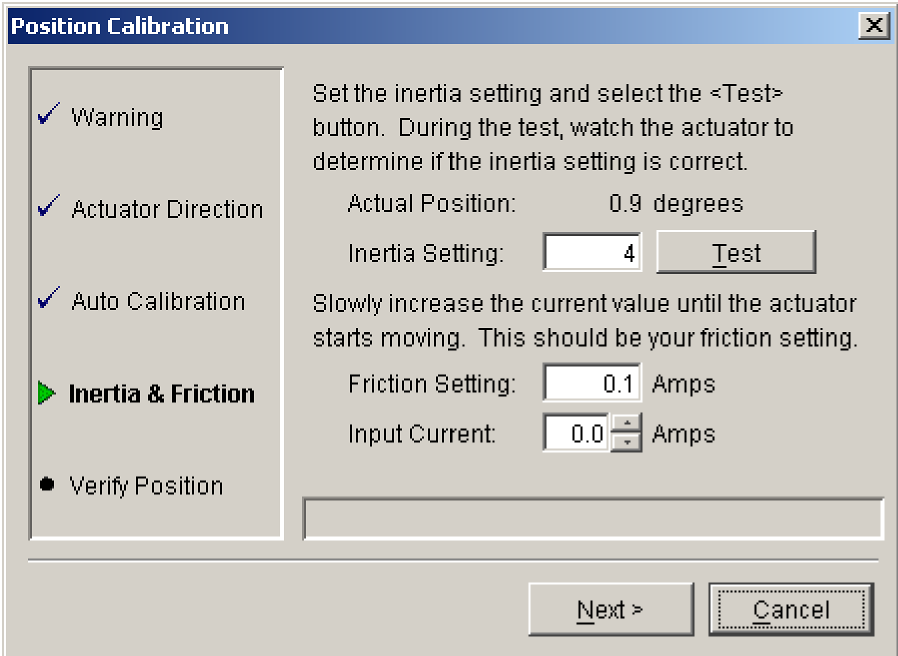


Figure 6-3. Auto Cal Inertia & Friction Screen

Adjusting the Inertia Setting

The inertia setting calibrates the position controller to the load inertia. A setting of zero represents the actuator shaft with no load attached. The higher the load inertia, the higher the required inertia setting.

The position calibration wizard provides an opportunity to test the settings. When the Test button is pressed, the actuator will go to the 30 % position, pause, go to the 60 % position, pause, return to the 30 % position, pause, and go to the 0 % position. The actuator response to these steps helps determine the correct inertia setting.

If the inertia setting is too low, there may be a slow oscillation when the actuator should be steady, or the step response may show excessive overshoot and ringing. If the inertia setting is too high, a high frequency oscillation or limit cycle may be seen. If a range of values is seen to provide adequate response, the lowest value that does not produce overshoot should be chosen.

Adjusting the Friction Setting

The friction setting represents the actuator current required to overcome static load friction.

Where no spring return is present, the Input Current value should be increased until the actuator just begins to move. That value of Input Current should then be entered as the Friction Setting. Ideally, this should be done in the middle of the travel range, and not at either end.

Where a return spring is present, the input current should be gradually increased until the actuator begins to move against the spring, then gradually decreased until it moves in the opposite direction. The Friction Setting should be one-half of the difference between these two values. For example, if it takes 0.7 A to begin moving against the spring, and at 0.5 A the actuator moves with the spring in the opposite direction, set the Friction Setting at (0.7 – 0.5) / 2 = 0.1 A.

If the friction setting is too low, the actuator may not respond well to small changes in the position demand. If the friction setting is too high, a high frequency oscillation or limit cycle will be seen.

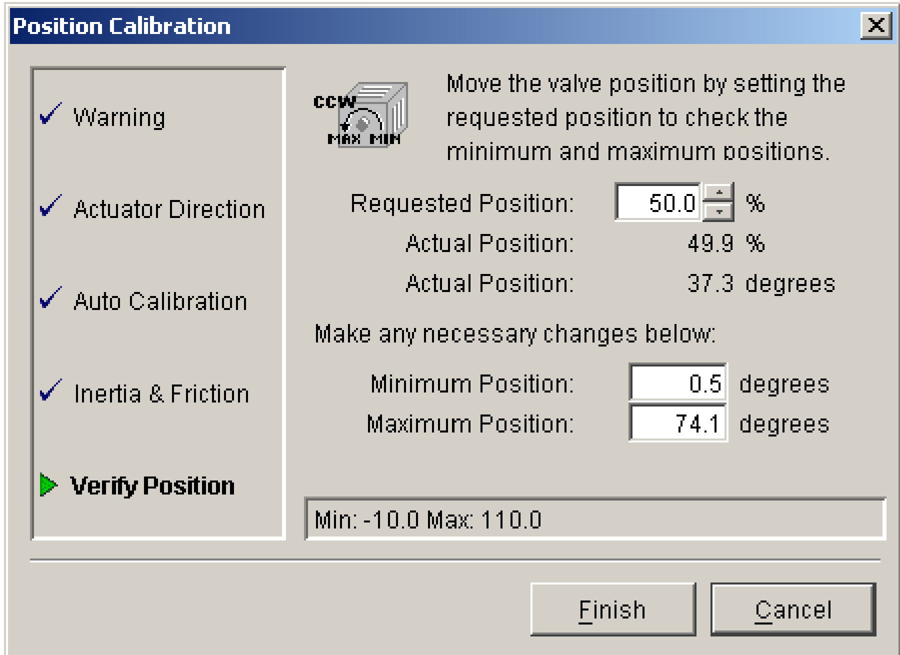


Figure 6-4. Auto Cal Verify Position Screen

Verify the Position Setting

A variety of Requested Position (%) values can be entered to verify the actuator strokes correctly from the minimum to maximum positions. The Minimum Position and Maximum Position settings can be adjusted, if necessary, to provide a more precise setting at these two end positions.

Click Finish when position verification is completed. Repeat calibration if the results are not correct.

Position Verification & Trend Window

A strip-chart style trend window is available in Service Tool version 1.8 and newer. This window can be utilized to monitor and verify position as well as tune position controller dynamics settings (inertia and friction). It is opened by selecting 'Position Verification' from the 'Tools' menu (Figure 6-5). For convenience the window is re-sizable and movable. Trend attributes like period, color, and range can be modified by selecting the Properties button.

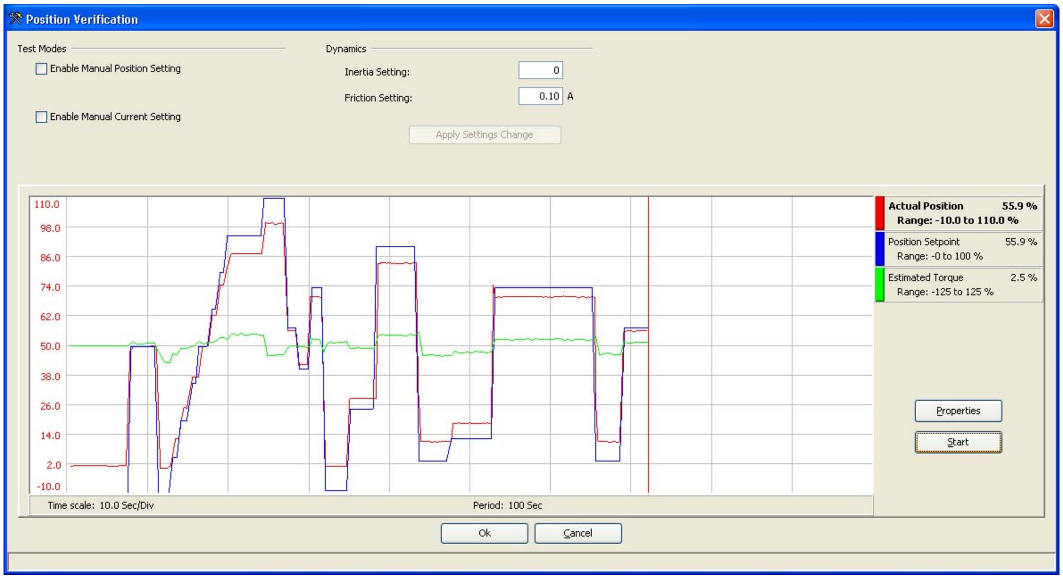


Figure 6-5. Tools Menu Position Verification

Trending is provided on this window as well as functions to adjust and verify controller settings.

Manual position and manual current control modes are available for test purposes. Selecting either manual control mode will prompt a warning screen, see Figure 6-6. Once enabled, the manual setting appears which provides the ability to directly set the actuator current or position setpoint. The manual position setpoint scaling of 0 and 100% corresponds to the calibrated min and max (see Position Calibration section above).

Closing this window will exit any selected test mode and the device will revert to normal operation.

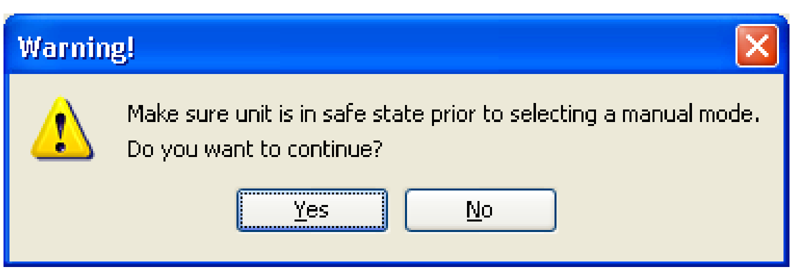


Figure 6-6 Position Verification Warning Screen

The controller dynamics, friction and inertia setting, can be modified and tested. When either setting is changed, the Apply Settings Change button becomes active. Selecting this button changes the controller dynamics in the device and allows testing of the new setting(s). The new dynamic settings can be reverted back by either selecting Cancel or closing the window ('x' in upper-right corner). The cancel operation reverts back to the device's friction and inertia values at the time the Position Verification window was opened.

The chart trend can be started and stopped using the Start/stop button. Selecting 'Start' will restart the chart, erasing an existing values.

The scaling of the trend's y-axis is color-coded to the signal and can be re-selected by clicking on the desired range's color bar on the right-hand side of the chart. For example clicking on the blue bar next to 'Position Setpoint' in Figure 6-6 will change the y-axis scaling to the position setpoint range, 0 % to 100 % in this case.

Estimated Torque is displayed in units of percentage of steady state (continuous) torque and is based on the current commanded to the actuator coil. During transients the torque/current limit may be as much as twice the steady state value for a short period of time. The actual torque varies with the actuator model, values are specified in the Appendix under 'Torque output'.

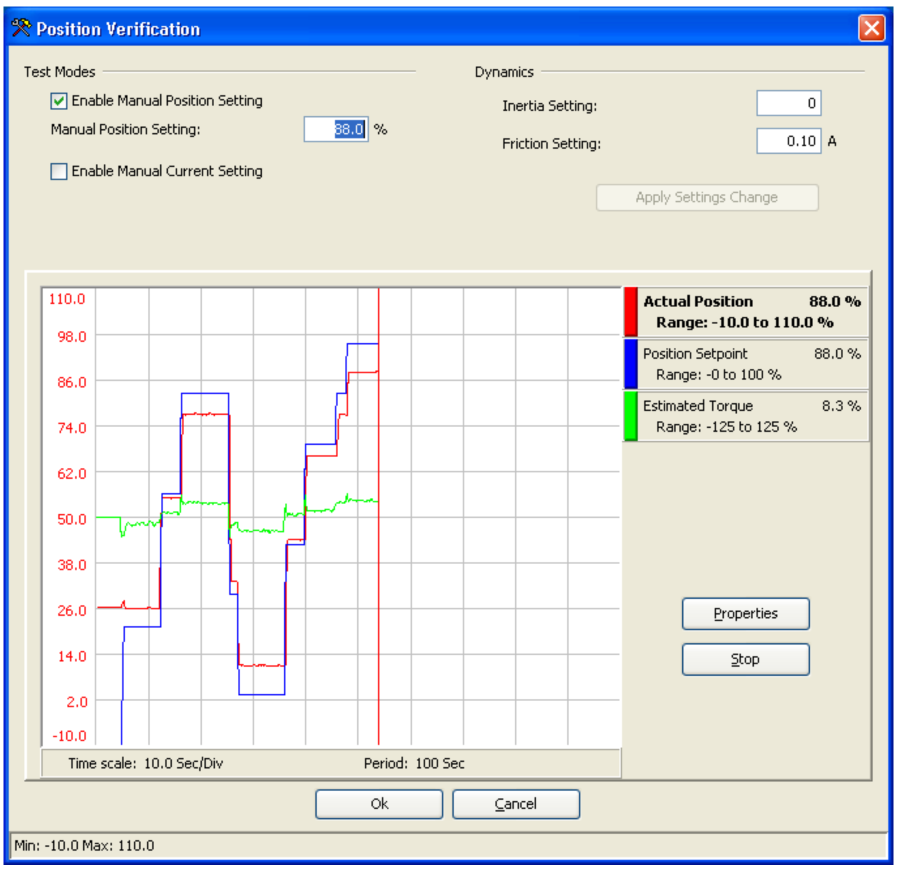


Figure 6-7 Position Verification Screen

Trend options can be modified by selecting the Properties button, which opens the Strip Chart Properties window (Figure 6-8). From this window the chart period, colors, ranges and grid options can be modified. Individual ranges can be modified by selecting the desired signal (Actual Position, Position Setpoint, Estimated Current) from the pen drop-down selection and modifying the attributes of that signal (e.g., min range, max range, color). Each signal can have different ranges.

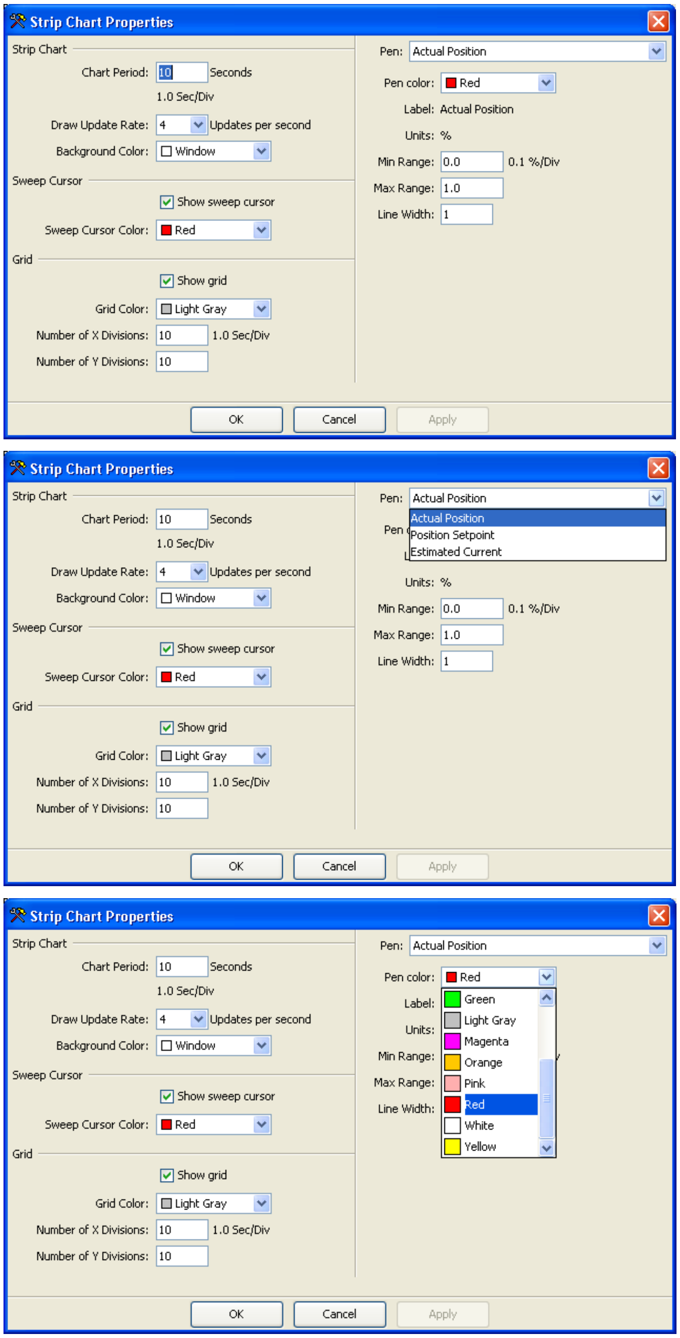


Figure 6-8. Options under Strip Chart Properties Window

Chapter 7.
CAN Details

Overview

The ProAct Actuator supports CAN communications in the SAE J1939 Higher Layer Protocol format. Further detailed information regarding the J1939 Standards Collection can be purchased at www.sae.org. Information about CAN is included in ISO 11898. Specific information regarding ProAct behavior is detailed below.

All ProAct J1939 messages use the CAN 2.0B 29-bit Extended Data Frame Format.

The ProAct P-Series has one transmitted (data) message and one receive message for commands. A Legacy mode is provided to allow for backward compatibility for most ProAct ISC and ProAct Digital Plus messages. The legacy mode does not provide the heartbeat message. Details on each message are provided below.

Harness Coding

The ProAct shall have 4 possible source addresses that will be set through harness coding to the configured Discrete Inputs (CAN ID High and CAN ID Low). If Legacy mode is configured, the Source Addresses are 19, 20, 21, and 22, otherwise they are set to the user-configured value. The source address is determined on power-up when the discrete inputs are initially read.

Unit Number	Can ID High	Can ID Low	Source Address	Source Address (Legacy mode)
1	Off	Off	configurable	0x13 (19)
2	Off	On	configurable	0x14 (20)
3	On	Off	configurable	0x15 (21)
4	On	On	configurable	0x16 (22)

Table 7-1. Source Address by Harness Code

CAN Bit Timing

Bit timing is 250 kbps by default, but configurable as 125 k, 250 k, 500 k, and 1 M bits/s.

CAN Messages Overview

The following information will be sent via CAN:

- Actual Valve Position
- Desired Valve Position
- Internal Electronics Temperature*
- Diagnostics (Alarms and Shutdowns)

These are all provided in one data message (2 messages in Legacy mode).

The following information will be sent via CAN upon request:

- Software Version Number

The ProAct P-Series controller receives the following information via CAN:

- Position Demand
- Stop command*
- Reset command*
- Reset Logged faults command*
- DM13

* not available in Legacy mode

CAN Message Details

Command Message (Rx)

This message is received by the ProAct P-Series when CAN position command is configured.

Transmission rep rate:	5 ms minimum interval
Data length:	8 bytes
Data page:	0
PDU format:	configurable PGN
PDU specific:	configurable PGN
Suggested priority:	1 (high)
PGN:	4 configurable PGNs provided, one for each unit number

Data:

Bytes 1-2: Position command

Data length: 2 bytes
Resolution: 0.0025 %/bit, 0 offset
Range: (0 to 160.6375) % (0x00 to 0xFAFF)

Note: The position demand setpoint is limited internally between 0 % and 100 %.

Byte 3: Command bits

Data length: 1 byte
Bits 0-1: Reset Active Diagnostics
00 No action
01 Reset action *
10 Reserved
11 Not supported
Bits 2-3: Reset Logged Diagnostics
00 No action
01 Reset action *
10 Reserved
11 Not supported
Bits 4-5: Operation Control (Run/Stop)
00 No action
01 Shutdown
10 Reserved
11 Not supported
Bits 6-7: RESERVED/NOT USED

* A reset action be preceded by a no action command or the ProAct P-Series will not perform the requested action - the bits cannot remain in a '01' state. The reset action occurs only upon the transition from 00 to 01.

Bytes 4-8: RESERVED/NOT USED (Send as 0xFF in each byte)

Command Message (Rx)—Legacy mode

Transmission rep rate:	5 ms max
Data length:	4 bytes
Data page:	0
PDU format:	255
PDU specific:	22, 23, 24, 25—for unit number 1-4
Suggested priority:	1 (high)
PGN:	65302 (FF16), 65303 (FF17), 65304 (FF18), 65305 (FF19)—for unit number 1-4

Data:

Bytes 1-4: Position command

Data length: 4 bytes
Resolution: 2.56E-8 %/bit, -5 offset
Range: (–5 to +105) % (scaled from 0x00 to 0xFFFFFFFF)

Note: The position demand setpoint is limited internally between 0 % and 100 %.

Data Message (Tx)

Transmission repetition rate:	100 ms
Data length:	8 bytes
Data Page:	0
PDU format:	configurable PGN
PDU specific:	configurable PGN
Default priority:	6
PGN:	4 configurable PGNs provided, one for each unit number

Data:

Byte 1: Actual Valve Position

Data length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Range: (0 to 100) % (0x00 to 0xFA)
Error Indicator set (0xFE) if position sensor is failed.

Byte 2: Desired Valve Position

Data length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Range: (0 to 100) % (0x00 to 0xFA)
Error Indicator set (0xFE) if all position demands are failed.

Byte 3: Electronics Temperature

Data length: 1 byte
Resolution: 1 °C/bit gain, -40 °C offset
(Subtract 40 from received value to recover °C value)
Range: -40 to +210 °C (0x00 to 0xFA)
Error Indicator set (0xFE) if temperature sensor is failed.

Byte 4: Status Bits

Data length: 1 byte
Bits 1-4: Operation Status (see definition below)
Bits 5-7: Control Mode (see definition below)
Bit 8: Discrete Output ON indication (0=off, 1=on)

Operation Status
- 0000 Normal
- 0001 Alarm (Fully operational but needs service)
- 0010 Alarm High Severity (Functional but transient performance may be reduced)
- 0011 Derate active (Torque output reduced due to environmental conditions)
- 0100 Controlled Shutdown active (Driving to the default position—usually this means closed)
- 0101 Uncontrolled Shutdown active (Actuator current is off so it is limp)
- 0110-1101 Reserved for future assignment
- 1110 Error
- 1111 Not available

Control Mode
- 000 Primary Demand in Control
- 001 Primary Demand in Control, Backup Failed
- 010 Backup Demand in Control, Primary Failed
- 011 All Demand Signals Failed, actuator in default position
- 100 Primary Demand enabled but inactive, delay from backup control
- 101 Reserved for future assignment
- 110 Error
- 111 Not available

Byte 5: Diagnostic Indications 1

Data length: 1 byte
- Bit 1: Internal Fault
- Bit 2: Stop commanded (Run/Stop)
- Bit 3: Input (Supply) Voltage Fault
- Bit 4: Position Error
- Bit 5: Temperature Sensor Fault
- Bit 6: Temperature derating active, above 100 °C
- Bit 7: Temperature above 120 °C
- Bit 8: Reserved for Spring Check Failed (not implemented)

Byte 6: Diagnostic Indications 2

Data length: 1 byte
- Bit 1: spare
- Bit 2: Loss of Position Demand
- Bit 3: Demand Tracking Fault
- Bit 4: Analog Position Demand Failed
- Bit 5: PWM Position Demand Failed
- Bit 6: CAN Position Demand Failed
- Bit 7: CAN Fault (CAN Bus Off, CAN Address Claim Error)
- Bit 8: CAN Stop Command

Byte 7: Logged Diagnostic Indications 1 (same format as byte 5)
Byte 8: Logged Diagnostic Indications 2 (same format as byte 6)

Data Message (Tx)—Legacy Mode

Transmission repetition rate: 100 ms
Data length: 8 bytes
Data Page: 0
PDU format: 255 (FF)
PDU specific: 251 (FB)
Default priority: 7
PGN: 65531 (FFFB)

Data:

Byte 1: Actual Valve Position

Data length:	1 byte
Resolution:	0.3922 %/bit, 0 offset
Range:	(0 to 100) % (0x00 to 0xFF)

Error Indicator not used.

Byte 2: Desired Valve Position

Data length:	1 byte
Resolution:	0.39221/2.55 %/bit, 0 offset
Range:	(0 to 100) % (0x00 to 0xFF)

Error Indicator not used.

Byte 3-8: Not Used (sent as 0xFF in each byte)

Diagnostics Message (Tx)—Legacy Mode

Transmission repetition rate:	100 ms
Data length:	8 bytes
Data Page:	0
PDU format:	FF
PDU specific:	10
Default priority:	6
PGN:	65296 (FF10)

Bit code legend

The following diagnostics and events status will be sent by the ProAct P-Series actuator in a sequence.

Bit code	Description
00	Inactive
01	Active
10	Reserved
11	Not Available

Bit position in a byte is “8 7 6 5 4 3 2 1”
Bit position 1 is the least significant bit.
Example: Bit position 2 is “1” and all others bits are “0”, byte value is 2.

Data:

Byte 1: Diagnostic Indications 1
Bits 1-2: Stop commanded (Run/Stop)
Bits 3-4: CAN Position Demand Failed
Bits 5-6: Internal Fault
Bits 7-8: Analog Position Demand Failed[2]

Byte 2: Diagnostic Indications 2
Bits 1-2: PWM Position Demand Failed[2]
Bits 3-4: not used (sent as 11)
Bits 5-6: General Alarm indication
Bits 7-8: General Shutdown indication

Byte 3-4: Not Used (sent as 0xFF in each byte)

Byte 5: Event Indications 1
Bits 1-2: Position Error
Bits 3-4: Temp Sensor Failed (>140 °C or <-45 °C)[1]
Bits 5-6: not used (sent as 1)
Bits 7-8: 24 V Supply Out of Range (High or Low)[1]

Byte 6: Event Indications 2
- Bits 1-2: 24 V Supply Out of Range (High or Low) [1]
- Bits 3-4: Temp Sensor Failed (>140 °C or <–45 °C) [1]
- Bits 5-6: Power up reset
- Bits 7-8: Temperature >100 °C (derated) [2]

Byte 7: Event Indications 3
- Bits 1-2: Temperature >120 °C (no torque) [2]
- Bits 3-8: not used (sent as 1 in each bit)

Byte 8: Not Used (sent as 0xFF)

[1] Modified diagnostic value. Previous ProAct ISC and ProAct Digital Plus versions sent Hi and Low failures separately, however they are combined in the ProAct P-Series so both the High and the Low indication will be set when either condition exists.
[2] New diagnostics, added in P-Series.

Address Claimed

The Address Claimed message will be sent out shortly after power has been applied. The Address Claimed message will also be sent out in response to a Request for Address Claimed if the preferred address was successfully claimed. The Request for Address Claimed can be sent to a specific Address or to the Global Destination Address, 255. The ProAct P-Series will respond to a specific query or a global query.

The Address Claimed Message will also be sent out if the ProAct P-Series receives an Address Claimed message from the same Address as the receiving node and a lower priority (higher value) NAME. The entire 8-byte value of the NAME is used for arbitration with the Arbitrary Address Capable Field as the Most Significant Bit.

The NAME has two user-configurable settings (Function Field and Source Address), one factory set value (Identity Number), and the ECU instance field corresponds to the harness code. The remaining values are all fixed. Refer to the NAME definitions below for more details.

PGN 60928 Address Claimed (ACL)

Address Claimed / Cannot Claim Message

Transmission rate:	on start-up, on request, response to Address Claimed
Data length:	8 bytes
Data Page:	0
PDU format:	238
PDU specific:	255
Default priority:	6
Parameter Group Number:	60928 (0x00EE00)

Bytes 1-3.1: (21 bits) Identity Number, SPN 2837
Bytes 3.6-4: (11 bits) Manufacturer Code, SPN 2838
Byte 5.1: (3 bits) ECU Instance, SPN 2840
Byte 5.4: (5 bits) Function Instance, SPN 2839
Byte 6: (8 bits) Function, SPN 2841
Byte 7.1: (1 bit) Reserved
Byte 7.2: (7 bits) Vehicle System, SPN 2842
Byte 8.1: (4 bits) Vehicle System Instance, SPN 2843
Byte 8.5: (3 bits) Industry Group, SPN 2846
Byte 8.8: (1 bit) Arbitrary Address Capable, SPN 2844

ProAct P-Series J1939 NAME Details

Component	Setting	Value
Arbitrary Address Capable Field	Not Supported	0
Industry Group Field	Global	0
Vehicle System Instance Field	First Instance	0
Vehicle System Field	Non-specific system	0
Function Field	Unspecified	255
Function Instance Field	First	0
ECU Instance Field	Unit 1 Unit 2 Unit 3 Unit 4	0 1 2 3
Manufacturer Code Field	Woodward Governor Industrial Controls	153
Identity Number Field	Unique	Unique

Table 7-2. J1939 NAME

See J1939-81 Section 4.1.1 for additional details on J1939 NAME.

Cannot Claim Address

The Cannot Claim Address message will be sent out if the P-Series receives an Address Claimed message with the same Source Address as the receiving node and with a higher priority (lower value) NAME. The entire 8-byte value of the NAME is used for arbitration with the Arbitrary Address Capable Field as the Most Significant Bit. The Cannot Claim Address will also be sent out in response to a Request for Address Claimed if the address was unsuccessfully claimed.

The Cannot Claim Address message is identical to the Address Claimed message in all aspects except that the Source Address of the TecJet 52 is replaced with 254. The Cannot Claim Address message will be sent out with a (0 to 153) ms pseudo-random delay between the reception of the triggering message and the transmission of the Cannot Claim Address message. If the ProAct P-Series cannot claim an Address, the CAN Address Claim Fault status bit will be set.

CAN Start/Stop Broadcast (DM13)

The ability to turn off CAN message broadcasts is provided in the ProAct P-Series, this feature is referred to as DM13 in the J1939 specification (see J1939-73). This feature allows a temporary (timed) stoppage of transmitted messages to minimize network traffic.

The ProAct P-Series will respond to DM13 directed to either our specific node (our source address) or globally (FF). The following is a summary of the Start/Stop broadcast implementation. If DM13 commands a Stop, then the ProAct P-Series will stop sending all broadcast messages for 6 seconds. During this time, if a Start is received (on byte 1.7) then message transmission will resume; if a Hold is received (on byte 4.5) then the 6 second timer is restarted. When the timer expires or if power is cycled on the device broadcasted messages will be restarted.

The ProAct P-Series only monitors the ‘Current Data Link’ bits of DM13 (bits 8-7 in byte 1) for Start/Stop commands and support for the DM13 ‘Suspend’ feature is not provided. A 'Start' command is a value of 01 on bits 6-7 of byte 1, a 'Stop' command is a value of 00 on bits 6-7 of byte 1, and a 'Hold' command is a value of 00 or 01 on bits 4-7 of byte 4.

While a DM13 commanded 'stop' is active, the CAN demand is internally set to zero and any CAN demand timeout will not be recorded. The commands shall be processed as follows in the event multiple commands are determined in the same message. When in QUIET/Stop mode, a Start shall have priority over a Hold and additional Stop commands are ignored. When not in QUIET/Stop mode, Start and Hold commands are ignored.

DM13 Message

Data length: 8 bytes
Data page: 0
PDU format: 223 (DF)
PDU specific: DA (responds to specific SA or global)
Default priority: 6
Parameter Group Number: 57088 (DF00)

Data:

Byte 1:
Bits 1-2: (ignored)
Bits 3-4: (ignored)
Bits 5-6: (ignored)
Bits 7-8: **Current Data Link** (see bit code legend 1 below)
Byte 2: (ignored)
Byte 3: (ignored)
Byte 4:
Bits 1-2: Suspend Signal (not supported)
Bits 3-8: **Hold Signal** (see bit code legend 2 below)
Byte 5-6: Suspend Duration (not supported)
Byte 7-8: SAE Reserved (not used)

Bit code legend 1

Bit code	Description
00	Stop Broadcast
01	Start Broadcast
10	Reserved
11	Don't care/take no action

Bit code legend 2

Bit code	Description
0000	All Devices
0001	Stopped Devices
0010-1110	Reserved
1111	Not available

Software Version Number

If the engine control system needs the software version number, it will use the request message PGN 59904. The ProAct will respond to a specific query or a global query.

PGN 59904 Requested Messages

PGN request received by the ProAct The software version number and address claimed messages can be requested using the request message.

Message

Update rate:	on request
Data length:	3 bytes
Data page:	0
PDU format:	234 (EA)
PDU specific:	destination address (global or specific)
Priority:	6
PGN:	59904 (0xEA00)

Data:

Byte: 1..3	requested data PGN* (byte 3 is msb)
Bytes 4..8	reserved

*Supported PGNs: 65242 (SOFT), 60928 (ACL)

PGN 65242 Software Identification (SOFT) message

The software identification message is provided only upon request. One identification field is sent.

Message

Update rate:	on request
Data length:	variable, <= 8 bytes
Data page:	0
PDU format:	254
PDU specific:	218
Priority:	6
PGN:	65242 (0xFEDA)

Data:

Byte 1:	Number of Software Identification Fields, SPN 965
Actual value:	1 (will always report 1)
Bytes 2-N:	Software Identification, SPN 234
Data length:	variable, up to 7 bytes
Resolution:	ASCII, 0 offset
Actual value:	varies, see listing below**
Byte N:	Delimiter, SPN 234
Actual value:	42 (0x2A)
Character:	*

**Data actual value listing
2.03 for firmware 5418-6507 NEW
2.02 for firmware 5418-6133 NEW

Chapter 8. Troubleshooting

Introduction

This chapter presents several broad categories of application failures typically experienced in the field, possible causes, and some tests used to verify the causes. Because the exact failure experienced in the field is the product of the mechanical/electrical failure combined with the configuration file resident in the control, it is left as the OEM's responsibility to create a more detailed troubleshooting chart for the end user. Ideally, this end-user troubleshooting chart will contain information about mechanical, electrical, engine, and load failures in addition to the possible governor failures. For more detailed information about governor system failure modes and effects, contact Woodward for a copy of the system IAFMEA.

The troubleshooting scenarios listed below assume that the end user has a digital multi-meter at his disposal for testing voltages and checking continuity, and assume that the application has been engineered and tested thoroughly.

General System Troubleshooting Guide

The following is a general troubleshooting guide for areas to check which may present potential difficulties. By making these checks appropriate to your engine/turbine before contacting Woodward for technical assistance, your system problems can be more quickly and accurately assessed.

- Is the wiring correct?
- Is the direction of the stroke correct?
- Is the direction of the failsafe shutdown correct?
- Does the valve move through its proper stroke smoothly?
- Does the valve travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the valve fully seat (close)?
- Does the valve fully open?

⚠WARNING

The actions described in this troubleshooting section are not always appropriate in every situation. Always make sure that any action taken will not result in loss of equipment, personal injury, or loss of life.

⚠WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING	**The ProAct P-Series wiring must be in accordance with North American Class I, Division 2 or Zone 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.**

⚠CAUTION	**The ProAct P-Series is used on prime movers that typically have a high noise level. Always use appropriate hearing protection while working around the ProAct P-Series.**

There are two parts to the troubleshooting section:
- Troubleshooting the ProAct P-Series
- Troubleshooting Diagnostic Flags

The first section is used for situations where the system is not acting correctly, but the ProAct is not giving any diagnostic flags. The second section is used if the ProAct has diagnostic flags active.

Troubleshooting the ProAct P-Series

Problem Description	Possible Source	Possible Action
The actuator is not communicating with the Service Tool.	There is no power supplied to the actuator.	Check fuse, wiring, and battery voltage.
	The wiring between the actuator and the laptop is incorrect.	Check wiring according to the wiring diagram.
	The Service Tool is disconnected.	Connect the Service Tool by using the connect menu.
	The wrong communication port has been selected.	If connected, use disconnect and then re-connect with the correct communication port. Check that Service Tool is running. Verify the port setting is correct.
	Old version of Service Tool or file corruption or bad install.	Re-install Service Tool, get the latest version from the Woodward web site (**www.woodward.com/software**).
Not controlling at desired position setpoint	PWM input signal inaccuracy	Measure input duty cycle and convert to percentage. Verify controller signal using Service Tool. If different, adjust the PWM Offset value in the Configuration Editor.
	Scaling mismatch	Verify the value of the position setpoint using the Service Tool. Verify the configured scaling of the demand inputs.
	Running on backup demand	Verify the demand source using the Service Tool.
	Incorrect dynamics Incorrect position calibration	Follow the procedures in Chapter 6 for verifying both the dynamics (inertia and friction settings) and the position calibration.

Problem Description	Possible Source	Possible Action
Not controlling at desired position setpoint (cont.)	Wiring fault or ground loop	Check the wiring. Look for loose connections and disconnected or misconnected cables and connections. Remove all wiring except the position command and power input and verify operation / functionality.
	Analog input signal inaccuracy	Measure the analog command voltage to verify that it is at the expected value. Use the Service Tool to verify that input is being read correctly.
	Output shaft is bound or sticking	Manually verify full shaft movement. Use the "verify position" function of the Service Tool (Chapter 4).
Discrete output not working	Wiring fault Configuration	Check the wiring leading to the pin for open, ground, or input power connections, for or a misconnection. Using the Service Tool, verify that the faults and shutdowns are selected properly and that the output is configured for expected operation (either normally "on" or normally "off").

Troubleshooting Diagnostic Flags

Error Flag	Description	Possible Source	Possible Action
Internal Shutdown	All internal shutdowns will set this flag.	The actuator is defective.	Return unit to Woodward.
Run Enable (Run/Stop) shutdown	The Run/Stop input is in the 'Stop' state.	Incorrect voltage at the Run/Stop input. Incorrect discrete input configuration. Input is incorrectly wired. The actuator's input is damaged.	Verify voltage level at connector. Check configuration of input including active high/low, and active open/closed settings. Verify reading of input using Service Tool. Return unit to Woodward for repair.
Loss of Position Demand	All configured position demand signals have been detected as out of range or failed.	Incorrect configuration. Inputs invalid or failed.	Check configuration of demand selection. Check troubleshooting of each input below (e.g., PWM Input Fault).
Demand Tracking Fault	The configured demand signals are not tracking each other within the configured tolerances.	Incorrect configuration. Inputs invalid or failed. Demand signals not matching, incorrectly sent or scaling problem. Device not sending demand signals that track each other. Incorrect configuration.	Check configuration of demand tracking. Verify demand inputs in Service Tool. Make sure they are tracking each other. Correct signals to ensure they track within configured limits. Verify configuration. Check Demand Tracking settings.

Error Flag	Description	Possible Source	Possible Action
Analog Input Fault	This error flag will be set if the analog input is higher or lower than the configured limits.	Analog input is driven outside of the diagnostic limit. Diagnostic limit is setup incorrectly. Input configuration (4 mA to 20 mA vs 0 V to 5 V) mismatch. Input is incorrectly wired - open or short or connected to the wrong input (4 mA to 20 mA vs 0 V to 5 V).	Check signal and fix incorrect signal level. Verify reading of input on the Service Tool. Verify correct diagnostic limits. Verify input configuration. Correct wiring problem.
PWM Input Fault	This error flag will be set if the PWM input duty cycle is higher or lower than the configured limits.	PWM input is driven outside of the diagnostic limit. PWM voltage levels out of specification range. Diagnostic limit is setup incorrectly. Input is incorrectly wired.	Check signal and fix incorrect signal level. Verify reading of input on the Service Tool. Verify correct diagnostic limits. Correct wiring problem.
Supply Voltage Fault	The power supply voltage is higher than the diagnostic limits. The Power supply voltage is lower than the diagnostic limits.	Bad or damaged battery. Defective battery charging system. Incorrect setting of power supply voltage level. Power supply wiring too long or too thin. Control will flag low voltage during higher power uses. The control's input is damaged.	Replace battery. Fix battery charging system. Set correct voltage levels on power supply. Make sure wiring is of the correct thickness and length according to manual. Verify input power reading using the Service Tool. If bad, return unit to Woodward for repair.
Electrical Temperature >100 °C or >120 °C	High internal temperature. The temperature inside the actuator is higher than the programmed limits.	Actuator has been placed in an environment that is too hot. The internal temperature sensor is defective.	Check ambient temperature around the actuator. Lower temperature by adding cooling, heat shielding, moving the unit, etc. Verify internal electrical temperature reading using the Service Tool. If the temperatures seem normal, could indicate a problem with the temperature sensor.
Electrical Temperature Fault	This error is set if the temperature inside the actuator is outside the limits allowed by the specifications.	The actuator has been placed in an environment that is too hot or too cold. The internal temperature sensor is defective.	Lower the actuator temperature by adding cooling, heat shielding, moving the unit, etc. Increase temperature by adding heat. Verify internal electrical temperature reading using the Service Tool. Return unit to Woodward for repair.

Error Flag	Description	Possible Source	Possible Action
Position Error	If the difference between the demanded position and the actual position are outside the configured limits.	Incorrect inertia or friction settings. Binding or excessive friction in the actuator linkage, or stops are set inside the desired range of travel.	Check position dynamics using the Service Tool. Click on Tools, then click on Position Calibration, and perform either the manual or automatic position calibration. Check all mechanical linkages and stops. Verify valve / ITB moves freely and is not blocked or binding.
CAN Communications Fault	This error is set if a CAN Bus Off or Address Claim error is detected.	Incorrect or intermittent wiring problem. Bus Off: Different device data rates. Bus Off: Incorrect or missing termination resistors. Address Claim: unable to claim or lost contention Wrong source address. Electrical problems within the controller or unit.	Check wiring for broken or loose connection. Verify configured data rate. Verify proper termination resistors at the ends of the CAN network. Verify selected harness code. Confirm CAN unit number on Service Tool. Confirm no other devices on the bus have the same source address. Verify configuration of CAN ID Low and High inputs. Confirm CAN unit number on Service Tool. Confirm correct source address is configured as well as the legacy mode selection. Possible problem with the actuator, although additional testing recommended before returning to Woodward.
CAN Stop (Run/Stop) Shutdown	A STOP command was received over CAN.	CAN data incorrect, CAN PGN incorrect.	Verify PGN configuration settings. Verify device sending J1939 messages. A specific bit pattern is required within the specified PGN to trigger this STOP command.

Error Flag	Description	Possible Source	Possible Action
CAN Demand Fault	This error is set if the CAN Bus is not communicating or messages received are slower than the configured update rate.	Incorrect or intermittent wiring problem.	Check wiring for bad or lost connection.
		Incorrect configuration.	Verify configuration.
		ECM is not sending updates fast enough or regularly (bursts).	Verify ECM messages and update rates. Verify configuration of ProAct CAN Fail timeout.
		CAN demand is missing (no signal).	Verify CANbus communication and connections.
		Incorrect Unit Number / source address.	Check the CAN ID inputs to the valve.
		ECM is not sending Demand messages, or is not sending to the correct unit number.	Verify that the ECM is powered up and sending valid demand messages, and that the correct unit number is selected.
		CAN termination problem.	Check if the CANbus has the right termination resistor connected at both ends of the bus.
		CAN wiring problem.	Check the CAN wiring for shorts, open connections, interchanged connections, and intermittent contacts.
		CAN noise problem.	Verify that the CAN wiring is installed according to the installation instruction
		CANbus incompatibility with ECM, e.g., baud rate.	Verify ECM CANbus compatibility. Verify configured data rate.
		CAN traffic overload.	Verify that there is not excessive CAN traffic that has higher priority than the actuator demand message.

Electrical Troubleshooting Guide

Analog Input

If the Analog Input is not functioning properly, verify the following:

- Measure the input voltage. It should be in the correct range based on configuration and wiring (e.g. 0 V to 5 V or 4 mA to 20 mA).
- Check the values seen by the P-Series driver using the Service Tool and verify that it matches the input signal.
- Verify that there are no or minimal ac components to the Analog Input signal. AC components can be caused by improper shielding.
- Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 V, look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly as the Demand Source.

PWM Input

If the PWM input is not functioning properly, verify the following:

- Measure the input voltage, frequency, and duty cycle.
- Check the values seen by the P-Series driver using the Service Tool and verify that is matches the input signal.
- Check the wiring. Look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly as the demand source.

CAN Input

If the CAN connection is not functioning properly, verify the following:

- Check faults indicated on Service Tool.
- Check the values seen by the ProAct driver, if any, using the Service Tool and verify that it matches the sent signal and/or received signal.
- Check the wiring. Look for loose connections and disconnected / misconnected cables/connections. Verify 120 Ohm resistor at ends of transmission lines.
- Check the software configuration to ensure that the signal is configured properly (Device ID, fail timeout, etc).
- Check active device number. This is based on the CAN ID Hi and Low inputs and their configurations.

Run Enable Discrete Input

If the run enable discrete input is not functioning properly, verify the following:

- Measure the input voltage at the connector.
- Check the status of the input from the Overview screen of the Service Tool.
- Check the wiring, looking for loose connections or misconnected cables.
- Verify the input is properly configured.

Alarm or Shutdown Conditions

If the ProAct control has any alarm or shutdown conditions, refer to Chapter 2 for details on the exact cause of the condition. The Service Tool must be used to determine the cause of any shutdown or alarm condition. Refer also to the 'Troubleshooting Diagnostics Flags' section above.

Discrete Output

If the discrete output is not functioning properly, verify the following:

- Measure the output voltage on the terminal block. It should be in the range of (10 to 28) V (dc) when the output is off/false. The status can be verified through the Service Tool.
- Check the wiring, looking for loose connections or disconnected / misconnected cables.
- Verify the configuration of the output.

Service Tool

If the Service Tool is not functioning properly, review the installation information in Chapter 4. Verify the following:

- Check the wiring, looking for loose connections or disconnected / misconnected cables.
- Check that Service Tool is running. Verify the Port setting is correct.
- Follow on-screen error messages. Re-install software as needed. The latest version of software is available for download from the Woodward web site (**www.woodward.com/software**).

Chapter 9. Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in “like-new” condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:
- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used In Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used In Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used In Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name ____________________

Site Location ____________________

Phone Number ____________________

Fax Number ____________________

Prime Mover Information

Manufacturer ____________________

Engine Model Number ____________________

Number of Cylinders ____________________

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) ____________________

Power Output Rating ____________________

Application (power generation, marine, etc.) ____________________

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter ____________________

Control Description or Governor Type ____________________

Serial Number ____________________

Control/Governor #2

Woodward Part Number & Rev. Letter ____________________

Control Description or Governor Type ____________________

Serial Number ____________________

Control/Governor #3

Woodward Part Number & Rev. Letter ____________________

Control Description or Governor Type ____________________

Serial Number ____________________

Symptoms

Description ____________________

____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix. ProAct P-Series General Summary

Performance:

Positioning Accuracy	±1 % of full travel at 25 °C
Positioning Repeatability	±1 % of full travel at 25 °C
Temperature Drift	350 ppm/°C of full travel (using CAN command)
Bandwidth	(measured at -6 db) > second order, 40 rad/s –3 db at 8 Hz with low inertia
Max Slew Rate	> 1000 degrees/second > 18.5 rad/s (10 % to 90 % travel)
Overshoot	< 4 % of full scale
1 % Settling Time	240 ms
2.5 % Setting Time	150 ms
Limit Cycle	< 0.25 degrees peak to peak with low friction loads
Steady State Error	<0.1 degree for loads up to 80 % of steady state current limit. Integrating control drives steady state error to zero.
Min Load Inertia	0

Environmental:

Ambient Operation Temperature	–40 to +85 °C (–40 to +185 °F)
Storage Temperature	–40 to +125 °C (–40 to +257 °F)
Humidity	H2: (Woodward) profile
Mechanical Vibration	RV2: US MIL-STD-202F, procedure 214A: 0.1 G^2 /Hz, 10 Hz to 2000 Hz, 3 hr/axis, 12.8 Grms
Mechanical Shock	US MIL-STD-810C, Method 516.3, 516.4 procedure 1
Ingress Protection	IP56 per IEC 60529
EMC emissions	EN 61000-6-4
EMC immunity	EN 61000-6-2

Reliability:

Mechanical	The B10 life is 60 000 Prime Mover service hours. The B10 life prior to a rebuild is 30 000 Prime Mover service hours.
Electrical	MTBF of 28 000 hours at 60 °C and the actuator is operating at 75 % of capacity.

Torque Output:

Model II Transient	5.2 N·m (46 lb-in)
Model II Continuous	2.6 N·m (23 lb-in)
Model III Transient	10.4 N·m (92 lb-in)
Model III Continuous	5.2 N·m (46 lb-in)
Model IV Transient	20.8 N·m (184 lb-in)
Model IV Continuous	10.4 N·m (92 lb-in)

Mechanical:

Travel	73 to 77 degrees
Weight	
Model II	11 kg (25 lb)
Model III	15 kg (32 lb)
Model IV	24 kg (52 lb)
Mass Moment of Inertia	
Model II MMOI	5.5E-4 kg-m² (4.9E-3 lb-in-s²)
Model III MMOI	6.4E-4 kg-m² (5.6E-3 lb-in-s²)
Model IV MMOI	8.2E-4 kg-m² (7.2E-3 lb-in-s²)

Power Supply Input

Parameter	Value
Normal Operation	(18 to 32) V
Transient/Starting	(8 to 40) V for 1 minute
Max Extended Voltage	40 V (1 minute)
Min Extended Voltage	8 V (limited performance)
Max Current Transient	Model II < 13 A @ 18 V Model III < 15 A @ 18 V Model IV < 20 A @ 18 V
Max Current Continuous	Model II < 3.5 A @ 18 V Models III & IV < 6.5 A @ 18 V
Max Power Steady Continuous	Model II - 65 W Model III - 73 W Model IV - 101 W
Max Power Transient	Model II - 251 W Model III - 282 W Model IV - 371 W
Hold Up Time	**NOTE**: Depends on operating conditions. 1.1 ms at 24 V (dc) with max load
Out of Range Detection	<9 V for 500 ms, <17 V for 70 s, >33 V for 500 ms. Action is configurable in software.

Analog Demand Input

Parameter	Value
Input Type	(0 to 5) V or (0 to 25) mA
Input scaling	Configurable in software
Accuracy @ 20 °C	0.05 % / FS (> 6 sigma)
Linearity @ 20 °C	0.5 % / FS (> 6 sigma)
Resolution	12 bits
Temperature drift	200 ppm/°C
Sample Rate	1 ms
CCM @ 60 Hz or lower	60 dB
CCM Voltage Range	±50 V
Input Impedance	100 kΩ (0 V to 5 V mode), 200 Ω (0 mA to 25 mA mode)
Isolation	None
Overvoltage Protection	Input protected against 32 V (dc) steady state
Out of Range Detection	Configurable in software

PWM Demand Input

Parameter	Value
PWM Input Type	Low-Side and Push-Pull (differential input)
PWM Amplitude Range	(8.4 to 32) V
Specified Frequency Range	300 Hz to 2000 Hz
PWM Compare Point	4.0 V nominal (1.8 to 8.4) V over temperature range
PWM Hysteresis	3.4 V nominal, 6.6 V over temperature range
Duty Cycle Scaling	Configurable in software
Isolation	None
Input Impedance	10 kΩ all modes
Resolution	12 bits up to 1953 Hz
	The duty cycle and frequency are read with reduced resolution at higher frequencies
Accuracy	±1 % at 32 V and frequencies < 1000 Hz
	±2 % at 32 V and frequencies > 1000 Hz
	NOTE: PWM detection accuracy could depend on integrity of signal source.
Pull-Up Level	15 V through 4.75 kΩ
I/O Execution Rate	1 ms
Calibration	Duty cycle offset adjustment is available in Service Tool. This will tailor the input to the signal source
Loss of Signal	<153 Hz. Sets Duty Cycle and Frequency to zero.
Out of Range Duty Cycle	Configurable in software.

Discrete Inputs

Parameter	Value
Input Function	Software Selectable
Low Level	< 4 V
High Level	> 7 V
Hysteresis	> 1 V
Min Current @24 V	> 1 mA
Max Current	< 10 mA
Min Hardware delay	> 2 ms
I/O Execution Rate	10 ms
Number of Samples	3
High / Low Side Switch	Software Selectable
Active Open / Close	Software Selectable
Protection	Can tolerate being wired to 32 V (dc)

Discrete Output

Parameter	Value
Function	Status output, software selectable.
Output Type	Low-side driver
Max Voltage at Output Pin	40 V (dc)
Max Short Circuit Current	500 mA
Max On-State Saturation Voltage at Max Current (Max Voltage Drop)	1.0 V (dc)
Max Off-State Leakage Current at 24 V (dc)	8 µA
Inductive Load Protection	Yes, internally protected low-side switch
Over-Current Protection	Utilizes circuitry that will open the contact when output contacts are short-circuited. Self-resetting when fault is removed
Activating Latency	< 100 ms
I/O Execution Rate	10 ms
Output Action	Configurable ON/OFF in software

Analog Output

Parameter	Value
Output Type	(0 to 25) mA
Output Scaling	Software configurable
Output function	Software configurable
Isolation	None
I/O Execution Rate	10 ms
Accuracy @ 20 °C	0.05 % / FS (> 6 sigma)
Linearity @ 20 °C	1 % / FS (> 6 sigma)
Resolution	12 bits
Temperature Drift	450 ppm/°C
Reverse Voltage Protection	Yes
Overvoltage Protection	Output protected against 32 V (dc), steady-state. Also protected from direct short to ground.
Minimum Load Impedance	0 Ω
Maximum Load Impedance	450 Ω at 25 mA

Serial Communication Service Port

Parameter	Value
Isolation	None
Baud Rate	Fixed 38.4 K baud
Maximum Cable Length	10 m (33 ft)—for service only (not intended for permanent connection)
Cable Type	Straight-through (no crossover)

CAN Communication Port

Parameter	Value
Wiring Specification	ISO-11898, SAE J1939-11
Isolation	None
Baud Rate	Software configurable from 125 kbps to 1 Mbps
Electrical Interface	CAN Hi and CAN Lo differential transmit/receive
Type	Supports CAN2.0B and SAE J1939-11
Maximum Cable Length	30 m
Cable Type	Two-conductor shielded cable according to SAE J1939-11
Fault Detection	Software selectable. CAN Fault (Bus Off, Address Claim) and Loss of CAN Demand provided.

Electronics Temperature (internal sensor)

Parameter	Value
Accuracy	±1 °C at 25 °C ambient ±2 °C over temperature range (–40 °C to +125 °C)
I/O Execution Rate	10 ms
Out of Range	< –45 °C, >140 °C. Action is configurable in software

Transfer Function (Positioner)

The transfer function of the position controller is nominally four lags and a rate limiter (see Figure B-1 below). The first lag is an input filter is set at 0.020 seconds, with a model-dependent slew rate limit. The second lag is set at 0.0033 seconds. The remaining two lags are scheduled with Inertia Number as shown in the following tables.

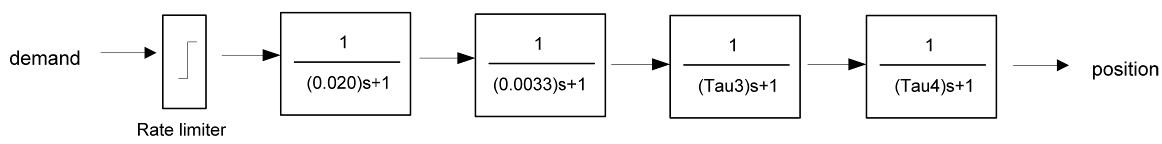


Figure B-1. Transfer Function

Size	Rate Limiter (deg/s)
Model II	2285
Model III	1882
Model IV, EHT	941

Table B-1 Rate Limiter Values

Tau_3	Tau_4	Model II Inertia Number	Model III Inertia Number	Model IV, IV EHT Inertia Number
0.0040	0.0050	>= 16	>= 17	>= 17
0.0044	0.0063	< 16	< 17	< 17
0.0053	0.0125	< 12	< 13	< 13
0.0063	0.0250	< 7	< 8	< 8

Table B-2 Transfer Function Parameters

Inertia Settings
Inertia=Base_Inertia*1.25^InertiaNumber
The actuator with no load has inertia = Base_Inertia

Size	Base_Inertia
Model II	5.5e-4 Kg-m^2
Model III	6.4e-4 Kg-m^2
Model IV	8.2e-4 Kg-m^2
Model IV EHT	8.2e-4 Kg-m^2

Revision History

Changes in Revision D—
- Updated European Compliance for CE Mark EMC Directive

Changes in Revision C—
- Change High Side PWM Source drawing (page 15) to show PNP transistor
- Correct inertial settings (page 90)

Changes in Revision B—
- Added new firmware version

Changes in Revision A—
- Added Service Tool strip chart trend feature available in version 1.8 and newer
- Added firmware version 5418-6133 & references to ProAct FL version
- Removed references to ProAct Model I

Declarations

DECLARATION OF CONFORMITY

EU DoC No.:	00130-04-CE-02-05
Manufacturer's Name:	WOODWARD, INC.
Manufacturer's Contact Address:	3800 Wilson Avenue Loveland, CO 80538 USA
Model Name(s)/Number(s):	P-Series Actuator
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)
Applicable Standards:	EN61000-6-4, 2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments

This declaration of conformity is issued under the sole responsibility of the manufacturer.
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Signature

Christopher Perkins
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

05-APR-2016
Date

5-09-1183 Rev 26

DECLARATION OF INCORPORATION
Of Partly Completed Machinery
2006/42/EC

File name:	00130-04-CE-02-06
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Address:	3800 Wilson Avenue Loveland, CO 80538 USA
Model Names:	P-Series
This product complies, where applicable, with the following Essential Requirements of Annex I:	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7

The relevant technical documentation is compiled in accordance with part B of Annex VII. Woodward shall transmit relevant information if required by a reasoned request by the national authorities. The method of transmittal shall be agreed upon by the applicable parties.

The person authorized to compile the technical documentation:

Name: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate.

The undersigned hereby declares, on behalf of Woodward Governor Company of Loveland and Fort Collins, Colorado that the above referenced product is in conformity with Directive 2006/42/EC as partly completed machinery:

MANUFACTURER

Signature: [signature]

Full Name: Christopher Perkins

Position: Engineering Manager

Place: Woodward Inc., Fort Collins, CO, USA

Date: 28- JUN - 2016

Document: 5-09-1182 (rev. 16)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26578D

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