



**Product Manual 26600**  
**(Revision E, 1/2024)**  
Original Instructions



## **F-Series Actuator and Integrated Throttle Body**

**F-Series ITB 33/48/60/68/75**  
**23-pin Version**

**Installation and Operation 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.



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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.



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## 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**

##### Lockout/Tagout LOTO

Ensure that personnel are fully trained on LOTO procedures prior to attempting to replace or service equipment on a “live” running engine. All safety protective systems (overspeed, over temperature, overpressure, etc.) must be in proper operational condition prior to the start or operation of a running engine. Personnel should be equipped with appropriate personal protective equipment to minimize the potential for injury due to release of hot hydraulic fluids, exposure to hot surfaces and/or moving parts, or any moving parts that may be activated and are located in the area of control of the unit.

#### **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.

**! WARNING****IOLOCK**

**IOLOCK:** driving I/O into a known state condition. When a control fails to have all the conditions for normal operation, watchdog logic drives it into an IOLOCK condition where all output circuits and signals will default to their de-energized state as described below. *The system MUST be applied such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.*

- Microprocessor failures will send the module into an IOLOCK state.
- Discrete outputs / relay drivers will be non-active and de-energized.
- Analog and actuator outputs will be non-active and de-energized with zero voltage or zero current.

Network connections like CAN stay active during IOLOCK. This is up to the application to drive actuators controlled over network into a safe state.

The IOLOCK state is asserted under various conditions, including:

- Watchdog detected failures
- Microprocessor failure
- PowerUp and PowerDown conditions
- System reset and hardware/software initialization
- PC tool initiated

**NOTE**—Additional watchdog details and any exceptions to these failure states are specified in the related section of the product manual.

**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

### NOTICE

#### Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

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*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
  - Do not touch any part of the PCB except the edges.
  - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
  - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

## J1939 CAN Demand Crosstalk

### NOTICE

When two F-Series valves (V1 and V2) are on the same CAN bus, crosstalk will occur resulting in indeterminate positioning in V2 when programmed as follows:

- V1 and V2 are programmed to J1939 CAN demand and Legacy messages is set to "No", and
- V1 is configured to use PGN 64931 (0xFDA3) as Inputs Position Command, and
- V1 is configured to use PGN 64931 (0xFDA3) as Outputs of Actual Position, and
- V2 is configured to use PGN 64931 (0xFDA3) for Inputs Position Command.

## Regulatory Compliance

### European Compliance for CE Marking:

These listings apply to stationary industrial markets only and are limited only to those units bearing the CE Marking.

**EMC Directive:** Declared to 2004/108/EC COUNCIL DIRECTIVE of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and all applicable amendments.

### Other European and International Compliance:

Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking. These listings only apply to stationary industrial markets.

**Machinery Directive:** Compliant as a component with 98/37/EC COUNCIL DIRECTIVE of 23 July 1998 on the approximation of the laws of the Member States relating to machinery.

### Pressure Equipment

**Directive:** Exempt per Article 1-3.10

### Other International Compliance:

These listings are limited only to those units bearing the appropriate marking. These listings only apply to vehicular markets.

**UNECE:** Type approved to UNECE Regulations 67 and 110.

### North American Compliance:

These listings are limited only to those units bearing the CSA identification.

**CSA:** CSA Certified for Class I, Division 2, Groups A, B, C, & D, T3 at 105 °C Ambient for use in Canada and the United States.  
Certificate 1975931  
Type 3R Enclosure Rainproof

This product is certified as a component for use in other equipment. The final combination is subject to acceptance by the authority having jurisdiction or local inspection.

Wiring must be in accordance with North American Class I, Division 2, or European Zone 2, Category 3 wiring methods, as applicable, and in accordance with the authority having jurisdiction.

**Special Conditions for Safe Use:**

Field Wiring must be suitable for at least 105 °C.

The Ingress Protection rating of the control depends on the use of proper mating connectors. Refer to Table 3-1 in the Installation section of this manual for information on the proper mating connectors for use with this control.

**WARNING**

**EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.**

**Substitution of components may impair suitability for Class I, Division 2.**

**Do not clean equipment unless power has been switched off or the area is known to be non-hazardous.**

**AVERTISSEMENT**

**RISQUE D'EXPLOSION—Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous vous situez bien dans une zone non explosive.**

**La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2.**

**Ne pas nettoyer l'équipement sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous vous situez bien dans une zone non explosive.**

# Chapter 1.

## General Information

### Purpose and Scope

The purpose of this manual is to provide the necessary background information for applying the F-Series actuator to reciprocating engines. Topics covered include mechanical installation, electrical wiring, software programming, and troubleshooting. While this manual is primarily targeted at original equipment manufacturer (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 operation of the complete engine system. For engine or plant operating instruction, contact the plant-equipment manufacturer.

This revision of the manual applies to 23-pin versions of the F-Series position control models with software 5418-2724 (FSTP), 5418-2725 (Actr), 5418-3834 (FSTP), 5418-3055 (FSTP), and 5418-3056 (Actr), 5418-7289, 5418-9520 or newer. Available functionality varies between software versions. The software version can be identified on the Service Tool by selecting Communications under the Device menu (Application ID).

Note: Firmwares 5418-3834, 5418-7289, 5418-9520 are proprietary. Some features perform differently than documented here.

### How to Use This Manual

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

- Unpack and inspect the hardware.
- Mount and wire the hardware following the procedures and recommendations in Chapters 2 & 3.
- Description of operation is provided in Chapter 4.
- Use the service tool to configure and setup the control following the procedures and recommendations in Chapters 5 and 6.
- Troubleshooting guidelines are provided in Chapter 7.
- Specifications are provided in Appendix B.

### Intended Applications

The F-Series actuator is intended to be mounted on-engine for use in various industrial applications, including, but not limited to, stationary generator sets, gas compressors, and on-highway industrial gas, gasoline or diesel reciprocating engines. The device is effectively a positioner that accepts a desired position signal from another device in the system, such as a speed control, and drives to that position. Key environmental characteristics of these applications include extended industrial operating temperatures (–40 °C to +105 °C/–40 °F to +221 °F), Industrial EMC Requirements, electrical transient response and stability and lower operating voltages (12/24 V).

## Introduction

The F-Series actuator is a modular electric actuator or an actuator with an integrated throttle body (ITB). There are currently three (3) types available:

- F-Series Throttle (FST)—*not covered in this manual*
- F-Series Throttle Plus (FSTP)
- F-Series Modular Actuator

The F-Series Throttle (FST) has a 14-pin connector and only accepts a PWM (pulse-width modulated) position demand. For additional information on the FST version, see Woodward manual 26355.

The F-Series Throttle Plus (FSTP) and Modular Actuators have 23-pin connectors and accept PWM, CAN, 0 V to 5 V, or 4 mA to 20 mA position demands. CAN communication is available in the FSTP and Modular Actuator versions.

The position demand signals are issued by the appropriate supervisory engine management system. The F-Series actuator must be set up properly in hardware and software to expect the correct signal for the application.

The F-Series drives the 0–70 degree output shaft to the demanded position based on an internal shaft position sensor. The high-efficiency torque motor delivers a net 1.36 N·m (1.0 lb-ft) steady-state torque output and a net 2.71 N·m (2 lb-ft) transient torque output over the 70° travel range. See the specifications in Appendix B for further details.

The F-Series integrated throttle body (ITB) types are available in 33, 48, 60, 68, and 75 mm bore sizes for a variety of air and fuel throttling applications. The ITB is designed to operate on air and gases ranging from pipeline quality natural gas to specialty gas (such as landfill, digester, or other biogases). The 33 and 48 mm ITBs are rated at 80 psia maximum working pressure (MWP). The 60, 68, and 75 mm ITBs are rated at 50 psia MWP. See the specifications in Appendix B for further details.

The flow output of the ITB is a function of throttle position. The actuator and throttle position respond proportionally to the position demand input. An optional non-linear position demand curve can be configured for a non-linear position demand versus position demand response. When the optional non-linear position demand curve is configured, the throttle position signal (TPS) is corrected to account for the effect of the curve, so that the TPS should still normally match the position demand input.

A sight cover is provided over the slotted throttle shaft end to view the actual throttle position. The slot in the end of the shaft is in line with the throttle plate and indicates the plate's angular position. Note that the throttle plate is 15 degrees off of horizontal (flange plane) when fully closed. Therefore the slot in the shaft will also be at about 15 degrees off of horizontal when the valve is fully closed.



### **WARNING**

**When included with an ITB, the actuator depends solely upon the return spring inside the throttle body assembly to drive toward minimum position when not powered. Therefore, other positive shutdown devices like fuel shut-off solenoids are recommended to ensure shutdown upon loss of signal to the control system. Also, separate overspeed trip devices are always mandatory.**

The F-Series actuator requires a power supply of 10 V to 32 V (dc). The supply must be capable of providing a sustained 24 W during steady-state (4 A at coil) operation and 98 W instantaneous during transients (8 A at coil) for at least 200 ms.

For monitoring or feed-forward control, the F-Series actuator provides a configurable 0 V to 5 V (dc) position feedback output signal proportional to a 0 % to 100 % shaft position. The position output signal will be equal to measured position within 1 % of full stroke after all effects and over the entire operating temperature range. When a demand curve is configured, the position output signal will be proportional to the demanded position rather than actual position.

For status purposes, a relay driver output is provided that changes state whenever the F-Series control detects a configured fault or error condition.

### ITB Flow Coefficient (Cv) and Sizing Equation

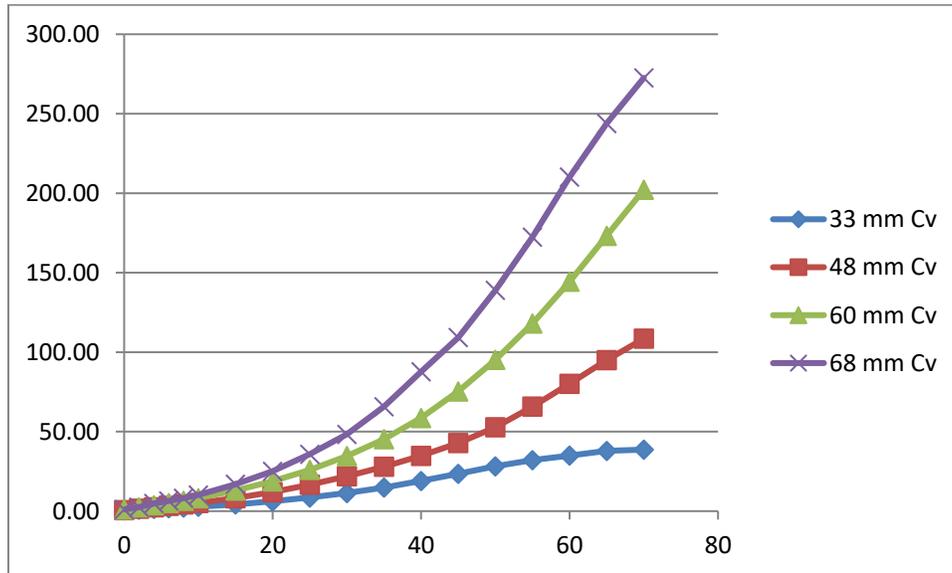


Figure 1-1. F-Series ITB Flow Coefficient (Cv) Curves

Cv (Flow Coefficient)				
Position (Deg)	33 mm Cv	48 mm Cv	60 mm Cv	68 mm Cv
0	0.55	0.65	1.08	1.08
2	0.95	1.54	2.43	2.51
4	1.39	2.44	3.78	4.82
6	1.85	3.35	5.11	6.43
8	2.28	4.22	6.54	8.16
10	2.78	5.15	8.16	10.2
15	4.23	8.18	12.99	16.94
20	6.18	12	18.77	25.11
25	8.57	16.64	25.94	35.8
30	11.39	21.95	34.67	48.31
35	14.85	27.96	45.24	65.7
40	18.98	34.82	58.62	87.71
45	23.49	42.86	75.33	109.22
50	28.20	52.76	95.19	138.93
55	32.10	65.75	118.06	172.42
60	34.97	80.12	144.36	210.18
65	37.88	94.99	173.22	243.87
70	38.67	108.5	202.19	272.55

Table 1-1. F-Series ITB Flow Coefficient (Cv) Table

F-Series ITB valve size can be determined by using the following equation:

$$C_v := \frac{Q \cdot 0.00976}{P_1 \cdot S_g} \cdot \sqrt{\frac{(T + 460) \cdot P_1 \cdot S_g}{P_1 - P_2}}$$

where:

- Cv = Flow Coefficient
- Q = Mass Flow (PPH [pounds/hour]) [1 pound = 0.45 kg]
- Sg = Specific Gravity of Gas (use 1.0 for air)
- T1 = Upstream Gas Temperature (°F) [°F = 1.8 \* °C +32]
- P1 = Inlet Pressure (psia) [1 psi = 6.895 kPa = 0.06895 bar]
- P2 = Downstream Pressure (psia)

**NOTE**—P2 must be greater than 0.528 \* P1 or flow becomes choked. If P2 is less than 0.528 \* P1, then use P2= 0.528 \* P1.

To properly size the ITB, the Cv (flow coefficient) should be calculated for the minimum and maximum flows expected (at 50 degrees) on the application.

## Programmable Features

Control setup is accomplished through the use of a PC (personal computer), Woodward Service Tool software, and a programming harness. All F-Series actuators are provided pre-configured with default settings and may not require additional setup. The features identified below are described in Chapters 5 and 6. Some features are not included with certain models. Briefly, the programmable features include:

- **Configure General Setup** (*modular actuator only*)
  - Shaft Direction of Rotation (CW or CCW)
  - Shutdown Direction (Min % or Max %)
  - Dynamics Setting (Inertia)
  - Holding Current (Min Amps & Max Amps)
- **Configure Position Demand**
  - Position Demand Input Source (PWM, CAN, or Analog)
  - Use Position Demand Filter
  - Position Demand Filter Cutoff Frequency (Hz)
- **Configure PWM Input**
  - PWM Duty Cycle Max & Min Input (%)
  - PWM Output at Max & Min Input (%)
  - PWM Fault Settings (Duty Cycle Low & High Thresholds) (%)
- **Configure Analog Input**
  - Analog Input Type (0 V to 5 V [dc] or 4 mA to 20 mA)
  - Analog Current Min & Max Input (mA)
  - AI Signal at Min & Max Current Input (%)
  - Analog Current Fault Settings (Current Low & High Thresholds)
  - Analog Voltage Min & Max Input (V [dc])
  - AI Signal at Min & Max Voltage Input (%)
  - Analog Voltage Fault Settings (Voltage Low & High Thresholds)
- Analog Demand is not available in firmware 5418-9520.
- **Configure CAN Input**
  - CAN Protocol used (CANopen, J1939)
  - CAN Demand Timeout
  - CANopen Settings (Baud, Heartbeat, Node Id)
- **Configure J1939**
  - Messaging (Legacy vs configurable)
  - Source Address and identity information
  - Diagnostics Support selection
  - PGN and SPN settings
  - Message configuration (start bit, priority, rate)

- **Configure Position Demand Curve**
  - Use Position Demand Curve
  - Position Demand In (% at 5 Breakpoints)
  - Position Demand Output (% at 5 Breakpoints)
- **Configure Analog Output**
  - Analog Output Min & Max Input (%)
  - Analog Output at Min & Max Input (V [dc])
- **Configure Discrete Inputs**
  - Run Enable Input selection (Not Used, Discrete Input, CAN)
  - Run Enable Input settings (Active Low/Open)
  - CAN ID High and Low input selection
  - CAN ID High and Low settings (Active Low/Open)
- **Configure Discrete Output**
  - Status Discrete Output (Always off, Normally On, Normally Off)
  - Status Output (up to 23 Fault Selections)
- **Configure Alarms & Shutdowns**
  - Latching or Non-Latching Fault Indication
  - Up to 17 Fault Selections as Used or Not Used
  - Up to 17 Fault Selections as Alarm or Shutdown
- **Configure Input Voltage**
  - Supply Voltage Fault Settings (Voltage Low & High Thresholds)
- **Configure Return Spring Check Settings**
  - Use Spring Check Function
  - Start Position (%)
  - Finish Position (%)
  - Max Start-to-Finish Position Time (sec)
  - Active Demand Threshold (%)
- **Position Setup** (*modular actuator only*)
  - Position Control
    - Disable Auto Control
    - Enable Manual Control
    - Manual Setpoint
  - Auto Inertia Test
  - Inertia Setting
  - Auto Find Mechanical Stops
  - Electrical Stop Settings
    - Span
    - Min Position Offset
  - Save Position Settings

## Service Tool Software

The F-Series Service Tool software is a Microsoft Windows based GUI (graphic user interface) used to configure and troubleshoot the F-Series actuator. The Service Tool Software is compatible with Microsoft Windows® 7, Vista, XP

(32- and 64-bit) and gives the OEM the ability to:

- Configure control settings based on application requirements
- Dynamic tuning
- Create configuration files for downloading into multiple controls
- Download configuration files
- Upload control configuration settings to a file
- Extract and view fault codes for field diagnosis
- View and trend control operating parameters
- Trend values and save the data points to a file

Detailed descriptions of software installation are available in Chapter 5.



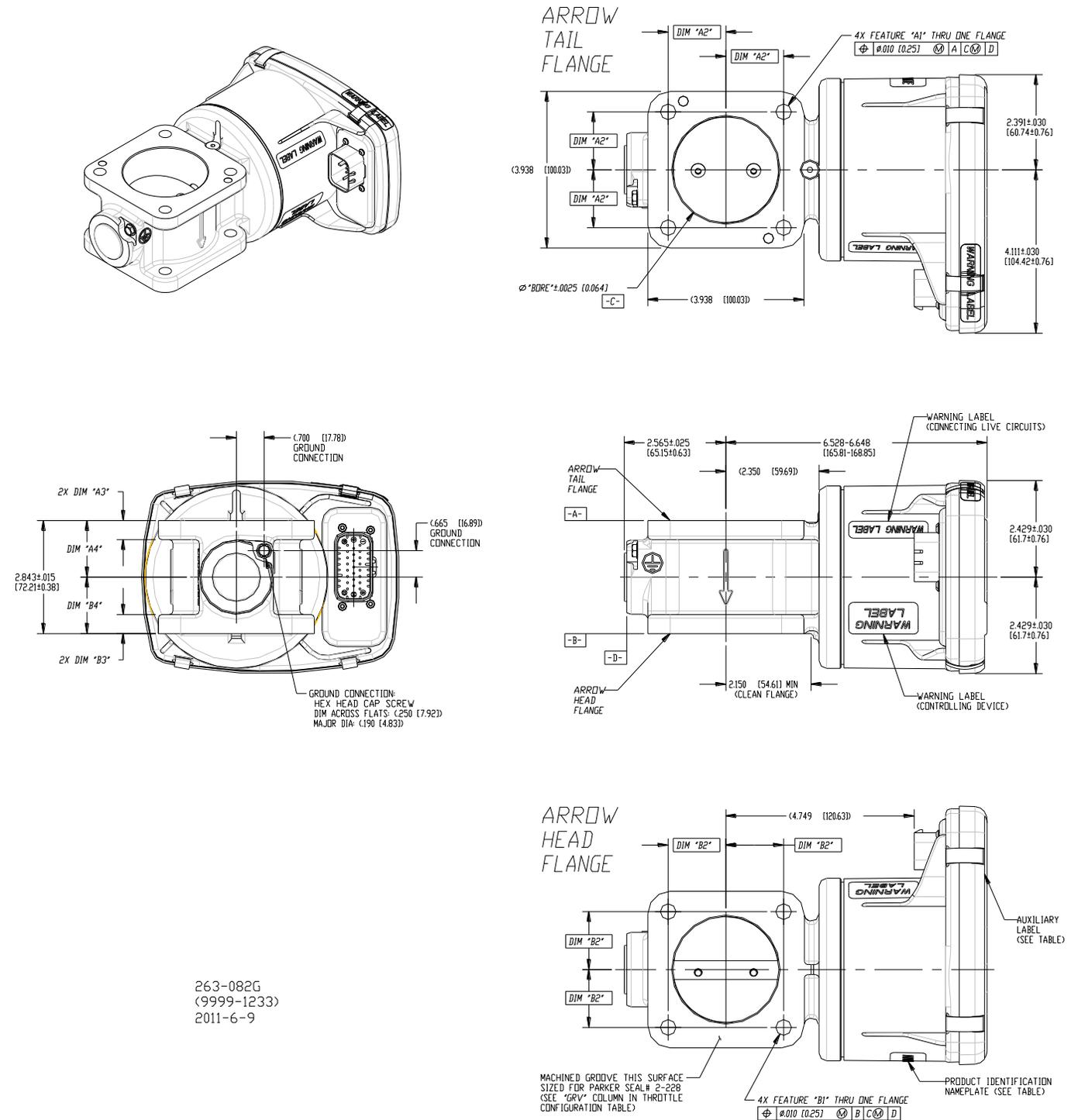


Figure 1-3a. F-Series ITB Outline Drawing

THROTTLE OPTION DETAILS												
THROTTLE OPTION	BORE	DETAILS -- ARROW TAIL FLANGE			A4	DETAILS -- ARROW HEAD FLANGE			B3	B4	GRV	THROTTLE DESCRIPTION (REFERENCE)
		A1	A2	A3		B1	B2	B3				
48/STD	1.8900 [48.006]	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	48 MM BORE, THRU ØS FOR .375 SCREWS	
48/M08	1.8900 [48.006]	Ø354±.010 [8.99±0.25]	1.339 [34.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø354±.010 [8.99±0.25]	1.339 [34.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	YES	48 MM BORE, THRU ØS FOR M8 SCREWS, GROOVE USES PARKER 2-228	
60/STD	2.3625 [60.008]	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	60 MM BORE, THRU ØS FOR .375 SCREWS	
60/JADE	2.3625 [60.008]	Ø354±.010 [8.99±0.25]	1.535 [38.99]	.425±.060 [10.8±.152]	(1.3665 [34.709])	M8X1.25 THD [METRIC]	1.457 [37.0]	.535±.060 [13.59±.152]	(1.4765 [37.503])	NO	60 MM BORE, THRU/THD'D ØS FOR M8 SCREWS	
60/M10	2.6800 [68.072]	Ø453±.010 [11.5]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø453±.010 [11.5]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	60 MM BORE, THRU ØS FOR M10 SCREWS	
68/STD	2.6800 [68.072]	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	68 MM BORE, THRU ØS FOR .375 SCREWS	
68/M10	2.6800 [68.072]	Ø453±.010 [11.5]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø453±.010 [11.5]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	68 MM BORE, THRU ØS FOR M10 SCREWS	
33/STD	1.299 [32.995]	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	33 MM BORE, THRU ØS FOR .375 SCREWS	
75/STD	2.952 [74.981]	Ø413±.010 [10.49±0.25]	1.875 [47.62]	.480±.060 [12.19±.152]	(1.813 [46.050])	Ø413±.010 [10.49±0.25]	1.875 [47.62]	.480±.060 [12.19±.152]	(1.813 [46.050])	NO	75 MM BORE, THRU ØS FOR .375 SCREWS	
60/SLOT	2.3625 [60.008]	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø515 X .375 SLOT	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	60 MM BORE, SLOT ON ARROW HEAD FLANGE.	
68/SLOT	2.6800 [68.072]	Ø515 X .375 SLOT	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	68 MM BORE, SLOT ON ARROW TAIL FLANGE.	
60/SLOT	2.3625 [60.008]	Ø515 X .375 SLOT	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	Ø394±.010 [10.0]±0.25	1.457 [37.0]	.480±.060 [12.19±.152]	(1.4215 [36.106])	NO	60 MM BORE, SLOT ON ARROW TAIL FLANGE.	

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(999-1233)  
2011-5-31

Figure 1-3b. F-Series ITB Throttle Options

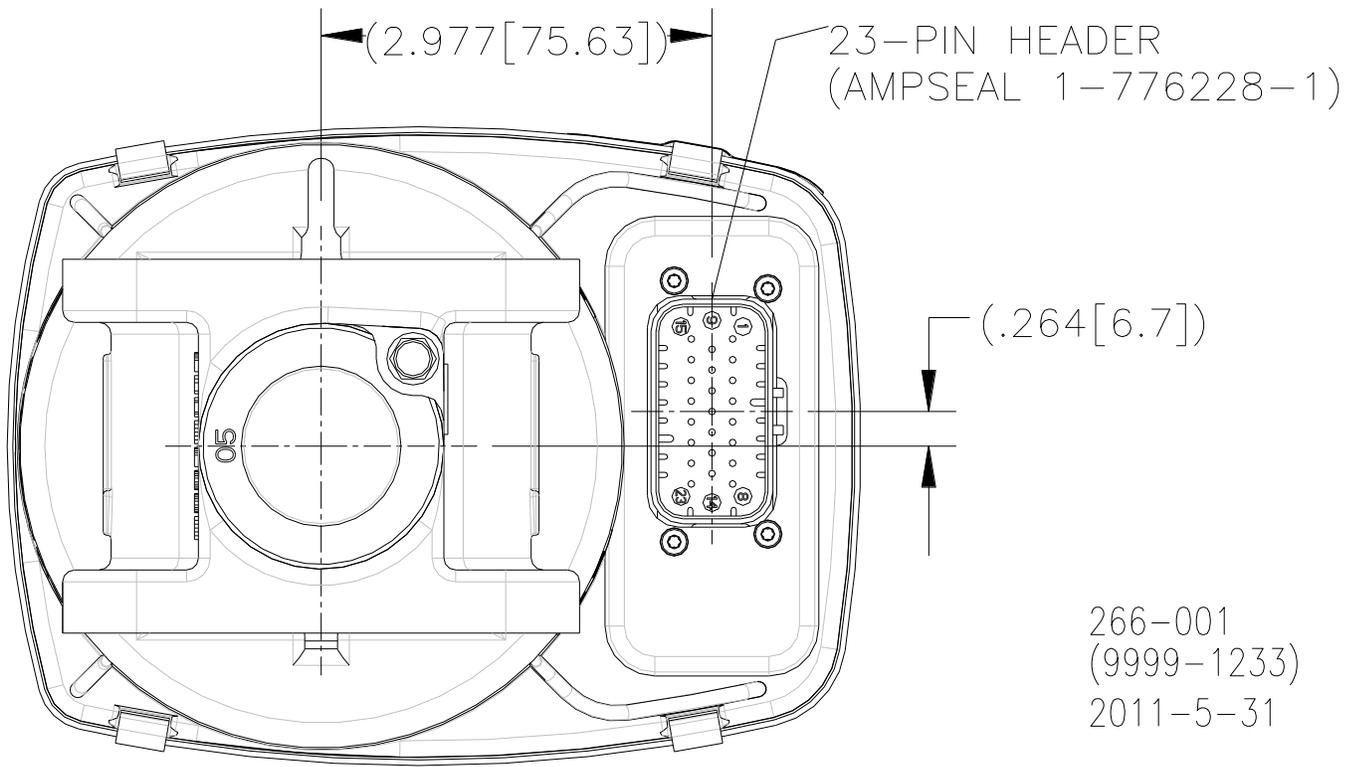
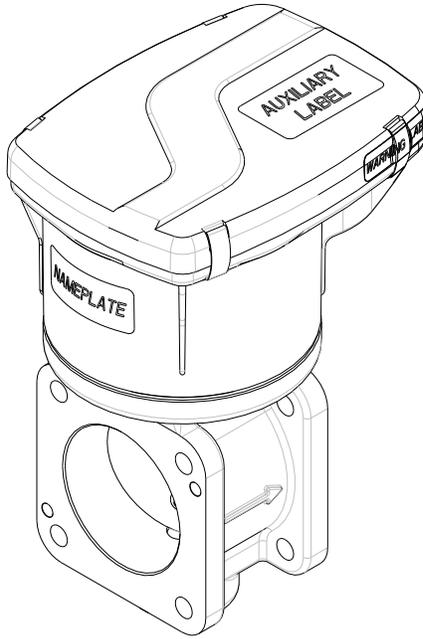


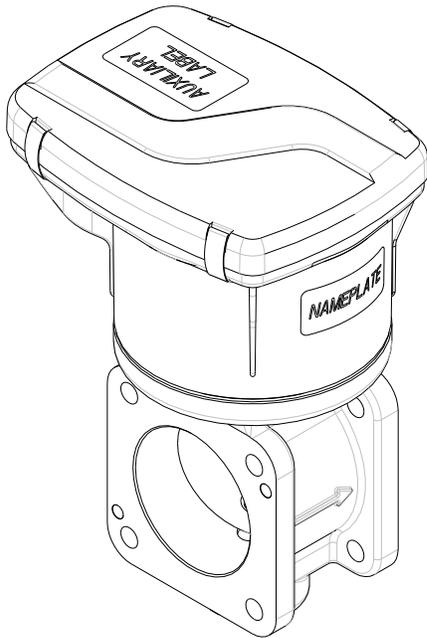
Figure 1-4. 23-Pin Electrical Connector



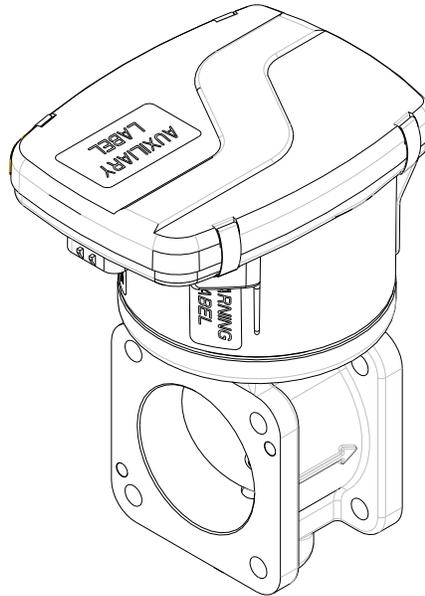
CONNECTOR PLAN A



CONNECTOR PLAN B



CONNECTOR PLAN C



CONNECTOR PLAN D

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Figure 1-5. Electrical Connector Orientation Options

## Chapter 2. Mechanical Installation

### Introduction

This chapter provides instructions on how to mount and connect the F-Series modular actuator and ITB into a system. Hardware dimensions are provided to mount the device for specific 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.

#### **CAUTION**

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

#### **CAUTION**

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.

### General Installation, Operation Notes and Requirements

Always make sure the application includes a primary overspeed protection device. Any overspeed detection that might be included, as part of the F-Series actuator design, must be considered a secondary backup only.

#### **WARNING**

Use of 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.

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. A separate overspeed trip device is always mandatory.

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.

Do not remove clips on cover. The unit contains no user-serviceable parts. Warranty void if clips are removed.

### Unpacking

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. Notify the shipper and Woodward if damage is found.

## Mechanical Installation

### Mounting Location

Locate the F-Series actuator away from sources of extreme radiant heat, such as exhaust manifolds or turbochargers. The operating temperature range of the control is  $-40\text{ }^{\circ}\text{C}$  to  $+105\text{ }^{\circ}\text{C}$  ( $-40\text{ }^{\circ}\text{F}$  to  $+221\text{ }^{\circ}\text{F}$ ). In spark-ignition applications, locate the F-Series actuator away from the ignition coils and leads, and do not route the actuator harness wires next to the spark plug wires.

As shown in the specifications, Appendix B, the F-Series actuator has 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. Moreover, orienting the actuator shaft parallel to the crankshaft of the engine, when possible, often reduces the vibration load on the actuator's rotor system.

### Mounting Orientation

The F-Series actuator may be mounted on-engine in any position. While it is not a requirement, it is good practice to orient the connector feature on the control in a horizontal or downward orientation to minimize fluid accumulation between the enclosure and the mating connector's gasket.

### Mounting the F-Series Actuator with an ITB

Typical mounting of actuators with Integrated Throttle Bodies (ITB) is accomplished by fastening the throttle to the inlet and outlet pipes. Ensure that the pipes can support the weight of the F-Series actuator and throttle body. A support bracket must be provided if the pipes do not provide adequate support.

The 33, 48, 60, 68, and 75 mm ITB sizes have two mounting flanges with four through holes each in a square pattern. Refer to the table in Figure 1-3b for the flange and bolt pattern dimensions and bolt diameters for the various ITB sizes.

Flange gaskets are not included with the Integrated Throttle Bodies (ITB) and these are not available from Woodward.

### F-Series Grounding

The F-Series 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  $< 30\text{ cm}$  (12 inches) in length,  $3\text{ mm}^2$  (12 AWG) minimum. See Figure 1-3a for ground screw location on the Actuator with ITB.

## Output Shaft

The F-Series actuator output shaft has 68° to 72° (nominal 70°) of available travel. In addition, the ITB versions incorporate the use of an internal return spring. Unless otherwise specified, the spring load drives the throttle plate to the closed position.

### **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 1800 degrees per second in both increase and decrease fuel directions under normal operating conditions. Exceeding the control input voltage requirements may cause a unit shutdown in which the actuator speed may exceed 1800 degrees per second.

## Chapter 3. Electrical Installation

### Introduction

This chapter provides instructions on how to connect the F-Series control into a system. Figure 3-1a shows typical control connections to external devices. Wiring pinouts, as viewed by looking into the F-Series control connector feature, are shown in Figure 3-1b.

The F-Series control has an operating voltage range of 10 V to 32 V (dc) with nominal voltages of 12 V or 24 V (dc). The power supply input is reverse polarity protected and consumes 24 W (0.75 A at 32 V [dc]) at maximum steady-state torque.

Typical max average current is 1 A at 24 V, and a max 2 A at 12 V. The application should be configured to turn on power to the actuator when the engine is first cranked.

#### **NOTICE**

**Do not remove or replace the actuator cover.**

### Shielded Wiring

Shielded wiring is generally not required. The use of cable with individually shielded-twisted pairs is only required where indicated by the control wiring diagram (Figure 3-1). However, some users may elect to run shielded wires for some I/O signals. Cable shields must be terminated as indicated in the control wiring diagram using the installation notes described below. DO NOT attempt to directly ground the shield at both ends since an undesired ground loop condition may occur.

#### 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 assure satisfactory operation of the product.

## Electrical Connections

### WARNING

**EXPLOSION HAZARD**—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2 or Zone 2.

Do not clean equipment unless power has been switched off or the area is known to be non-hazardous.

### WARNING

The Ingress Protection rating of the F-Series requires use of a proper mating connector. Refer to Table 3-1 for a list of proper mating connectors.

### 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 3-1).

### NOTICE

In order to ensure that the F-Series performance is not inhibited by ignition system noise, Woodward recommends that the F-Series housing and harness be kept at least 2 cm away from coil primary wires and 3 cm from high-voltage secondary leads/wires.

This recommendation assumes that the ignition system utilizes a resistive secondary (5 k $\Omega$  minimum) and a worst-case secondary voltage of 20 kV. In cases where the ignition does not utilize a resistive secondary or generates higher voltages, the distances may need to be increased in order to maintain compatibility.

### General

Prior to installation, refer to the wiring diagrams and the representative I/O interface schematics in this chapter.

Use 1 to 1.5 mm<sup>2</sup> (16 to 18 AWG) stranded copper wire with insulation meeting temperature requirements in the harness design. A wiring harness stress relief within 150 mm (6”) of the control’s connector is recommended.

Limit all I/O and signal lines to less than 30 m (98 ft) for Stationary Industrial EMC Compliance.

For the TPS output wiring, the (AGND) TPS– connection pin is internally connected to Input Power –. Therefore (AGND) TPS– should only be used when the users controller contains a differential input or isolated input. Otherwise a ground loop will exist, assuming the users controller power ground is common to the F-Series power ground (Input power –). If the TPS output is used with a Differential or Isolated input, the TPS– must be used or the system will not function. If TPS output is not used with an isolated or differential input on the users end (i.e. single ended), the return path is through the common system/power ground back to F-Series Input Power.

Dress the wiring harness with wire loom (or equal) to contain it in a single bundle. Use grommets when passing the harness through metal panels.

In spark-ignition engine applications, route the F-Series actuator harness wires away from the spark plug wires.

## Connector

The following AMP mating connector components (or equal) are needed for harness designs:

Description	AMP P/N	Woodward P/N
Mating Connector, 23-Pin	770680-1	1751-805
Gold Sockets for all Connectors	770854-3	1608-1044

Table 3-1. F-Series Mating Connector

## Description of Electrical I/O

Representative circuitry is shown for the F-Series actuator inputs/outputs in the figures in this chapter.

### Power Supply Input

Pin 1 = Input Power (+)

Pin 16 = Input Power (–)

The F-Series actuator requires a voltage source of 10 V to 32 V (dc), with a current capacity of at least 10 A. The actuator is functional in the range of 7 V to 32 V (dc), but for supply voltages < 10 V (dc), full steady state torque may not be available over the entire operating range. To withstand an engine start when control power is from the starting batteries, a control reset will not occur down to 6 V (dc). Input power failure diagnostics are provided based on software configuration.

Run the power leads directly from the power source to the control. Do not power other devices with leads common to the control (see Figures 3-2a and 3-2b). If the power source is a battery, be sure the system includes an alternator or other battery-charging device.

### **NOTICE**

**The input power must be fused. Failure to fuse the F-Series actuator could, under exceptional circumstances, lead to personal injury, damage to the control, and/or explosion.**

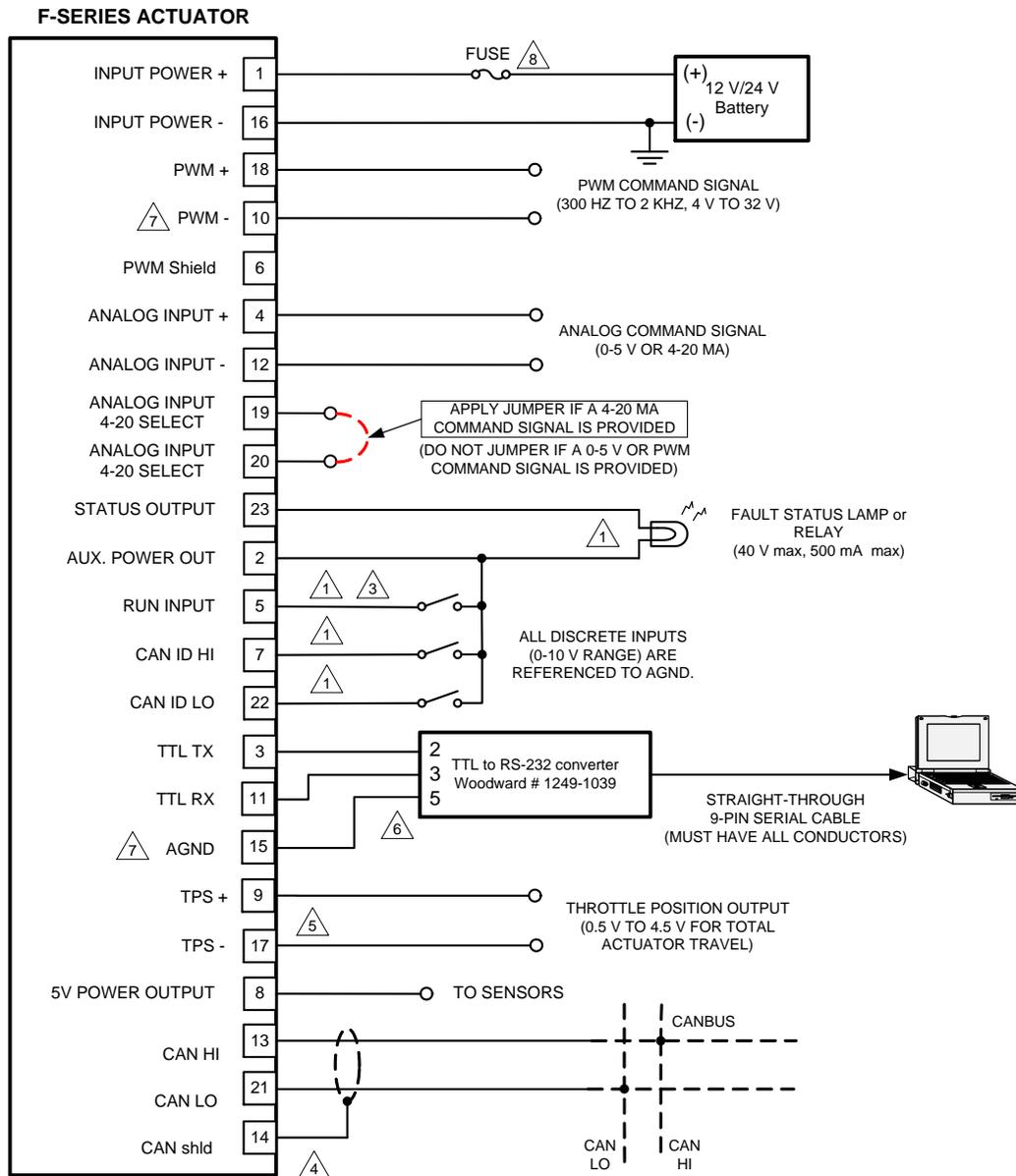


Figure 3-1a. Typical F-Series Actuator Control Wiring, 23-Pin Version

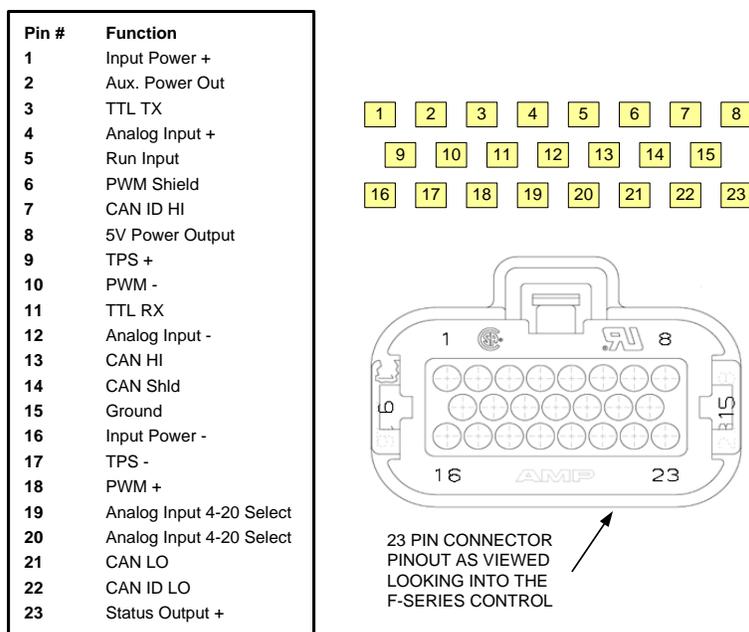


Figure 3-1b. 23-Pin Connector Pin Assignments

**IMPORTANT**

When wiring pins 15 & 17, be careful to ensure that the external circuit interface is isolated from battery ground, either by means of galvanic isolation or differential input/output.

If it is not, a ground loop could be formed that can cause excess noise on the lines and/or damage to circuits.

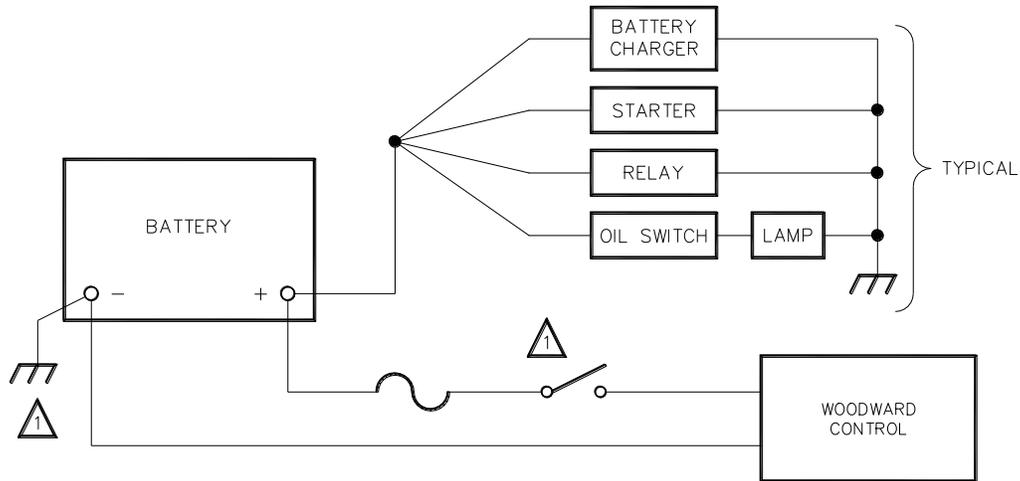
The power supply terminals are reverse polarity protected, and in the case that a reverse polarity condition exists, the F-Series actuator will not power-up and, if attached to a throttle body (ITB) with an internal return spring, will remain at the position dictated by the return spring.

Woodward recommends using a 9 A slow-blow fuse for 12 V applications and a 6 A slow-blow fuse for 24 V applications.

**IMPORTANT**

All connector pins are short-circuit protected to ground and power except pins 15 & 17, which are not protected against shorts to battery positive.

Installation of a fuse on the battery negative (B-) wire (pin 16) would provide protection to these pins but does not mean one is not needed in the power connection. Pin 1 (B+) still needs protection against a short to ground.

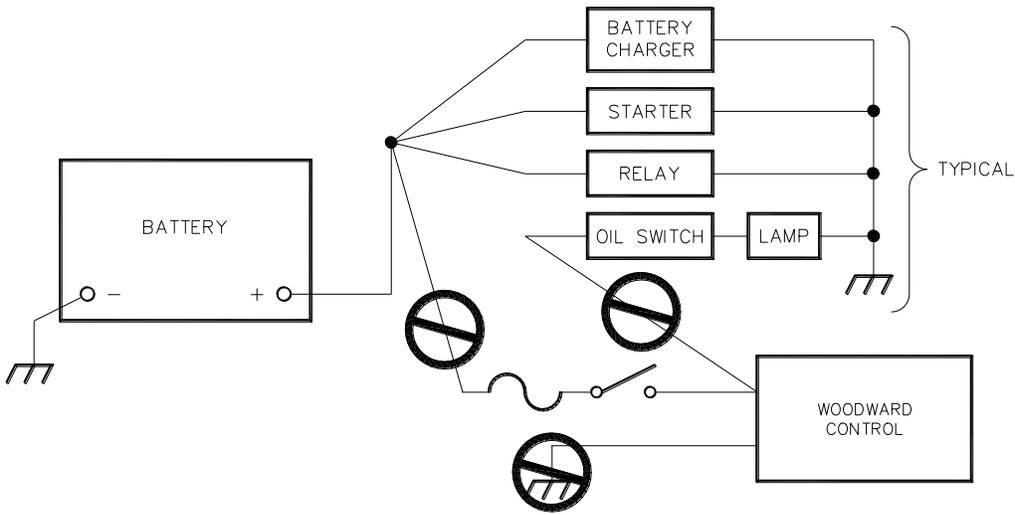


RIGHT

NOTE:

⚠ A NEGATIVE GROUND SYSTEM IS SHOWN. IF A POSITIVE GROUND SYSTEM IS USED, THE SWITCH AND FUSE MUST BE LOCATED IN SERIES WITH BATTERY (-) AND INPUT POWER (-) ON THE WOODWARD CONTROL. THE POSITIVE TERMINAL OF THE BATTERY BECOMES CHASSIS GROUND AND IS CONNECTED TO INPUT POWER (+) ON THE WOODWARD CONTROL.

Figure 3-2a. Correct Wiring to Power Supply



WRONG

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07-1-10

Figure 3-2b. Incorrect Power Supply Wiring

## Service Port

Pin 3 = TTL TX  
 Pin 8 = TTL RX  
 Pin 11 = TTL Ground (-)

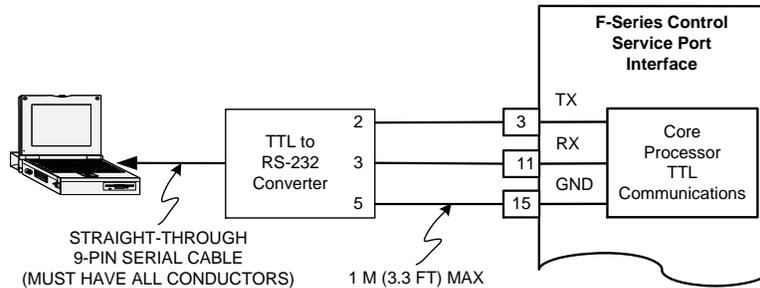


Figure 3-3. Service Port Interface

The RS-232 service port is used to configure, calibrate and trouble shoot the F-Series control. The F-Series Service Tool can be downloaded from the Internet at [www.woodward.com/software](http://www.woodward.com/software). The RS-232 wiring must meet the requirements in the EIA RS-232 Standard document.

An external TTL to RS-232 converter is necessary to make communications possible with the Woodward F-Series Service Tool. The converter must be located a maximum of 1 meter from the F-Series actuator. A connectivity kit can be purchased from Woodward to accomplish this. Further instructions for using this connectivity kit are provided in Chapter 5.

### **WARNING**

Additional voltage (approximate 0.3 V) can be observed on TPS Output when an un-powered device is connected to the PC via RS 232 interface. This situation can appear during cranking. Using an isolated RS-232 interface helps to avoid the error.

## PWM Demand Input

Pin 18 = PWM (+)

Pin 10 = PWM (-)

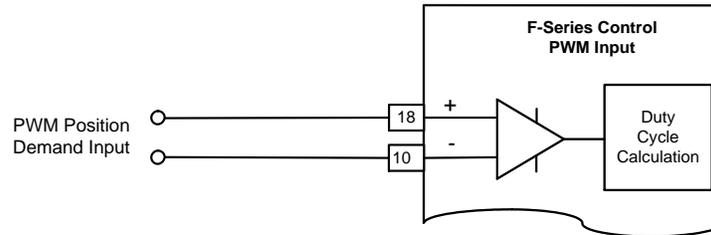


Figure 3-4. PWM Input

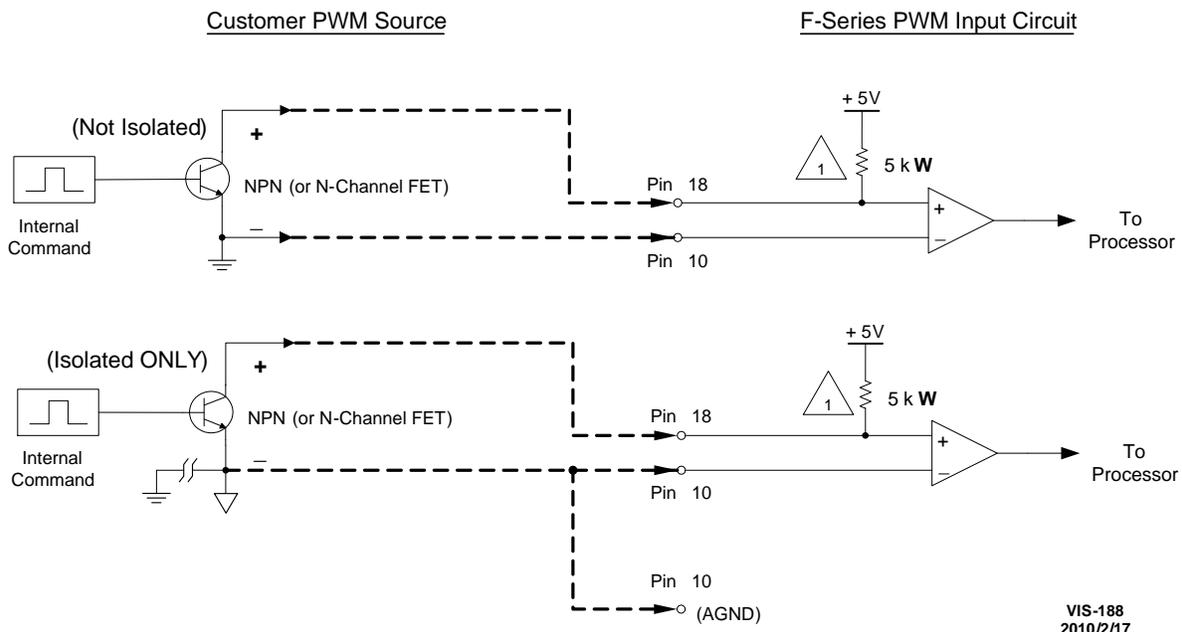
The PWM demand input is a differential type capable of handling low-side and push-pull style PWM sources. Pull-up level is 5 V through 4.99 k $\Omega$ . See Figure 3-6 for acceptable PWM input types.

This input will handle a PWM frequency range from 300 to 2000 Hz at amplitudes ranging from 4 to 32 V. Normal operating range is from 10 % to 90 % duty cycle, however these settings are configurable using the service tool.

**IMPORTANT**

The PWM demand input can be configured to handle a high-side PWM source when an additional Flo-Tech-to-F-Series adapter cable is used. The adapter cable part number can be found in application note 51305.

### Low - Side Open - Collector ( open - drain ) PWM Source



**NOTES:**

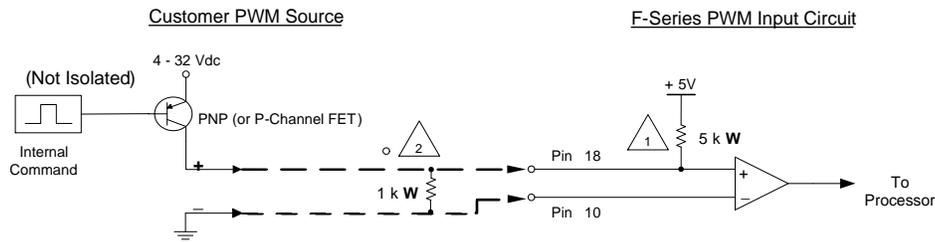


This resistor is present in all F-Series versions. It must be taken into consideration when selecting an external pull-up or pull-down resistor to ensure that the PWM signal passes through the detection threshold

Figure 3-5a. Acceptable PWM Input Types

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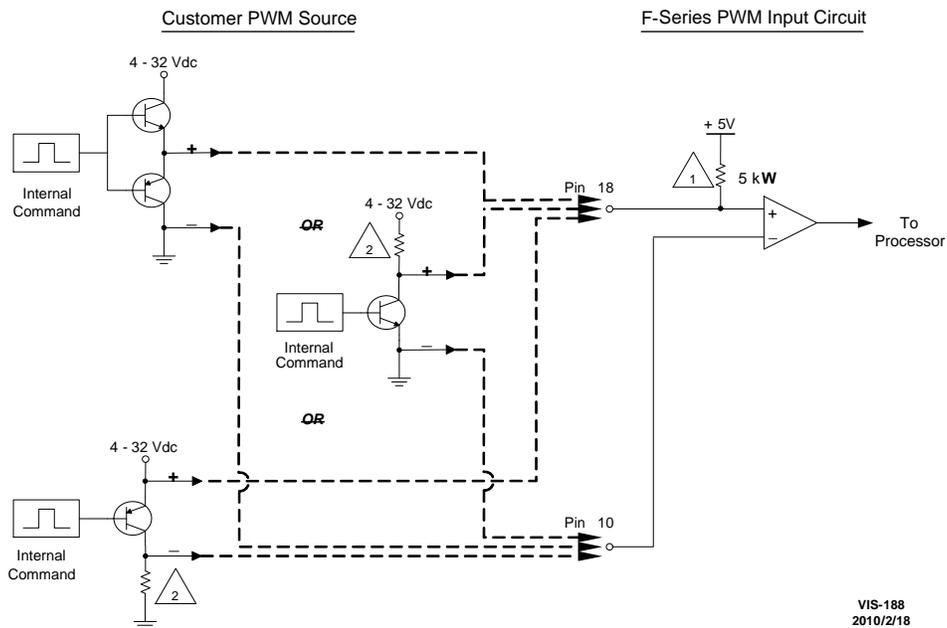
## High-Side PWM Source



### NOTES:

- △ 1 This resistor is present in all F-Series versions. It must be taken into consideration when selecting an external pull-up or pull-down resistor to ensure that the PWM signal passes through the detection threshold.
- △ 2 This resistor is supplied by the customer. It is NOT internal to the F-Series.

## Push-Pull PWM Source (three variations)



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### NOTES:

- △ 1 This resistor is present in all F-Series versions. It must be taken into consideration when selecting an external pull-up or pull-down resistor to ensure that the PWM signal passes through the detection threshold.
- △ 2 This resistor is supplied by the customer to complete the push-pull source externally. It is NOT internal to the F-Series actuator.

Figure 3-5b. Acceptable PWM Input Types

## TPS Output

Pin 9 = TPS (+)  
Pin 17 = TPS (-)

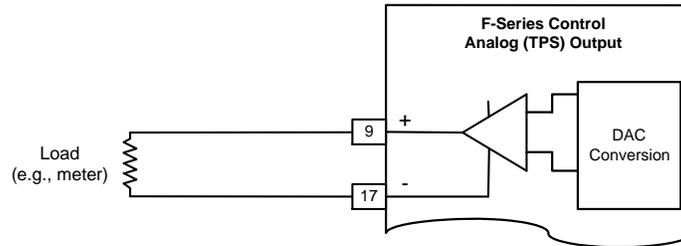


Figure 3-6. Analog (TPS) Output

The F-Series actuator provides a 0 V to 5 V (dc) output signal representing the actual shaft rotational position (Throttle Position Signal). The position output scaling is configurable. Default scaling is for a 0.5 V to 4.5 V (dc) output with a 0 % to 100 % shaft rotation. The position output will be equal to the measured position within 1 % and is updated at least every 10 ms. However, when the optional non-linear position demand curve is configured, the TPS is corrected to account for the effect of the curve, so that the TPS should still normally match the position demand input. In this case the TPS signal will be proportional to the position demand rather than the actual shaft rotational position.

### **! WARNING**

Do not try to inject signals into the TPS output, as it will negatively impact the performance of the F-Series actuator. This output is intended to be used with a high impedance device, such as a voltmeter. Do not tie TPS (+) directly to battery or ground. If the application does not use this output, leave it open.

### **! WARNING**

It is recommended that the TPS output be used to externally verify that the position command and subsequent actual position matches the command signal sent. In addition to a positioning error validation, the TPS signal should be monitored to detect out-of-range errors on the TPS output. Failure to comply with this recommendation can result in undetected system faults, and in extreme cases, can cause personal injury and/or property damage.

## 5 V Power Output

Pin 8 = +5 V Power Output  
Pin 16 = Return (-)

A +5 V (dc) output is provided on the F-Series actuator to power external sensors, if necessary. The 5 V output is limited to 30 mA, which is sufficient for most light-duty sensors. The tolerance of the 5 V output is  $\pm 0.5$  % of full scale.

## Analog Input

Pin 4 = Analog Input (+)

Pin 12 = Analog Input (-)

Pins 19 & 20 = Analog Input 4 mA to 20 mA Select

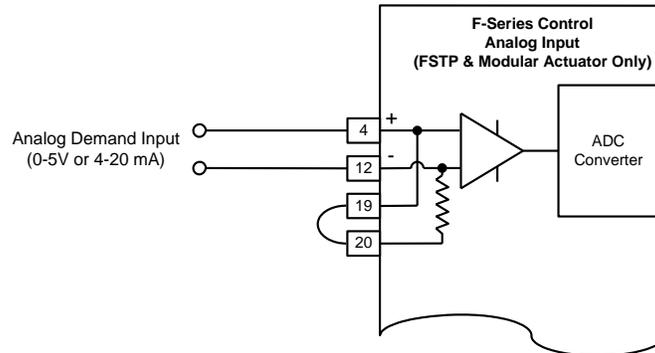


Figure 3-7. Analog Input

The Analog input can be configured for use as a 4 mA to 20 mA or 0 V to 5 V (dc) position demand input. The hardware must be configured for either a 4 mA to 20 mA or 0 V to 5 V (dc) analog input type.

Note: Analog Demand is not available in firmware 5418-9520.

### IMPORTANT

The FSTP F-Series can be configured to accept a 0 mA to 200 mA analog input signal. The 0 mA to 200 mA input capability is only available when a Flo-Tech-to-F-Series adapter cable (as called out in application note 51305) is used. The resistors in the adapter cable will convert the 0 mA to 200 mA signal to a 0 V to 5 V input that the F-Series will respond to. The F-Series should be set up in the 0 V to 5 V mode as described below.

#### Mode: 0 to 5 V

If the input is used with a 0 V to 5 V position demand, connect a voltage source between pins 4 and 12. Make sure that there is no connection between pins 19 and 20. The signal at pin 4 must be more positive than the signal at pin 12 for proper operation.

#### Mode: 4 to 20 mA

If the input is used with a 4 mA to 20 mA position demand, connect a current source between pins 4 and 12. Make sure that pins 19 and 20 are connected as close as possible to the connector. The signal at pin 4 must be more positive than the signal at pin 12.

Analog Input failure diagnostics are provided based on software configuration.

## Aux Power Out

Pin 2 = Aux Power Output (+) Internal Return

An auxiliary power output is provided for powering the discrete input High Side Switch contacts and the discrete output load. This output is basically a surge-suppressed version of the Input Power (+). Woodward highly recommends using this output to power all discrete input contacts and the discrete output load since this output is clamped. The discrete inputs are not rated for battery surge.

## Discrete Inputs

Pin 5 = Discrete Input 1 (Run Enable Input or Not Used)  
 Pin 7 = Discrete input 2 (CAN ID HI or LO)  
 Pin 22 = Discrete input 3 (CAN ID HI or LO)  
 Pin 2 = Aux Power (clamped positive supply for High Side Switch)  
 Pin 15 = Ground (for Low Side Switch)

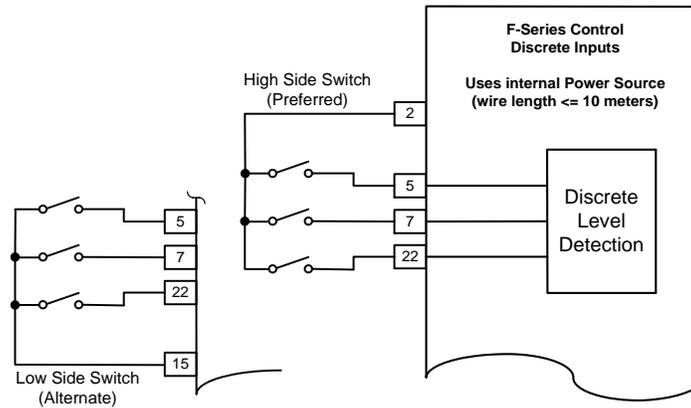


Figure 3-8. Discrete Inputs

The discrete inputs are used to control the behavior of the F-Series actuator from a control panel or other supervisory control system. There are three discrete inputs on the F-Series control. The input functions are dedicated as listed above.

All three discrete inputs are the same electrical circuits. The Run Enable discrete input can be configured in the software for a high side 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 Aux Power pin (supply plus) of the F-Series actuator. The high side switch configuration is preferred.

### Low Side Switch

If used as a low side switch, the switch contact must be connected to the discrete input pin and to the Ground pin of the F-Series actuator.

### 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 can be used for situations where it is safer to make the function active if the wire is broken, or disconnected.

## Run Input

Pin 5 = Discrete input 1 (Run Enable Input)  
 Pin 2 = High Side Switch Source  
 Pin 15 = Low Side Switch

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. This mode provides for minimal power consumption of the device.

The Run Input can also be configured as 'Not Used' or CAN Input. With either of these configurations, the Run Input wiring is not needed. If configured for use as a discrete input, the Run Input must be active to run the actuator.

## CAN ID Inputs

Pin 7 = Discrete input 2 (configurable as CAN ID High or Low)  
 Pin 22 = Discrete input 3 (configurable as CAN ID High or Low)  
 Pin 2 = High Side Switch Source  
 Pin 15 = Low Side Switch

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 F-Series is used on an engine. If one F-Series valve is replaced with another, the new valve will read the correct ID number from the engine harness connector.

Up to four F-Series controls can be on the same CANbus, however, each must have a different device address. The CAN device address is based on the selected F-Series Unit Number (1-4) which is determined on power-up by the states of the CAN ID discrete inputs (see Table 3-2). The TRUE/FALSE state is based on the control's configuration settings (see Table 3-3).

F-Series Unit 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 3-2. F-Series Control CAN Address

F-Series Control 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 3-3. Discrete In Configuration Logic

**IMPORTANT**

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

## CAN Communication

Pin 13 = CAN HI  
 Pin 21 = CAN LO  
 Pin 14 = CAN Shield

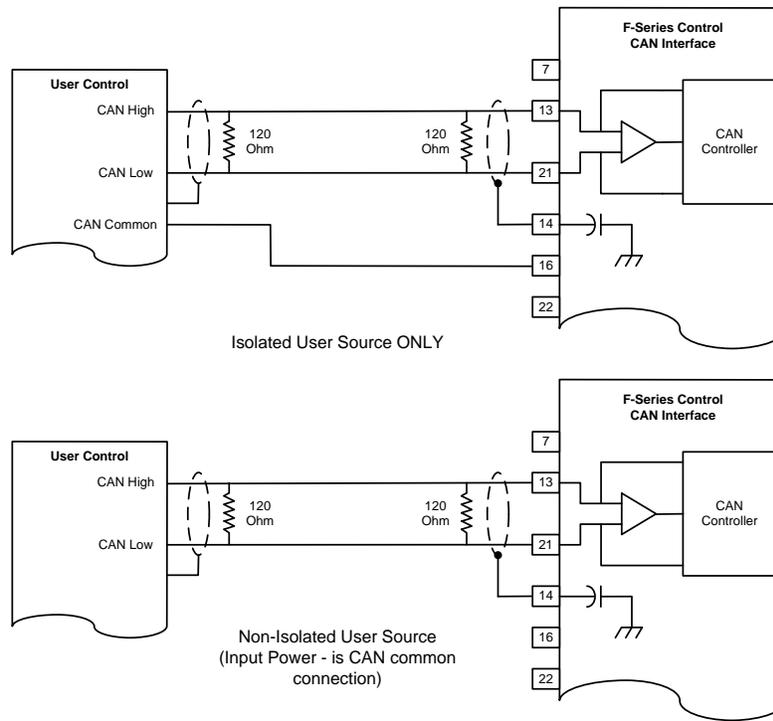


Figure 3-9. CAN Communication

The CAN (Control Area Network) communication link is used for supervisory control and monitoring of the actuator position and for possible I/O expansion.

The use of CANbus cable that meets SAE J1939 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 F-Series 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 3-7).

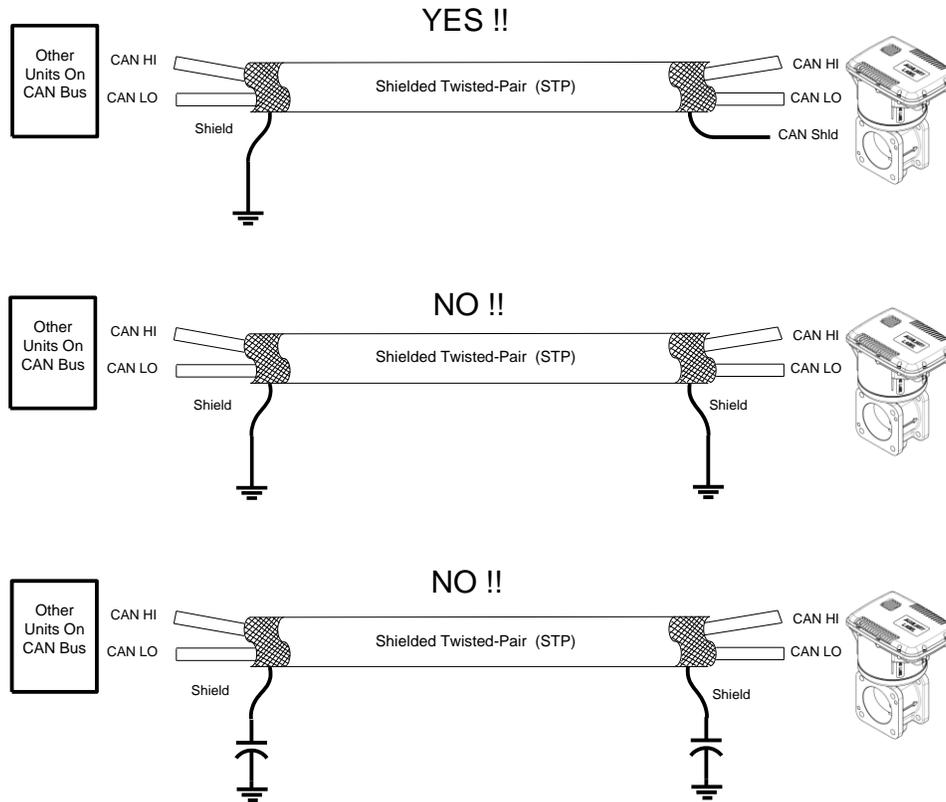


Figure 3-10. CAN Shielded Wiring

**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

**Status Output**

Pin 23 = Status Output +  
 Pin 2 = Aux Power Output (+)  
 Pin 16 = Negative Power Input

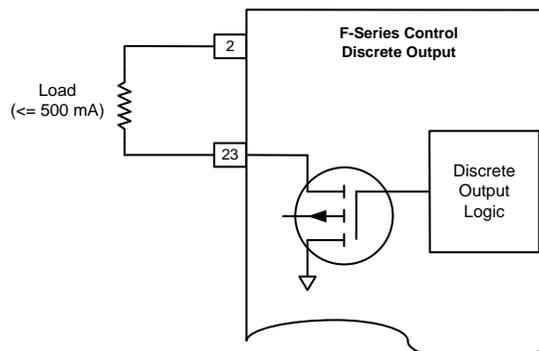


Figure 3-11. Status Discrete Output

The Status Output is a discrete output that changes state when a configured fault occurs and can provide a status indication to a control system or an operator panel. The output action can be set to be Always Off, Normally On or Normally Off. The user can turn the output on or off by configuring the use of a number of alarm and shutdown flags. See Discrete I/O configuration in chapter 6 for details.

The electrical circuit is a low-side switch with the return current going to input power minus. The output load must be connected to the discrete output pin and to the Aux Power pin (supply plus) of the F-Series actuator. If the load is below 500 mA, the load can be driven directly from the output. It is possible to drive a relay if more current is needed for the load.

If it is necessary to use an independent power supply instead of the F-Series actuator Aux Power, then a protective fuse must be provided and the negative connection of the independent power supply must be tied to the F-Series actuator negative power input pin. The maximum voltage when the switch is in the "Off" state is 40 V (dc).

The output is current protected and turns off if driven above 500 mA. If the short is removed, the output automatically returns to normal operation.

## Chapter 4.

# Description of Operation

### General

The F-Series actuator is ready for operation immediately (within 1 second) when the power supply is connected. Power may be connected to the control at the same time the engine starter is engaged. The actuator will power up in a stable and predictable manner whether a demand signal is present or not. Upon power-up, the actuator will immediately go to the demanded position. The demanded position will be the initial spring check start setting, if the spring check is configured for use, and the permissives are present. Once the spring check function is finished, the actuator then drives to maintain the position demanded by the supervisory control.

Optionally, a Run Enable input can be set to activate or de-activate the F-Series actuator position output. It can also be used to reset shutdown fault conditions.

Upon an engine shutdown command, the independent engine shutdown solenoid or solenoid valve in the fuel supply should be de-activated to stop the flow of engine fuel. This engine shutdown signal should be sent directly from the engine control panel and should be independent and separate from the F-Series control.

The supply voltage fault low and high thresholds are configurable. Default values are below 9 V (dc) and above 33 V (dc) respectively. The unit can be configured to either alarm or shutdown upon detection of a supply voltage fault.

### Position Control

The F-Series actuator provides closed-loop position control based on an internal position sensor and the desired position demand signal. Software model-based position and current controllers are utilized to position the output. Position control is provided using a customer's position demand, an internal position feedback sensor and an internal driver output. The driver provides a 0 V to 5 V (dc) analog output (TPS) for indication of actual throttle or actuator output shaft position. If an optional non-linear position demand curve is configured, the TPS is corrected to account for the effect of the curve, so that the TPS should still normally match the position demand input.

### Driver Input Power

The F-Series actuator operates at full-specified torque over a voltage range of 10 V to 32 V (dc). The actuator is functional in the range of 7 V to 32 V (dc), but accuracy and/or torque can be diminished at the extreme ends of this range. The actuator tolerates input voltages as low as 6 V (dc) without resetting the internal processor.

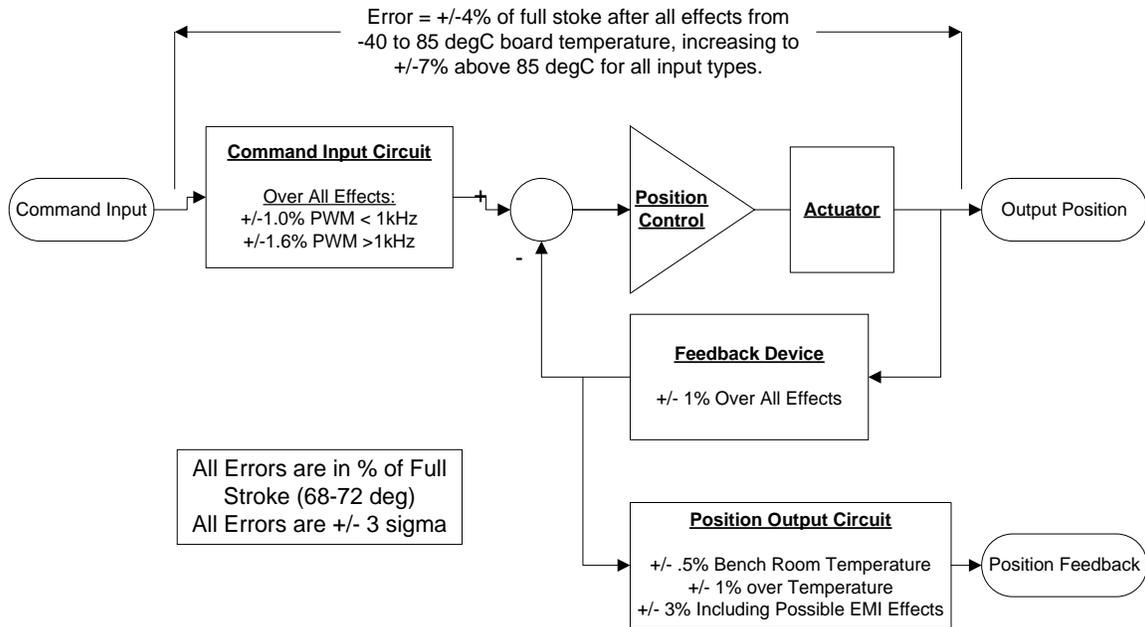


Figure 4-1. Position Tolerances

## Position Demand Signal

The F-Series 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 mA to 20 mA or 0 V to 5 V [dc]) command signal input, depending on how the software application is configured.

A low-pass Position Demand Filter can be configured in the software. The filter cut-off frequency has an adjustable range of 1 Hz to 20 Hz.

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 Input

The PWM input will function with low-side open collector and push-pull source types. It will handle a PWM frequency range from 300 Hz to 2000 Hz at amplitudes ranging from 4 V to 32 V. Default range is from 10 % to 90 % duty cycle, representing the hard stops in the actuator.

The input failure levels are below 2 % and above 98 % 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.

**IMPORTANT**

**When the optional non-linear position demand curve is configured, the TPS is corrected to account for the effect of the curve, so that the TPS should still normally match the position demand input. Be sure the TPS output (if used) is applied correctly for this configuration.**

**CAN Demand**

The CAN position demand is configured in the software and hardware. For software configuration instructions see Chapter 5. The CAN protocols available are CANopen and SAE J1939. For hardware configuration instructions see Chapter 3, CAN ID discrete inputs and CAN Communications.

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.

**Analog Input**

The analog input type (4 mA to 20 mA or 0 V to 5 V [dc]) is configured in the software and hardware. For software configuration instructions see Chapter 6. For hardware configuration instructions see Chapter 3, Figure 3-3.

The analog current position demand input has a configurable range of 0 mA to 24 mA, with a default setting of 4 mA to 20 mA, to demand the throttle from minimum to maximum position.

The analog voltage position demand input has a configurable range of 0 V to 5 V (dc), with a default setting of 0.5 V to 4.5 V (dc), to demand the throttle from minimum to maximum position.

The input is monitored for out of range condition and the failure levels are user configurable. The unit can also be configured to alarm, shutdown or ignore the fault upon detection of an analog input failure.

Note: Analog Demand is not available in firmware 5418-9520.

**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 4-2). 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).

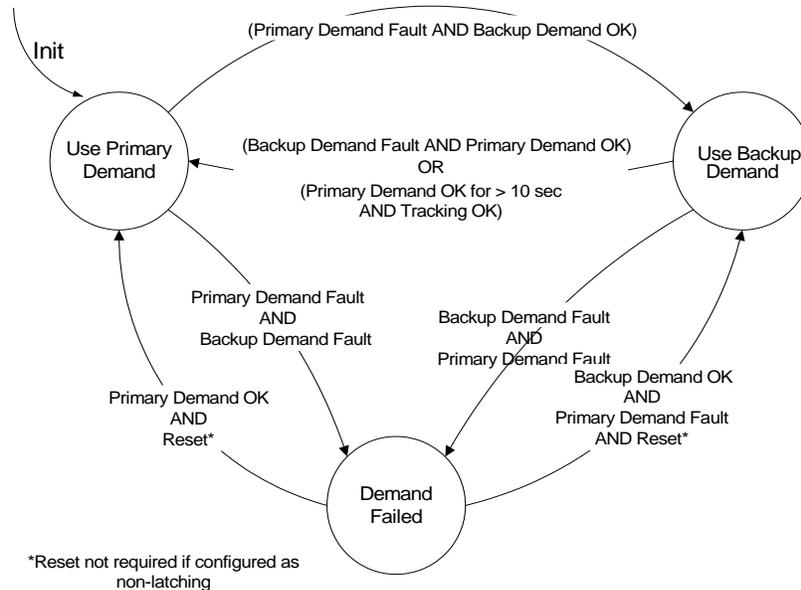


Figure 4-2. Position Demand Logic

## Actuator Output

The F-Series Modular Actuator is configurable for clockwise (CW) or counterclockwise (CCW) rotation. Direction of rotation is determined by looking at the output shaft end. See Configuration, Chapter 6, for setup instructions.



## Analog Output (TPS)

The F-Series actuator provides a configurable 0 V to 5 V signal representing actual shaft rotational position. Default setting is for a 0.5 V and 4.5 V to correspond to full counterclockwise to clockwise rotation. The actual position output will be equal to measured position within 1 % of full stroke after all effects and over the entire operating temperature range. When an optional non-linear position demand curve is configured, the TPS is corrected to account for the effect of the curve, so that the TPS should still normally match the position demand input. A condition that causes the actuator to be off-position will cause a mismatch between the position demand and the TPS signal.

## Discrete Output

The discrete output is a low-side driver that changes state upon a diagnostic or detected driver fault. The F-Series actuator discrete output can be configured to monitor specific fault conditions. It can also be configured as normally on (preferred failsafe setting), normally off or always off. This output can provide a useful diagnostic signal for monitoring the engine. It can also be used to shutdown the engine by external means separate from commanding the actuator to the minimum position or to a zero current condition.

There are two conditions that will prevent the discrete output from operating correctly. The first is if battery positive is accidentally connected to it, and the second is if it is shorted to ground. The circuit will protect itself in the event of a wiring error, but it will hold the output open (floating) until the fault is removed.

## Run/Stop Input

An optional Run/Stop function is available to enable/disable the control operation. This input can be configured as a CAN command, as a discrete input, or disabled completely. When configured for use, a stop command forces the coil current to zero (actuator goes limp). On ITB applications, under normal conditions, the internal spring will move the ITB valve to the spring return position. Changing the Run discrete input from active to inactive also issues a shutdown/alarm reset command and can be used to clear a latched shutdown condition (only when discrete input is used).

When a discrete input is selected, the input is configurable as either active high (default) or as active low (active is a Run selection and inactive is Stop). The input switch action can be configured as active when the switch is closed (default) or when the switch is opened.

## Serial Communications

RS-232 communications are available on the F-Series actuator when used with an external transceiver. Serial communications provide for use of the F-Series Service Tool. The service tool communicates at 38,400 bps. The simplest way to establish communication is to use Woodward communication harness kit part number 8923-1255 (23-pin). Functions available through this port include troubleshooting, setup, tuning and configuration of the F-Series control. Detailed driver status information is also displayed.

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 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 during normal prime mover operation. The service port is provided for configuration, setup and trouble-shooting only.

## Temperature Sensing

The F-Series actuator monitors board temperature with on-board temperature sensors to protect the unit from over temperature. If configured, a fault is annunciated when temperature greater than 140 °C or less than -45 °C is detected. Internal monitoring also provides temperature level indications for temperatures exceeding 118 °C and 125 °C (see current limiting).

## Current Limiting based on Temperature

The controller provides actuator current limiting based on the electronics temperature. Dependent on board and actuator thermal models, the software reduces current as necessary to avoid conditions that would damage the unit due to extreme temperatures. A status LED on the Service Tool is illuminated when high temperature derating is active.

Current limiting based on temperature begins when the combined current and temperature environment causes board temperatures greater than 118 °C. The limit curve is a linear de-rate from full current at 118 °C down to zero current at 125 °C. Depending on the current (actuator torque) and ambient operating temperatures, the unit may never reach the current limiting state.

## Position Control Near the Mechanical Stops

When operating very near the mechanical actuator stops, the F-Series controller will switch from position control to current control. If the measured position, as seen by the controller, is seen to move away from the stop, the unit will return to active position control in order to move back to the stop, where current control is resumed. The amount of current used for holding against each mechanical stop is user configurable in the modular actuator version only.

## CAN Communications

The F-Series supports both CANopen and J1939 CAN communications, the CAN protocol is configurable. If desired, CAN communications can be turned off completely. A diagnostic fault is provided to annunciate a Bus Off condition.

The use of a CAN position command is optional, allowing the user to just use CAN for monitoring purposes. The CAN demand input is monitored and diagnostic faults are provided when the input is out of range or sent too slowly.

Harness coding is provided to facilitate multiple F-Series units on a common bus. The CAN Id Low and High discrete inputs select the F-Series Unit number (1-4) in power up. For details, see CAN ID inputs in Chapter 3.

## CANopen Communications

The F-Series supports CAN communications in the CIA CANopen Protocol format complying with DS301 version 4.02. Further detailed information regarding CANopen can be obtained at [www.can-cia.org](http://www.can-cia.org). Information about CAN is available in ISO 11898. Specific information regarding F-Series behavior is detailed below.

The CANopen Electronic Data Sheet (EDS) can be downloaded from [www.woodward.com/software](http://www.woodward.com/software).

All F-Series CANopen messages use the CAN 2.0 11-bit Standard Data Frame Format. All data in CANopen is formatted as “Little Endian” also known as “Intel Format”.

### Baud Rate

The baud rate is tunable for 125, 250, 500, 1000 kbps. The default is 250 kbps.

### Node ID

The Node ID for each unit, number 1 through 4, is tunable between 1 and 31. The defaults are 14, 13, 12, and 11 for unit 1, 2, 3, and 4 respectively.

### Heartbeat Production Rate

The Heartbeat rate is tunable between 0 s and 10 s, but defaulted to 1 second. When set to ‘0.0’, the heartbeat is turned off. Note that actual transmission time is a multiplier of 9.6 ms (that is, 100 ms setting is actually 96 ms).

### CANopen State

The F-Series starts in boot-up mode, sends the required Boot Message, and then goes to the pre-operational state. If configured for PWM demand, for example, it will operate based on the PWM signal regardless of the CANopen State (the valve is fully operational) – similarly for Analog demand. Once it receives the operational command on the CANbus, the PDOs will be available on the CANbus.

If CAN demand is configured, it needs to receive a command to go to the operational state followed by receiving a valid position demand on the CANbus before the valve will be operational.

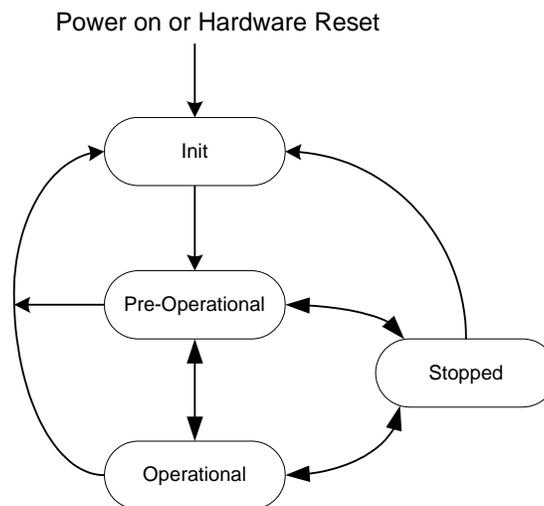


Figure 4-3. CANopen State Chart

## Network Management (NMT) States

The NMT state machine is implemented per the DS301 standard. When the F-Series powers up, it will transfer through the Initialization state to the Pre-Operational state where it will remain until commanded into the Operational state.

The following are not supported:

- Synchronization (SYNC) object
- Node Guarding
- Service Data Objects (SDOs) write access
- Time Stamp Object
- Emergency Object

In the Pre-Operational State:

- Module Control Services (NMT commands) are handled
- Heartbeat is functional
- SDOs (those supported) are functional

In the Operational State:

- All communication objects are handled including PDOs (Process Data Objects)

In the Stopped State:

- Module Control Services (NMT commands) are handled
- Heartbeat is functional

The following Module Control (NMT) Protocols/Services are supported:

- Start Remote Node - command specifier: 1 (0x01)
- Stop Remote Node - command specifier: 2 (0x02)
- Enter Pre-Operational mode - command specifier: 128 (0x80)
- Reset Node - command specifier: 129 (0x81)
- Reset Communication - command specifier: 130 (0x82)

NMT Services commands utilize COB-ID = 0x0 and date in the following format: 1st byte is the Command Specifier (0x01 is Start) and 2nd byte is the Node ID. The Node ID is specific to the commanded unit OR 0x0 for ALL units.

## Summary of Supported Objects

A summary of the supported objects is listed below with details are provided in the CANopen Objects section.

### Mandatory Objects

- 1=0x1000 Device Type
- 2=0x1001 Error Register
- 3=0x1018 Identity Object

### Optional Objects

- 1=0x1017 Producer heartbeat time
- 2=0x1200 Server SDO parameter
- 3=0x1400 Receive PDO parameter
- 4=0x1600 Receive PDO mapping
- 5=0x1800 Transmit PDO parameter
- 6=0x1A00 Transmit PDO mapping

### Manufacturer Objects

- 1=0x2210
- 2=0x2211
- 3=0x2212
- 4=0x2213
- 5=0x2214
- 6=0x2215
- 7=0x2216
- 8=0x2219
- 9=0x221A
- 10=0x221B
- 11=0x221C
- 12=0x221D
- 13=0x221F
- 14=0x2220
- 15=0x2221

### F-Series PDO Support

The F-Series utilizes 1 PDO transmit (Valve data message) and 1 PDO receive (Valve position demand), using the standard connection set to assign PDO numbers. The Node ID determines the COB ID for the PDOs.

Transmit PDO table.

Name	TxPDO	COB_ID	Type	Rate
Valve Data	1	384+NodeId	ASYNCR	96 ms

Receive PDO Table.

Name	RxPDO	COB_ID	Timeout
Valve Position Command	1	512+NodeId	Adjustable

## Received Messages

The F-Series utilizes one CAN Rx PDO programmable to receive a position command and basic operational commands, summarized in the following table. Details on each manufacturer-specific object are provided in the CANopen Objects section.

### PDO1 (Rx)

Maximum Reception rate:	5 ms (Engine Control to F-Series)
Message type:	"ASYNCR" (does not require SYNC message)
Timeout:	Configurable from 10 to 10,000 ms
COB Id:	512+NodeId (0x200+NodeId)
Data length:	4 bytes (bytes 5-8 are ignored, if received)
SubIndex0:	Number Of Entries = 17
SubIndex1:	Valve Position Command
SubIndex2-9:	Clear Diagnostics bits ( <i>not available in 5418-2724, 5418-2725, or 5418-3834</i> )
SubIndex10-17:	Command Bits ( <i>not available in 5418-2724, 5418-2725, or 5418-3834</i> )

Node ID: 14 is the default ID when the CAN ID discrete inputs are selecting F-Series Unit #1. The Node ID for Units 1-4 are configurable, see Chapter 6 for details.

Byte	Parameter	Object	Representation
1 -2	<b>Valve Position Command</b> (Low byte first )	<b>2216</b>	0-160.6375 % is (0-0xFAFF)
3	<b>Clear Diagnostics</b> Bit1-2 – Clear Active Diagnostics Bit3-4 – Clear Historical Diagnostics	<b>221F</b>	Bit field
4	<b>Command Bits</b> Bit1-2 – Run/Stop (Power-down Mode Select)	<b>2220</b>	Bit field

## Transmitted Messages

The F-Series utilizes one CAN Tx PDO summarized in the following table. Details on each manufacturer-specific object are provided in the CANopen Objects section.

**PDO1 (Tx)** - Message size is 8 bytes. Unused bytes will be set to FF

The following message is continuously transmitted by the F-Series when in the CANopen Operational mode.

Transmission rate: 96 ms  
 Message type: "ASYNCR" (does not require SYNC message)  
 COB Id: 384+NodeId (0x180+NodeId)  
 Data length: 8 bytes

SubIndex0: Number Of Entries = 27  
 SubIndex1: Actual Position  
 SubIndex2: Desired Position  
 SubIndex3: Electronics Temperature  
 SubIndex4-11: Status Array 1 bits  
 SubIndex12-18: Status Array 2 bits  
 SubIndex19-27: Status Array 3 bits

Node ID: 14 is default address when the CAN ID discrete inputs are selecting F-Series Unit #1 (configurable).

Byte	Parameter	Object	Representation
1 -2	Actual Position (Low byte first )	2210	0-160.6375 % is (0-0xFAFF)
3-4	Desired Position (Low byte first )	2211	0-160.6375 % is (0-0xFAFF)
5	Electronics Temperature	2212	-40 °C to 210 °C is 0x0 to 0xFA
6	Status Array 1	2213	Bit field
7	Status Array 2	2214	Bit field
8	Status Array 3	2215	Bit field

## Additional Non-mapped Objects

The following table provides a summary of the supported application-specific SDO requests. These are only available in firmware versions 5418-3055, 5418-3056 or newer.

Parameter	Object	Representation
Input Voltage	2219	0-642.55 V is (0-FAFF)
Desired Drive Current	221A	-32.127 to 32.128 A is (0-FAFF)
Analog Position Command	221B	0-160.6375 % is (0-FAFF)
PWM Position Command	221C	0-160.6375 % is (0-FAFF)
CAN Position Command	221D	0-160.6375 % is (0-FAFF)
<b>Status Data</b> Bits 1-4 Controller Operation Status Bit 5 Discrete Output active status Bits 6-8 Demand State	2221	Bit field

## CANopen Objects

The following section provides additional details on the CANopen objects supported by the F-series, manufacturer specific objects. The product EDS file (Woodward part number 9927-1917) is available for download on the Woodward website ([www.woodward.com](http://www.woodward.com)).

### Object 1000 – Device Type

Requests of the device type always returns a 0, indicating the F-Series does not follow a standardized device profile. Any SDO request for index 0x1000, sub-index 0 will be 0 Sub-indexes other than 0 return an abort code 0609 0011, Sub-index does not exist.

### Object 1001 – Error Register

Requests of the Error Register always return a 0. Any SDO request for index 0x1000, sub-index 0 will be 0 Sub-indexes other than 0 return an abort code 0609 0011, Sub-index does not exist.

### Object 1017 – Producer Heartbeat Time

Requests of the producer heartbeat time return the value set by the user-configured Producer Heartbeat Time. COB-ID: 700h + NodeId

### Object 1018 – Identity Object

Provides the following subindexes:

- > SubIndex 0: Number of Entries (always = 4)
- > SubIndex 1: Vendor Id (0x0170 for Woodward)
- > SubIndex 2: Product Code (Woodward product part number, 8404-1234 is represented as 84041234)
- > SubIndex 3: Product Revision Number
  - Revision level of the Woodward product part number where 1=rev NEW, 2=rev A, 3=rev B, etc.
  - Values of 100 or greater indicate a preliminary revision.
- > SubIndex 4: Product Serial Number (Woodward product serial number)

### Object 1200 – Server SDO parameter

Provides the following subindexes:

- > SubIndex 0: Number of supported entries
- > SubIndex 1: COB-ID Client -> Server (rx) NODEID+0x600
- > SubIndex 2: COB-ID Server -> Client (tx) NODEID+0x580

### Object 1400 – Receive PDO parameter

The RxPDO 1 parameter provides the following subindexes:

- > SubIndex 0: number of elements (2)
- > SubIndex 1: Cob Id used by PDO (NODEID+0x200)
- > SubIndex 2: Transmission Type (0xFE)

### Object 1600 – Receive PDO mapping

Provides the following subindexes:

- > SubIndex 0: Number of supported entries
- > SubIndex 1: Desired Position Setpoint (0x2216)
- > SubIndex 2: Clear Diagnostics (0x221F) (*not available in 5418-2724, -2725, or -3834*)
- > SubIndex 3: Command Bits (0x2220) (*not available in 5418-2724, -2725, or -3834*)

**Object 1800 – Transmit PDO parameter**

The TxPDO 1 parameter provides the following subindexes:

- > SubIndex 0: Largest Sub-index supported (5)
- > SubIndex 1: COB-ID used by PDO (180h + NodeId)
- > SubIndex 2: Transmission Type (1h)
- > SubIndex 5: Event Timer (0h)

**Object 1A00 – Transmit PDO mapping**

Provides the following subindexes:

- > SubIndex 0: Number of supported entries
- > SubIndex 1: Actual Valve Position (0x2210)
- > SubIndex 2: Desired Valve Position (0x2211)
- > SubIndex 3: Electronics Temperature (0x2212)
- > SubIndex 4-11: Status Array 1 (0x2213)
- > SubIndex 12-19: Status Array 2 (0x2214)
- > SubIndex 20-27: Status Array 3 (0x2215)

**Object 2210 – Actual Valve Position**

Actual valve position indication, in percentage of user-calibrated overall travel. A hex value of 9C40 corresponds to 100 %.

Mapping: PDO1 (Tx), bytes 1-2

Access: Read-only

Data Type: unsigned 16-bit

Scaling: 0-160.6375 % is 0-0xFAFF

**Object 2211 – Desired Valve Position**

Desired valve position setpoint indication, in percentage of user-calibrated overall travel. . A hex value of 9C40 corresponds to 100 %.

Mapping: PDO1 (Tx), bytes 3-4

Access: Read-only

Data Type: unsigned 16-bit

Scaling: 0-160.6375 % is 0-0xFAFF.

**Object 2212 – Electronics Temperature**

Electronics temperature indication, in degrees Celsius.

Mapping: PDO1 (Tx), byte 5

Access: Read-only

Data Type: unsigned 8-bit

Scaling: 1 degC/bit, -40 degC offset (-40 °C to +210 °C is 0x0 to 0xFA)  
(Subtract 40 from received value to recover °C value)

**Object 2213 – Status Array 1**

Provides a bit indication of the overall F-Series status.

Mapping: PDO1 (Tx), byte 6

Access: Read-only

Data Type: bit field, 8 sub-indexes (8-bits)

Bit Representation (1=active, 0=inactive)

Bit 1: Shutdown

Bit 2: Alarm

Bit 3: Derating Active

Bits 4-8: RESERVED (5418-2724, -2725, or -3834 versions only)

Bit 4: Shutdown excluding Run Enable (5418-3055, 5418-3056 or newer only)

Bit 5: Loss of All Position Demands (5418-3055, 5418-3056 or newer only)

Bit 6: Demand Tracking Error (5418-3055, 5418-3056 or newer only)

Bit 7: Temperature above 125 °C (5418-3055, 5418-3056 or newer only)

Bit 8: RESERVED (5418-3055, 5418-3056 or newer only)

**Object 2214 – Status Array 2**

Provides an indication of currently active faults within the F-Series.

Mapping: PDO1 (Tx), byte 7

Access: Read-only

Data Type: bit field, 8 sub-indexes (8-bits)

Bit Representation (1=active, 0=inactive)

Bit 1: PWM Input High Duty Cycle Error

Bit 2: PWM Input Low Duty Cycle Error

Bit 3: Analog Input High Error

Bit 4: Analog Input Low Error

Bit 5: Input (Supply) Voltage High Error

Bit 6: Input (Supply) Voltage Low Error

Bit 7: Electronics Temperature High Error

Bit 8: Electronics Temperature Low Error

**Object 2215 – Status Array 3**

Provides an indication of currently active faults within the F-Series.

Mapping: PDO1 (Tx), byte 8

Access: Read-only

Data Type: bit field, 8 sub-indexes (8-bits)

Bit Representation (1=active, 0=inactive)

Bit 1: Position Error

Bit 2: Run Enable not active

Bit 3: Spring Check Failed

Bit 4: Internal Fault

Bit 5: CAN Fault (includes CANbus Off, CAN Demand Failed, CAN demand out of range)

Bit 6: Power up indication (*5418-2724, -2725, or -3834 versions only*)

Bits 7-8: RESERVED

**Object 2216 –Valve Position Command**

Desired valve position setpoint command to the F-Series, in percentage of user-calibrated overall travel. To accept this command, a Demand Source must be set to CAN. The minimum receive rate, prior to an annunciated fault, is determined by the configured CAN Fault Timeout setting. A hex value of 9C40 corresponds to 100 %.

Mapping: PDO1 (Rx)

Access: Write-only

Data Type: unsigned 16-bit

Scaling: 0-160.6375 % is 0-0xFAFF.

**Object 2219 –Input Voltage**

**(5418-3055, 5418-3056 or newer only)**

Controller input voltage indication, in volts.

Mapping: not mapped

Access: Read-only

Data Type: unsigned 16-bit

Scaling: 0.01 V/bit, 0-642.55 V is (0-0xFAFF)

**Object 221A –Desired Drive Current**

**(5418-3055, 5418-3056 or newer only)**

Indication of the internally commanded coil current, in amperes.

Mapping: not mapped

Access: Read-only

Data Type: unsigned 16-bit

Scaling: 0.001 A/bit, -32.127 to 32.128 A is (0-0xFAFF)

**Object 221B –Analog Position Command****(5418-3055, 5418-3056 or newer only)**

Desired valve position setpoint command set by the Analog (voltage) input, in percentage of user-calibrated overall travel. This indication is only valid when a Demand Source is set to Analog.

Mapping: not mapped

Access: Read-only

Data Type: unsigned 16-bit

Scaling: 0-160.6375 % is 0-0xFAFF.

**Object 221C –PWM Position Command****(5418-3055, 5418-3056 or newer only)**

Desired valve position setpoint command set by the PWM input, in percentage of user-calibrated overall travel. This indication is only valid when a Demand Source is set to PWM.

Mapping: not mapped

Access: Read-only

Data Type: unsigned 16-bit

Scaling: 0-160.6375 % is 0-0xFAFF.

**Object 221D –CAN Position Command****(5418-3055, 5418-3056 or newer only)**

Desired valve position setpoint command set by CAN, in percentage of user-calibrated overall travel. This indication is only valid when a Demand Source is set to CAN.

Mapping: not mapped

Access: Read-only

Data Type: unsigned 16-bit

Scaling: 0-160.6375 % is 0-0xFAFF.

Note: Above 0x9C40, a CAN Demand Out of Range Error will be annunciated by the F-Series. The position demand setpoint will be limited to 100 %. Above 0xFAFF, the F-Series will issue a CAN Demand Fault and force the position demand setpoint to 0 (zero).

**Object 221F – Clear Diagnostics Command****(5418-3055, 5418-3056 or newer only)**

Permits commands to Clear active and logged diagnostics (see Objects 2213, 2214,2215). A command to Clear (Active) Diagnostics is only meaningful when Enable Fault Latching is configured, otherwise faults automatically clear. The ability to clear diagnostics is also provided on the Service Tool.

Mapping: PDO1 (Rx), byte 3

Access: Write-only

Data Type: bit field, 8 sub-indexes (8-bits)

[SubIndex0]	Number Of Entries = 8
[SubIndex1]	Clear Active Diagnostics on transition to '1' if allowed
[SubIndex2]	Disable Active Diagnostics Clear Functionality when '1'
[SubIndex3]	Clear Logged Diagnostics on transition to '1' if allowed
[SubIndex4]	Disable Logged Diagnostics Clear Functionality when '1'
[SubIndex5-8]	Not Used

For clear active and logged/historical diagnostic bits, action shall only be taken upon transition from '0' to '1' AND only when not disabled. Realistically, this can be thought of as a 2-bit function where:

Data Bits 1-2: Clear Diagnostics  
 Data Bits 3-4: Clear Historical Diagnostics  
 Data Bits 5-8: (spare/not used)

Bits	Clear Diagnostics Command Function
00	No Action
01	Clear Diagnostics
10	Reserved, no action
11	Not supported, no action

Upon timeout of receiving this message (message is late), the last received value shall be latched. However, since these commands only take place upon transition from 00 to 01, no sustained action is taken. The key however, is that upon this message coming again, the value in the message must be set back to '00' before a new reset action can be taken with a subsequent '01'.

### Object 2220 – Command Bits

*(5418-3055, 5418-3056 or newer only)*

Provides Run/Stop (Run Enable) command functionality. To use this function the Run Enable input must be configured as CAN.

Mapping: PDO1 (Rx), byte 4

Access: Write-only

Data Type: bit field, 8 sub-indexes (8-bits)

[SubIndex0] Number Of Entries = 8  
 [SubIndex1] STOP command on transition to '1', if allowed  
 [SubIndex2] Disable Stop command functionality, when '1'  
 [SubIndex3-8] Not Used

For the run/stop STOP command, action shall only be taken upon transition from '0' to '1' AND only when not disabled. Realistically, this can be thought of as a 2-bit function where:

Bits 1-2: Run/Stop Command  
 Bits 3-8: (spare)

Hex Value	Bits	Run/Stop Command Function
0	00	Reset Stop (Run)
1	01	Stop
2	10	Reserved, no action
3	11	Not supported, no action

### Object 2221 - Status Data

*(5418-3055, 5418-3056 or newer only)*

These bits provide F-Series status indications including the controller's operating status, the demand redundancy state, and the discrete output status.

Mapping: not mapped

Access: Read-only

Data Type: bit field, 3 sub-indexes (8-bits)

[SubIndex0] Number Of Entries = 3  
 [SubIndex1] Controller Operation Status (size 4 bits)  
 [SubIndex2] Discrete Output Status (size 1 bit)  
 [SubIndex3] Demand State (size 3 bits)

**Controller Operation Status**

These 4 bits provide an indication of the controller's operating status, defined in the table below. When multiple conditions exist, the highest active severity is indicated (0001 is lowest and 0101 is highest).

Hex Value	Bits	Indication
0	0000	Normal
1	0001	Alarm (fully operational but needs service)
2	0010	Alarm High Severity (functional but transient performance may be reduced)
3	0011	Derate Active (torque output reduced due to environmental conditions)
4	0100	Controlled Shutdown Active (driving to the shutdown position)
5	0101	Uncontrolled Shutdown Active (actuator current is off so it is limp)
6-D	0110-1101	Reserved for future assignment
E	1110	Error
F	1111	Not Available

**Discrete Output Active status**

This status is a single bit of data providing an indication of the commanded state of the discrete output (1=ON, 0=OFF). The conditions that set this output are configurable allowing a customizable CAN indication when the discrete output is not used.

**Demand State**

Provides information on the state status of the demand redundancy controller. Applicable primarily when redundant demand inputs are configured. The data is represented using 3 bits and defined by the table below.

Value	Bits	Demand Operating State
0	000	Primary Demand In Control
1	001	Primary Demand In Control (Backup Fault)
2	010	Backup Demand In Control (Primary Fault)
3	011	All Demand Signals Failed
4	100	Primary Demand enabled but not active (delay from Backup Control)
5	101	Reserved for future assignment
6	110	Error
7	111	Not Available

**SAE J1939 Communications**

The F-Series 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](http://www.sae.org). Information about CAN may be found in ISO 11898. This version of the F-Series supports the SAE J1939 standard messages defined in J1939-21, J1939-71, J1939-73, and J1939-81 with further details indicated here.

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

Note that in accordance with SAE J1939 definitions, the first instance shall be used when only 1 actuator is used, or for the primary fuel of a dual fuel engine, or for the left bank if a valve/actuator is used on each bank of a Vee engine. The left bank is as seen while facing the engine from the flywheel housing.

The F-Series provides a flexible method to customize how information is sent and received via J1939. Each data parameter (SPN – Suspect Parameter Number) may be assigned to a PGN (Parameter Group Number) and its location within the PGN may be defined using the service tool. There is possibility to define initial Source Address and Dynamic Addressing. The J1939 NAME used to acquire a Source Address may also be defined. A Legacy mode is provided as well so that backward compatibility to earlier F-Series models is fully provided if needed. All of this customization may be done uniquely for each of the four harness ID selections.

## Flexible Messaging Definition

The F-Series flexible messaging allows the user to customize the content of messages to be sent or received by the F-Series on the J1939 network. This feature allows the user to implement most of the standard actuator and valve types already defined in J1939-71 or to create custom proprietary messages. This feature is not available in firmware versions 5418-2724, 5418-2725, or 5418-3834. The firmware versions function strictly in a limited legacy mode (see Legacy Mode).

## Diagnostic Reporting

### Diagnostic Bit Field

The F-Series supports multiple methods of reporting diagnostic information. A proprietary bit-field may be reported (typically in a proprietary PGN) by assigning the Diagnostic Bit Field to a PGN location using the service tool. To use the Bit Field:

1. Select Enable from the drop down box in the service tool.
2. Provide a PGN number (normally between 65280 and 65535 using the Proprietary B range) in which the F-Series will populate the measured position data.
3. Select the byte within the PGN in which the data is to start. The Bit Field will consume 4 bytes.
4. Provide a PGN Priority and select a transmit Rate. The priority is used in the 29-bit CAN ID as identified by J1939-21. If the same PGN is used elsewhere in the F-Series configuration, the same Priority and Rate must be used each time.

The Bit Field uses the J1939 format of 2 bits / 4 states per parameter:

State	Description
0	The diagnostic condition is not active
1	The diagnostic condition is active
2	Reserved (not used)
3	Not Available (this diagnostic is not supported)

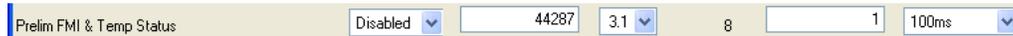
The diagnostics are mapped as follows:

Position	Description
1.1	Internal Fault
1.3	Supply Voltage Fault (either Low or High)
1.5	Spring Check Failed
1.7	Position Error
2.1	Configuration Error
2.3	Temperature Sensor Failed
2.5	Derating Active (>118 °C)
2.7	Zero Drive Current (>125 °C)
3.1	Run Enable Input Caused Shutdown
3.3	Demand Tracking Fault
3.5	Loss of (all) Position Demand(s)
3.7	Analog Demand Failed (either Low or High)
4.1	PWM Failed (Duty Cycle is either Low or High)
4.3	CAN Demand Failed
4.5	Unused (set to 3)
4.7	Unused (set to 3)

Table 4-1. Diagnostic Bit Field

### **Preliminary FMI and Temperature Status**

Likewise, the Preliminary FMI method may be used to report diagnostics. This is a method that is loosely defined in J1939 for many of the actuator/valve types such as Throttle and Compressor Bypass. Preliminary FMI reporting consumes 5 bits and is always paired with the Temperature Status which consumes the other 3 bits of a byte.



A preliminary FMI is a Failure Mode Indicator which reports a diagnostic condition within the F-Series. The following table indicates which diagnostics are reported using this method. If more than 1 diagnostic is active simultaneously, the one higher in the table will be reported.

FMI Value	Description
12	Internal Fault
5	Run Enable Input Caused Shutdown
0	Zero Drive Current (>125 °C)
14	Loss of (all) Position Demand(s)
15	Analog Demand Failed (High)
17	Analog Demand Failed (Low)
8	PWM Failed (Duty Cycle is either Low or High)
9	CAN Demand Failed (No Signal)
7	Position Error
4	Supply Voltage Fault (Low)
15	Derating Active (>118 °C)
3	Supply Voltage Fault (High)
2	Demand Tracking Fault
12	Temperature Sensor Failed
7	Spring Check Failed
16	CAN Demand Failed (Signal Out of Range)
13	Configuration Error

Table 4-2. Preliminary FMI

The temperature status reports if there is a problem related to the internal temperature of the F-Series. The 3-bit status is defined in the standard as follows:

Value	Definition	F-Series Usage
0	High Most severe	Zero Drive Current (Limp)
1	High Least severe	Reduced torque due to temperature > 118 °C
2	In Range	Temperature is in normal range
3	Low Least severe	Not used in F-Series
4	Low Most severe	Not used in F-Series
5	Not Defined	Not used
6	Error	Onboard temperature sensor is failed high or low
7	Not available	Not used

Table 4-3. Temperature Status

### **SAE 1939-73 DM1, DM2, DM3, DM11 and DM13 messages**

The well defined DM1 (active diagnostics) and DM2 (previously active diagnostics) may also be used. Any of these methods may be used simultaneously as well.

Diagnostics Support

Enable DM1 (Active Trouble Codes) Msg 65226

Enable DM2 (Logged Trouble Codes) Msg 65227

Enable DM3 (Reset Logged Trouble Codes) Msg 65228

Enable DM11 (Reset Active Trouble Codes) Msg 65235

Enable DM13 (Stop Start Broadcast) Msg 57088

Device SPN

Both Active and Logged Diagnostics are tracked by the F-Series. When a diagnostic condition is detected, it is added to both the Active and the History Log. As long as the diagnostic is still active, it may be reported using the Diagnostic Bit Field, Preliminary FMI, and/or DM1. If the condition causing the diagnostic is corrected, the Active status will be removed leaving only the History Log of the diagnostic condition. The History Log may be viewed using DM2 (or the service tool). As a note, according to J1939, if an event is active for the first time, it will not be reported in DM2 until it is no longer active.

Active diagnostics may be reset (if possible) using DM11 if the message reception is enabled using the service tool. Similarly, logged diagnostics may be reset using DM3 if the message reception is enabled using the service tool. Use the request message (PGN 59904) to request the DM11 PGN (65235) or DM3 PGN (65228). The act of requesting either PGN is the trigger that causes the specified reset action to occur. If the action is successful, a positive acknowledgement will be sent by the F-Series. If it is not allowed, a negative acknowledgement will be sent.

The DM13 Start / Stop Broadcast messaging capability is provided as an option. Enable this by selecting the appropriate checkbox in the J1939 setup. The F-Series will respond to Start and Stop Broadcast commands for the "Current Data Link" (SPN 1230) and supports the Hold Signal (SPN 1236) to maintain the Stop state for another 6 seconds. DM13 should only be used when the engine is stopped.

**PGN 65242 Software Identification (SOFT) message**

Transmission repetition rate: On Request (F-Series → Engine Control)  
 Data length: Variable  
 Data Page: 0  
 PDU format: 254  
 PDU specific: 218  
 Default priority: 6  
 Parameter Group Number: 65242 (0xFEDA)

**Data:**

Byte 1: Number of Software Identification Fields, SPN 965

Data length: 1 byte  
 Resolution: 1 /bit, 0 offset  
 Range: 0 to 250 (0x00 to 0xFA)  
 Actual value: 1 (F-Series will always report 1)

Bytes 2 - (N+1): Software Identification, SPN 234

Data length: N, up to 200 characters  
 (For 5418-3055 rev NEW, N = 11)  
 Resolution: ASCII, 0 offset  
 Range: 0 to 255 per byte  
 Actual value: Depending on current software version:  
 54183055NEW for software 5418-3055 rev NEW  
 Character: 53, 52, 49, 56, 51, 48, 53, 53, 78, 69, 87  
 (hex: 35, 34, 31, 38, 33, 30, 35, 35, 4E, 45, 57)

Byte (N+2): Delimiter, SPN 234

Data length: 1 byte  
 Resolution: ASCII, 0 offset  
 Range: 0 to 255 (0x00 to 0xFA)  
 Actual value: 42 (0x2A)  
 Character: \*

**Received Data – Commands****Position Demand**

When a Position Demand is configured to come via CAN, configuration of the data location becomes visible in the service tool. The position demand data format is fixed but the data location is configurable.

To accept this data, the SPN of the Position Command must be provided. This is necessary for DM1 and DM2 reporting and is required to be unique compared to all other configurable SPN values (even if not using DM1 or DM2).

From the J1939-71 standard or from the Proprietary PGN range, select a PGN number in which the F-Series will find the Position Command SPN data. Configure the byte within the PGN in which the data starts. The data is 2 bytes long (16 bits).

Engine Actuator/Valve Control Command SPN

Data length: 2 bytes, unsigned  
 Resolution: 0.0025 %/bit, 0 offset  
 Range: 0 to 160.6375 %  
 Operational Range: 0 to 100 % (0=closed, 100=max position)

Note: The F-Series will cap values between 100 % (0x9C40) and 160.6375 % (0xFAFF) at 100 % and continue to use the flow demand as 100 %. However, above 0x9C40, a CAN Demand Out-of-Range Error will be annunciated by the F-Series. If the value exceeds the Valid Signal range (> 0xFAFF or 64255) the CAN Demand Fault will be set and the CAN position demand setpoint will be forced to 0.

### **Run/Stop Command**

It is possible to control the Run status via CAN. However, there is no public standard J1939 message for this feature so it must be manually mapped into a PGN. When a Run/Stop Command is configured to come via CAN, configuration of the data location becomes visible in the service tool.

Configure the PGN in which the F-Series will find the Run/Stop Command data. Configure the byte and bit position within the PGN in which the data starts. The data is 2 bits long.

The Run/Stop Command uses the J1939 format of 2 bits / 4 states per parameter:

State	Description
0	Run
1	Shutdown
2	Reserved (no change in operating state)
3	Not Supported (no change in operating state)

### **Transmitted Data – Status Reporting**

#### **Engine Valve/Actuator Position**

The Engine Valve/Actuator Position reports the actual measured position. To send this data, the SPN of the Position Data must be provided. This is necessary for DM1 and DM2 reporting and is required to be unique compared to all other configurable SPN values (even if not using DM1 or DM2).

From the J1939-71 standard or from the Proprietary PGN range, select a PGN number in which the F-Series will populate the measured position data. Configure the byte within the PGN in which the data is to reside. The data is 1 byte long (8 bits).

#### Engine Valve/Actuator Position SPN

Data length: 1 byte, unsigned  
 Resolution: 0.4 %/bit, 0 offset  
 Range: 0 to 100 %  
 Operational Range: 0 to 100 % (0=closed, 100=fully open)  
 Error State: 254 (0xFE) Sent if the position sensor is failed or position error occurs.

#### **Engine Desired Valve/Actuator Position**

The Engine Desired Valve/Actuator Position reports the target position. If redundant position demands are used, this SPN will report the position demand based on the currently selected and active demand.

From the J1939-71 standard or from the Proprietary PGN range, select a PGN number in which the F-Series will populate the desired position data. Configure the byte within the PGN in which the data is to reside. The data is 1 byte long (8 bits).

Engine Desired Valve/Actuator Position SPN	
Data length:	1 byte, unsigned
Resolution:	0.4 %/bit, 0 offset
Range:	0 to 100 %
Operational Range:	0 to 100 % (0=closed, 100=fully open)
Error State:	254 (0xFE) Sent if all position command inputs are failed

### **Engine Valve/Actuator Operation Status**

The operation status reports alarm (warning) and shutdown (error) conditions by severity. It provides a simple method for an engine control to understand if the F-Series is operating normally or shutdown.

From the J1939-71 standard or from the Proprietary PGN range, select a PGN number in which the F-Series will populate the operation status data. Configure the byte and bit position within the PGN in which the data is to reside. The data is 4 bits long.

The Operation Status uses the J1939 format of 4 bits / 16 states per parameter as defined below:

Value	Definition	F-Series Usage
0	Normal	No diagnostic conditions are active
1	Alarm	Operational but needs service
2	Alarm High Severity	Functional but accuracy may be reduced
3	Derate Active	Torque output reduced due to Temperature Status
4	Controlled Shutdown Active	Driving to the default position – usually this means closed
5	Uncontrolled Shutdown Active	Actuator current is off so it is limp
6–13	Reserved for future assignment	Not used in F-Series
14	Error	Not used in F-Series
15	Not available	Not used in F-Series

Table 4-4. Operation Status

### **Engine Valve/Actuator Control Mode Status**

The control mode status reports what demand source is being used. It is a simple way for the engine control to get feedback on which of a pair of redundant command inputs is actually being used. It also provides the current state of the discrete output.

From the J1939-71 standard or from the Proprietary PGN range, select a PGN number in which the F-Series will populate the control mode status data. Configure the byte and bit position within the PGN in which the data is to reside. The data is 4 bits long.

The Control Mode Status uses the J1939 format of 3 bits / 8 states per parameter as defined below:

Value	F-Series Usage
0	Primary demand is in control and no Backup is configured or the Backup signal is OK
1	Primary demand is in control and the Backup signal is failed
2	Backup demand is in control and the Primary signal is failed
3	All demand signals are failed
4	Primary Demand enabled but not active / delay from Backup control
5	Not used in F-Series
6	Error (Not used in F-Series)
7	Not Available (Not used in F-Series)

Table 4-5. Control Mode Status

The discrete output status is a single bit that occupies the first bit position of the 4. A '1' indicates the output is "on" and a '0' indicates the output is "off".

Control Mode Status Field:

Bit 4	Bit 3	Bit 2	Bit 1
Control Mode Status			Discrete Status

### Engine Valve/Actuator Temperature

The Engine Valve/Actuator Temperature reports the internal electronics temperature of the F-Series.

From the J1939-71 standard or from the Proprietary PGN range, select a PGN number in which the F-Series will populate the desired position data. Configure the byte within the PGN in which the data is to reside. The data is 1 byte long (8 bits).

Engine Valve/Actuator Temperature SPN

Data length:	1 byte, unsigned
Resolution:	1 °C/bit, -40 offset
Range:	-40 °C to 210 °C
Operational Range:	-40 °C to 210 °C
Error State:	254 (0xFE) Sent if the temperature sensor is failed

### Legacy Mode Definition

The messages below apply when the Legacy Mode is selected.

#### RECEIVED MESSAGE

##### **PGN 61184 Engine Valve/Actuator Control Command**

Transmission repetition rate:	10 ms or as required (Engine Control → F-Series)
Data length:	8 bytes
Data page:	0
PDU format:	239
PDU specific:	F-Series Source Address
PGN:	61184 (0xEF00)

**Data:****Byte 1-2:** Valve Position Command

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

Note: The F-Series will cap values between 100 % (0x9C40) and 160.6375 % (0xFAFF) at 100 % and continue to use the flow demand as 100 %. However, above 0x9C40, a CAN Demand Out-of-Range Error will be announced by the F-Series. If the value exceeds the Valid Signal range (> 0xFAFF or 64255) the CAN Demand Fault will be set and the CAN position demand setpoint will be forced to 0.

**Byte 3:** Reset Diagnostic Faults Command Bits (*not available in 5418-2724, 5418-2725, or 5418-3834*)

Bit 0: Reset Active Diagnostic (2 bits)  
 00 – No action  
 01 – Clear active faults  
 10 – Reserved  
 11 – Reserved

Bit 2: Reset Logged Diagnostic (2 bits)  
 00 – No action  
 01 – Clear logged faults  
 10 – Reserved  
 11 – Reserved

Bit 4-7: RESERVED

Note: Faults are reset only once after transition 00 → 01.

**Byte 4:** Run/Stop Command Bits (*not available in 5418-2724, 5418-2725, or 5418-3834*)

Bit 0: Run/Stop Command Bits (2 bits)  
 00 – Run  
 01 – Shutdown  
 10 – Reserved (no change in operating state)  
 11 – Not Supported (no change in operating state)

Bit 2-7: RESERVED

**Bytes 5-8:** RESERVED

The F-Series will accept any message length of 2 bytes up to 8 bytes. These 6 bytes (Bytes 3 – 8) will be ignored regardless of their value.

**TRANSMITTED MESSAGES****PGN 65530 F-Series Data Message**

Transmission repetition rate: 100 ms (F-Series → Engine Control)  
 Data length: 8 bytes  
 Data Page: 0  
 PDU format: 255  
 PDU specific: 250  
 Default priority: 6  
 PGN: 65530 (0xFFFA)

**Data:****Byte 1-2:** Engine Valve/Actuator Position (Actual)

Data length: 2 bytes  
 Resolution: 0.0025 %/bit, 0 offset  
 (Multiply received value by 0.0025 to recover the position as 0 % to 100 %)  
 Range: 0 to 160.6375 % (0x00 to 0xFAFF)  
 Error: 65279 (0xFEFF) Sent if position sensor is failed

**Byte 3-4:** Engine Desired Valve/Actuator Position

Data length: 2 bytes  
 Resolution: 0.0025 %/bit, 0 offset  
 (Multiply received value by 0.0025 to recover the position as 0 % to 100 %)  
 Range: 0 to 160.6375 % (0x00 to 0xFAFF)  
 Error: 65279 (0xFEFF) Sent if all position demand sources are failed

**Byte 5:** Engine Valve/Actuator Temperature (Electronics)

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: 254 (0xFE) Sent if temperature sensor is failed

**Byte 6:** Specific Diagnostic Indications (1)

Data length: 1 byte  
 Bit 0: Shutdown  
 Bit 1: Alarm  
 Bit 2: Derating Active (Temperature > 118 °C)  
 Bit 3: Shutdown excluding Run Enable (*not available in 5418-2724, 5418-2725, or 5418-3834*)  
 Bit 4: Loss of Position Demand (*not available in 5418-2724, 5418-2725, or 5418-3834*)  
 Bit 5: Demand Tracking Error (*not available in 5418-2724, 5418-2725, or 5418-3834*)  
 Bit 6: Temperature > 125 °C (*not available in 5418-2724, 5418-2725, or 5418-3834*)  
 Bit 7: RESERVED

**Byte 7:** Specific Diagnostic Indications (2)

Data length: 1 byte  
 Bit 0: PWM Input High Duty Cycle Error  
 Bit 1: PWM Input Low Duty Cycle Error  
 Bit 2: Analog Input High Error  
 Bit 3: Analog Input Low Error  
 Bit 4: Input (Supply) Voltage High Error  
 Bit 5: Input (Supply) Voltage Low Error  
 Bit 6: Electronics Temperature High Error  
 Bit 7: Electronics Temperature Low Error

**Byte 8:** Specific Diagnostic Indications (3)

Data length:	1 byte
Bit 0:	Position Error
Bit 1:	Run Enable not active
Bit 2:	Spring Check Failed
Bit 3:	Internal Fault
Bit 4:	CAN Fault (includes CAN Bus Off, CAN Demand Failed, CAN demand out of range, CAN Address Claim Error)
Bit 5:	Power up indication ( <i>only provided in 5418-2724, 5418-2725, and 5418-3834</i> )
Bit 5-7:	RESERVED

Note: All Units report using the same PGN when set to Legacy Mode. If more than one unit is present on the same CAN network, the receiving ECU must use source address filtering to identify which actuator the received message is from.

**PGN 65242 Software Identification (SOFT)**

Transmission repetition rate:	On Request (F-Series → Engine Control)
Data length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	218
Default priority:	6
Parameter Group Number:	65242 (0xFEDA)

**Data:**

Byte 1: Number of Software Identification Fields, SPN 965

Data length:	1 byte
Resolution:	1 /bit, 0 offset
Range:	0 to 250 (0x00 to 0xFA)
Actual value:	1 (F-Series will always report 1)

Bytes 2-7: Software Identification, SPN 234

Data length:	6 bytes
Resolution:	ASCII, 0 offset
Range:	0 to 255 per byte
Actual value:	002.00
Character:	48, 48, 50, 46, 48, 48 (hex: 30, 30, 32, 2E, 30, 30)

Byte 8: Delimiter, SPN 234

Data length:	1 byte
Resolution:	ASCII, 0 offset
Range:	0 to 255 (0x00 to 0xFA)
Actual value:	42 (0x2A)
Character:	*

**Common Messages**

The messages are used in both Legacy Mode and Custom Mode.

**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 (0xEE00)

Bytes 1.1 - 3.5: (21 bits) Identity Number, SPN 2837  
Bytes 3.6 - 4.8 : (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 6.1: (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

The Address Claimed message will be sent out shortly after power has been applied to the F-Series. The Address Claimed message will also be sent out in response to a Request for Address Claimed. The Request for Address Claimed can be sent to a specific Address or to the Global Destination Address, 255. The F-Series will respond to a specific query, or one to the Global Destination Address, 255.

Note: The configured source address and NAME components will be used even in Legacy Mode. The defaults represent the values used in the past.

The Source Address for the F-Series is configurable uniquely for each Unit Number using the service tool. If the Dynamic Addressing option is disabled (default), the F-Series will only try to claim the configured address. If a higher priority device claims the configured address, the F-Series will stop communicating as defined per SAE J1939. If the Dynamic Addressing option is enabled, the source address saved using the service tool will be the first address attempted by the F-Series. If the F-Series is unable to acquire the specified address, it will attempt to claim another address starting at 128 and increasing by 1 until an available source address can be claimed. If no address can be claimed, it will stop communicating until power cycled. Once an address has been claimed it will be saved and used on all future boot-ups as the first address to attempt.

The Address Claimed Message will also be sent out if the F-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 Cannot Claim Address message will be sent out if the F-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 F-Series is replaced with 254. The Cannot Claim Address message will be sent out with a 0–153 millisecond pseudo-random delay between the reception of the triggering message and the transmission of the Cannot Claim Address message.

If the F-Series cannot claim an Address a status bit will be set and any position demand value from CAN will be forced to zero (this may cause a shutdown depending on demand source settings).

F-Series NAME:

Component	Setting	Default Value	Configurable?
Arbitrary Address Capable Field	Disabled	0	Yes
Industry Group Field	Global	0	No
Vehicle System Instance Field	First Instance	0	No
Vehicle System Field	Non-specific system	0	No
Function Field	Unspecified	255	Yes
Function Instance Field	First	0	Yes
ECU Instance Field	Unit 1	0	Yes
	Unit 2	1	
	Unit 3	2	
	Unit 4	3	
Manufacturer Code Field	Woodward Governor Industrial Controls	153	No
Identity Number Field	Unique	Unique	No

Table 4-6. J1939 NAME

See Appendix B for examples of each NAME component.

**PGN 59904 Request (RQST)**

PGN Request Message. Sent by Engine Control (or Tool) to the F-Series to obtain a PGN that is not sent cyclically and used with DM3 and DM11.

Transmission rate: As needed  
 Data length: 3 bytes  
 Data Page: 0  
 PDU format: 234  
 PDU specific: F-Series Source Address  
 Default priority: 6  
 Parameter Group Number: 59904 (0xEA00)

Bytes 1-3: (24 bits) Parameter Group Number requested, SPN 2540

As defined in SAE J1939-21, if the PGN to be requested is a PDU1 type (PDU format field <240) then the lower byte of the PGN number (the PDU specific byte) shall be set to 0.

To request the Software ID PGN, use this request message with the data equal to 65242.

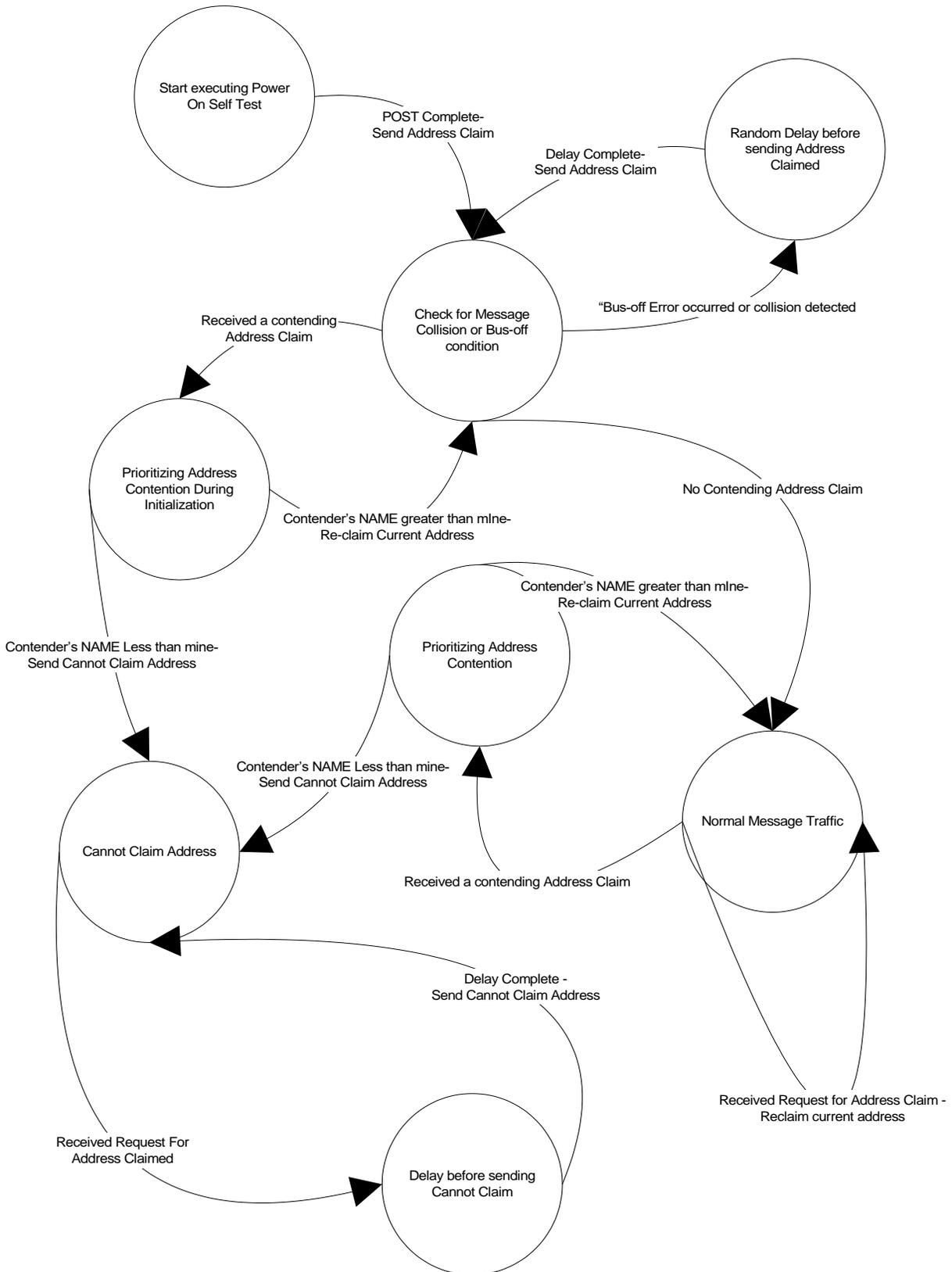


Figure 4-4. Address Claimed State Chart

**PGN 59392 Acknowledgment (ACK)**

This message is sent by the F-Series (as a NACK) as needed according to the protocol.

Transmission rate: As needed  
 Data length: 8 bytes  
 Data Page: 0  
 PDU format: 232  
 PDU specific: Destination Address  
 Default priority: 6  
 Parameter Group Number: 59392 (0xE800)

**Data:****Byte 1:** Control Byte

- 0: Positive Acknowledgement (Reset action was successful)
- 1: Negative Acknowledgement (Reset action unsuccessful or PGN not available)

**Bytes 2-4:** Group Function and Reserved

The F-Series does not use these bytes. Sent as 255.

**Byte 5:** Source Address of device being acknowledged (or NACK'd)

**Bytes 6-8:** PGN being acknowledged (or NACK'd)

See J1939-21 for further details on the data.

**J1939 Diagnostics Summary**

The following table helps correlate each warning and error condition with the multiple J1939 reporting methods.

See Tables 4-2, 4-4, and 4-3 for definitions of Prelim FMI, Operation Status, and Temperature Status. Diagnostic conditions details are provided in the Faults section.

Diagnostic Condition	Legacy Bit Field	New Bit Field	Data Indications	Prelim FMI	Operation Status (When Diag is config as an Alarm)	Operation Status (When Diag is config as a SD)	Temperature Status
Internal Fault	6.4	1.1	Data not reported in an SPN	12	CONTROLLED SD	CONTROLLED SD	Not affected
Run Enable Shutdown	6.2	3.1	Data not reported in an SPN	5	UNCONTROLLED SD	UNCONTROLLED SD	Not affected
Zero Drive Current (>125 °C)	5.7	2.7	Temperature value >= 125 °C	0	CONTROLLED SD	CONTROLLED SD	HIGH MOST SEVERE
Loss of Position Demand (all)	None	3.5	Desired Position set to 0xFE	14	ALARM HIGH SEVERITY	CONTROLLED SD	Not affected
Analog Demand Failed High	5.3	3.7	Desired Position shows value in use	15	ALARM	CONTROLLED SD	Not affected
Analog Demand Failed Low	5.4	3.7	Desired Position shows value in use	17	ALARM	CONTROLLED SD	Not affected

Diagnostic Condition	Legacy Bit Field	New Bit Field	Data Indications	Prelim FMI	Operation Status (When Diag is config as an Alarm)	Operation Status (When Diag is config as a SD)	Temperature Status
PWM Duty Cycle Failed High	5.1	4.1	Desired Position shows value in use	8	ALARM	CONTROLLED SD	Not affected
PWM Duty Cycle Failed Low	5.2	4.1	Desired Position shows value in use	8	ALARM	CONTROLLED SD	Not affected
CAN Demand Failed - No Signal	6.5	4.3	Desired Position shows value in use	9	ALARM	CONTROLLED SD	Not affected
Position Error	6.1	1.7	Position feedback shows position	7	ALARM HIGH SEVERITY	CONTROLLED SD	Not affected
Low Supply Voltage Fault	5.6	1.3	Data not reported in an SPN	4	DERATE	CONTROLLED SD	Not affected
High Supply Voltage Fault	5.5	1.3	Data not reported in an SPN	3	ALARM	CONTROLLED SD	Not affected
Electronics Temp High (Derating)	None	2.5	Temperature value $\geq 118$ °C	15	DERATE	CONTROLLED SD	HIGH LEAST SEVERE
Demand Tracking Error	None	3.3	Data not reported in an SPN	2	CONTROLLED SD	ALARM state	Not affected
Temperature Sensor Failed	None	2.3	Temperature data set to 0xFE	12	DERATE	DERATE state	ERROR state
Spring check failed	6.3	1.5	Data not reported in an SPN	7	ALARM HIGH SEVERITY	CONTROLLED SD	Not affected
CAN Demand Out of Range	6.5	4.3	Desired Position shows one in use	16	ALARM	CONTROLLED SD	Not affected
Normal	None	None	Normal	31	NORMAL	NORMAL state	IN RANGE state
Electronics Temperature Low	5.8	None	Temperature value $< -40$ °C	None	ALARM	CONTROLLED SD	LOW LEAST SEVERE
Power up Reset	6.6	None	None	None	ALARM	CONTROLLED SD	Not affected
Watchdog Reset	None	None	None	12	ALARM	CONTROLLED SD	Not affected
Configuration Error	None	2.1	None	13	ALARM	CONTROLLED SD	Not affected
Address Claim Error	None	None	None	None	Can't Transmit	Can't Transmit	Can't Transmit

Table 4-7. J1939 Diagnostic Reporting

## Return Spring Check

If configured for use, a spring check function attempts to verify proper operation of a return spring.

Once the position control becomes active at power-up, the F-Series actuator moves the output shaft to the configured 'Start' position. Once the output shaft reaches the 'Start' position, an internal timer starts and the actuator drive current drops to zero (the unit goes limp). Failure to reach the 'Start' position in 200 ms or failure to reach the 'Finish' position before the timeout period expires will trigger a Spring Check fault. If successful, the spring check Status area of the Service Tool will display 'Passed'.

The spring check function is not performed if a valid demand signal or shutdown condition is present before the spring check completes. The spring check status area of the Service Tool will display 'Not Performed'.

## Position Error Handling

The F-Series actuator detects and triggers a position error between the position set point and the actual position of the actuator shaft by monitoring an internal position feedback sensor.

During dynamic changes of the set point, the allowed position of the feedback is a range instead of only one value (the set point) in the actuator. The range is defined by the area between the set point and an allowed position error rate. The rate is the max of the default programmed rate and the rate of the actual feedback position, meaning if the actuator moves faster than the default rate, the actual position rate will be used to defined the position error range. See Figure 4-5.

The error is measured by the difference between the range boundary and the actual position from the feedback. The Position Error is triggered in the shutdowns and alarms when the error is over the instantaneous threshold or over the filtered threshold. A 150 ms filter is used for the filtered error threshold. The parameters are internal and can't be customized through the Toolkit Service Tool.

Parameter	Value	Unit
PosFaultRate	683	Rad/sec
PosFaultRads	0.1	Rad
PosFaultRadsInst	0.2	Rad

Table 4-8. Position Error Internal Settings

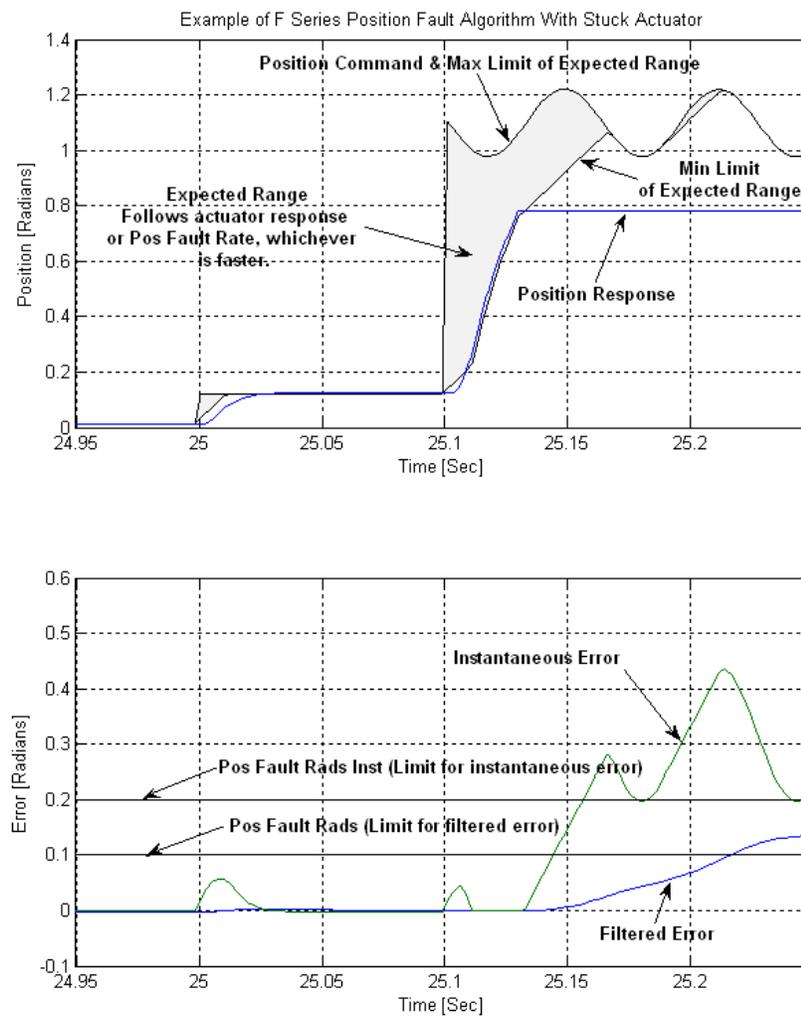


Figure 4-5. Position and Error Example with Stuck Actuator

## Fault Detection and Annunciation

The Shutdowns and Alarms screens on the F-Series Service Tool 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.

Faults can be configured to either alarm or shutdown on occurrence. An alarm basically does nothing but annunciate the fault. A shutdown forces the actuator to a predetermined position regardless of the demanded position. The 'Not Run Enabled' shutdown is an exception that simply causes the actuator to go limp. Faults can be globally set as either latching or non-latching. When set as latching, the fault action continues until the control is reset. Shutdown faults must be reset to allow the unit to restart. If non-latching, the actuator is returned to a non-shutdown state when the shutdown condition no longer exists.

### NOTICE

**A non-latching shutdown configuration can lead to a situation where the system is rapidly cycling between two states and should be used with caution.**

## Faults

Active Faults are those presently detected or previously detected but latched and not reset. The configuration as latching/non-latching faults factors into this indication. If the fault is latching, then an active fault could either be one that is still present or one that had occurred but is now normal and has not been reset.

When active faults are configured as non-latching, a reset is not needed. If latching faults are configured, a reset command or power-cycle is required to clear the fault and resume positioning. A reset command is accomplished by activating and de-activating the Run Enable discrete input (if available and configured), using the Reset Active Faults button on the service tool or by issuing a Reset Active Diagnostic command over CAN.

Parameters are available to configure a fault to be used or ignored and, if used, to be configured as an alarm or shutdown. Each fault can also be independently set to change the state of the discrete output. The shutdown action performed is fault-dependent. Some faults are dedicated as shutdowns only and cannot be configured—they are identified as such below.

A logged fault is one that has occurred but is no longer active or latched in the control. Logged faults are non-volatile and can only be cleared by selecting the 'Reset Logged Faults' button on the Service Tool Alarm or Shutdown screens.

### Shutdown List

The following diagnostic conditions always cause a shutdown:

**Configuration Error**—This indicates the configuration settings are not valid and operation is not allowed until corrected.

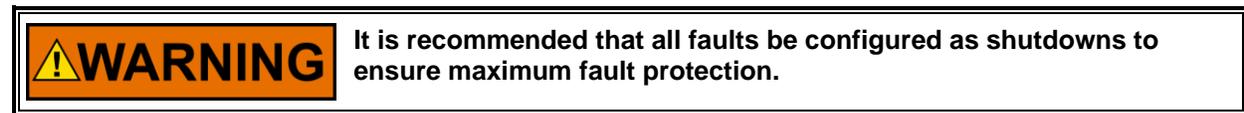
**Temperature > 125 degC**—This indicates the internally sensed temperature of the F-Series has exceeded 125 °C and the maximum drive current allowed has been decreased to zero (see the temperature-based current limiting in Chapter 4).

**Internal Fault**—Indicates an internal failure has occurred. The Internal Faults shown on the Shutdowns page of the service tool indicate the exact cause. If detected, the control output will drive to the Fail Direction using current control. This fault always latches and requires a reset or power cycle to clear.

- **Position Sensor Failed**—An internal diagnostic check has determined the actuator position sensor has failed. This is a hard-coded internal shutdown. If detected, the control output will drive to the Fail Direction using current control. This fault always latches and requires a reset or power cycle to clear.
- **EEPROM Read Fail**—Indicates a read problem with the EEPROM values. EEPROM is always read twice. If the values do not match a retry counter is incremented. After 5 retries the fault is set.
- **EEPROM Write Fail**—Indicates a problem with writes to the EEPROM. When writing to the EEPROM every byte is checked. If the value does not match the written value after 5 retries the fault is set.
- **Parameter Error**—Indicates the CRC stored with the parameters does not match the CRC of the parameters stored in non-volatile memory.
- **Parameter Version Error**—Indicates the versions of parameters are mixed. This fault is set if the CRC stored with the parameters does not match the CRC currently residing in non-volatile memory.
- **SPI A/D Error**—Indicates the A/D is not communicating or did not complete all its conversions for more than 5 ms.
- **+15 V Supply Error**—Indicates the internal +15 V power circuit is out of range.
- **–15 V Supply Error**—Indicates the internal –15 V power circuit is out of range.
- **5 V Reference Supply Error**—Indicates the internal 5 V reference is out of range.
- **5 V Supply Error**—Indicates the internal 5 V power circuit is out of range.
- **A/D Converter Error**—Indicates the A/D is not getting interrupts and not providing updates for more than 96 ms.

## Configurable Alarm and Shutdown List

The following diagnostic conditions can be configured as an alarm, a shutdown, or ignored (not used):



**Loss of Position Demand**—Indicates all configured position demand signals are determined to be failed, both the primary and the backup (when used).

**Demand Tracking Error**—Indicates all primary and backup demand signals are not within the configured tolerances, exceeding the Tracking Error Max for longer than the Tracking Error Delay.

**Analog Input High**—Indicates the analog input went above the configured analog input Diagnostic Maximum threshold.

**Analog Input Low**—Indicates the analog input went below the configured analog input Diagnostic Minimum threshold.

**PWM Duty Cycle High**—Indicates the PWM input went above the configured PWM Duty Cycle High Threshold.

**PWM Duty Cycle Low**—Indicates the PWM input went below the configured PWM Duty Cycle Low Threshold.

**Input Voltage High**—Indicates the input supply voltage went above the configured Supply Voltage High Threshold.

**Input Voltage Low**—Indicates the input supply voltage went below the configured Supply Voltage Low Threshold.

**Electronics Temperature High**—Indicates the internal electronics temperature went above 140 °C.

**Electronics Temperature Low**—Indicates the internal electronics temperature went below –45 °C.

**Not Run Enabled**—Indicates the Run Enabled discrete input is in the Not Enabled position. Note this selection cannot be set as an alarm, it is either not used or a shutdown.

**Position Error**—Indicates the position feedback is not following the position demand. Position Error detection logic is designed to account for normal actuator response times to prevent unwarranted position error indications during transient conditions.

**Watchdog Reset Occurred**—Indicates an internal fault caused a watchdog timer timeout that resulted in a reset of the microprocessor. A watchdog timer is set at 13.1 ms. If the timer times out, the unit will reset and this fault is set.

**Spring Check Failed**—This indicates the return spring failed to reach the configured 'Finish' position in the configured timeout period during power-up.

**CAN Bus Off Error**—Indicates the CAN bus controller detects a bus off condition. Typically caused by wiring problems on the CAN link, incorrect or missing termination resistors, or electrical problems within the controller or driver. This fault has a 400 ms diagnostic filter. If this fault goes away and non-latching faults are configured, CAN will return to normal operation.

**CAN Demand Fault**—This fault is set if the CAN demand is missing (no signal), or is too slow (slower than the Demand Timeout setting), or the value received is above 0xFAFF. The position demand signal is forced to zero when this fault is active. If this fault goes away and non-latching faults are configured, the unit will return to normal operation (positioning under CAN command).

**CAN Demand Out of Range**—Indicates the CAN demand value was received above 100 % (> 0x9C40) for longer than 400 ms. The position demand signal is internally limited to 100 % when this fault is active. If this fault goes away and non-latching faults are configured, the unit will return to normal operation (positioning under CAN command).

**CAN Address Claim Error (J1939 only)**—This J1939 fault is set if the control's address cannot be claimed on the CAN bus. Typically a result of another unit on the bus with the same id with a higher priority. The control cannot automatically recover from this fault, a power cycle is required.

## Alarm List

The following diagnostic conditions always cause an alarm:

**Configuration Warning**—This indicates the configuration settings are not valid, however the error is not severe and unit operation is allowed.

**Temperature > 118 degC (derated)**—This indicates the internally sensed temperature of the F-Series has exceeded 118 °C and the maximum drive current allowed has been decreased (see the temperature-based current limiting in Chapter 4).

## Position Dynamics and Stops Settings

(Modular Actuator Only)

The F-Series Service Tool is used to set and save the dynamic (inertia) and mechanical stops settings used by the modular actuator position control. See Chapter 5 for setting instructions.

Position control dynamics are provided to compensate for the system inertia of an installed unit. An automatic inertia test feature is provided to determine and set the optimum inertia setting. The inertia setting can also be manually adjusted. The automatic inertia test method is preferred and recommended for setting the optimum inertia.

The location of mechanical stops must be saved in the F-Series control to properly scale actuator travel (0 % to 100 %) between these stops. An Auto Find Mechanical Stops feature is provided to simplify locating the stop positions at min and max travel. The range of travel can then be manually adjusted by modifying the span and min position offset values. The automatic method for finding the mechanical stops is preferred and recommended. However, the min position offset may need to be adjusted if sticking of the end device (e.g., butterfly valve) is experienced at the min position.

The inertia and stops settings must be saved to the control. If not saved, the control will revert to the previous settings upon loss of power.

The control settings for a specific engine system can be used for other duplicate engine builds provided adequate measures are employed to assure the system inertia, linkage and stop settings are equal to the original engine settings.



**External mechanical stops must be provided in the linkage system. Do not use the internal actuator stops to limit output shaft travel. The internal actuator stops are provided for actuator setup purposes only.**

## Chapter 5. Service Tool

### Introduction

This chapter covers the process of installing and servicing the control by using the F-Series Service Tool. It is assumed that the control has already been installed on the engine.

**IMPORTANT**

Many F-Series actuators are delivered pre-configured and calibrated with OEM specific settings. These units do not require the use of the Service Tool. However, the Service Tool is a valuable troubleshooting aid.

**NOTICE**

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

### Description

The Service Tool software is used to configure, setup, and troubleshoot the F-Series actuator. This chapter describes the installation and use of the Service Tool. It identifies the control parameters available for viewing. Detailed instructions for configuring and setting up the F-Series control for the customer-specific application is provided in Chapter 6.

Connection and configuration for all 23-pin F-Series actuators is provided in one Service Tool. The 14-pin versions (FST) require a different Service Tool.

The F-Series Service Tool software resides on a PC (personal computer) and communicates to the F-Series control via RS-232 connection. An external RS-232 transceiver is necessary to make communications possible with the Woodward F-Series Service Tool. This works best if it is wired into the harness within 18 inches (1 meter max) of the F-Series control.

A communication harness kit (see Figure 5-2) can be purchased from Woodward, part number 8923-1255. The communication harness kit is a service port adaptor not intended to remain in the engine wiring harness during normal operation (only during engine setup). To use this adaptor, a 9-pin straight-through serial cable is needed between the harness transceiver RS-232 port and the PC. This serial cable must include ALL conductors. If it is limited to only pins 2, 3, and 5, it will not function correctly with the adaptor.

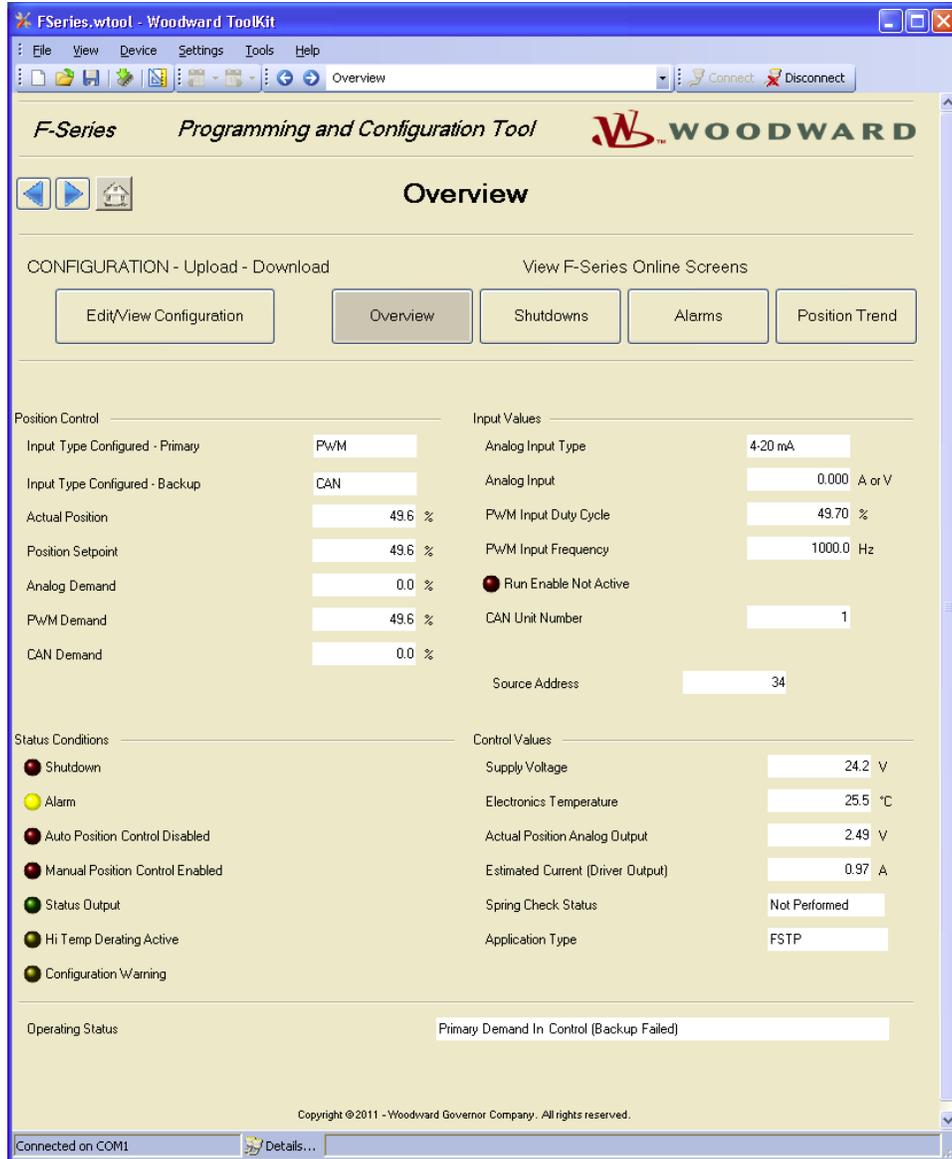


Figure 5-1. Example Service Tool Screen

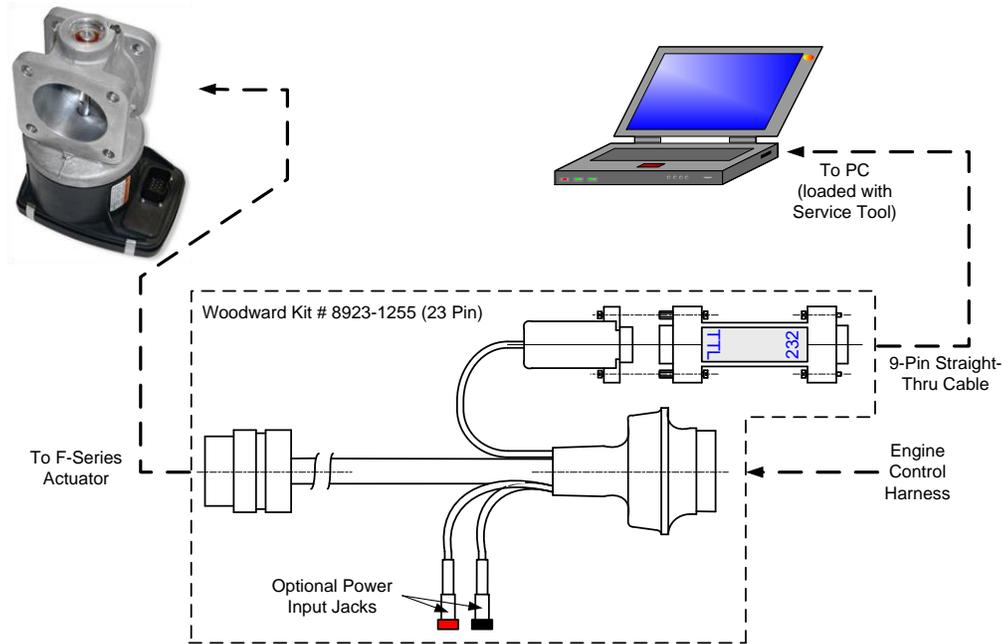


Figure 5-2. Communication- Harness Connections

**NOTICE**

There is a potential for serial port damage when communicating with the F-Series control. 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 F-Series control is referenced to battery ground (AC earth ground), a large amount of current can be experienced. To avoid this situation, we strongly recommend either placing an isolation transformer between the AC outlet and the PC or utilizing an RS-232 port isolator (B+ B 9SPOP2).

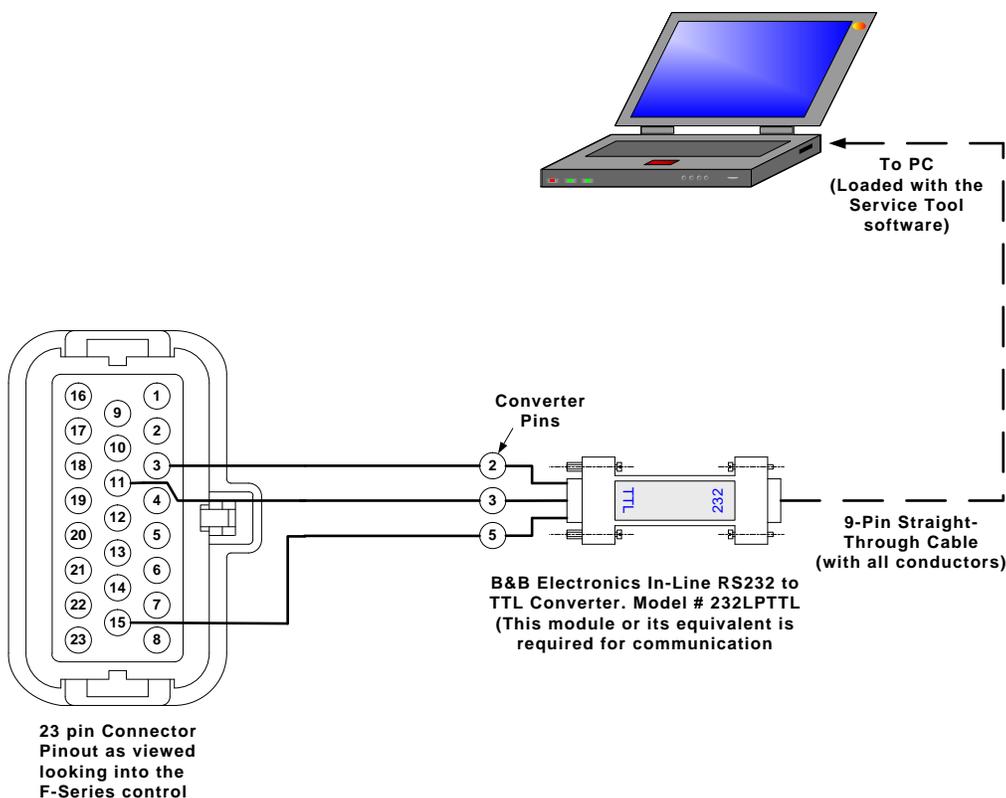


Figure 5-3. Programming Harness Wiring

## System Requirements

The following hardware is required to work with the F-Series control:

- PC-compatible laptop or desktop computer
- Microsoft Windows® 7, Vista, XP (32- and 64-bit)
- Microsoft .NET Framework version 3.5 SP1
- 600 MHz Pentium® CPU
- 96 MB of RAM
- Minimum 800 by 600 pixel screen with 256 colors
- Serial Port
- Serial Extension Cable
- Communication/data link harness.

## System Default Font

A system default font of 'large fonts' will cause some data on the Service Tool to be displayed incorrectly. The following describes the steps to set this value: Right-click on the PC's screen and select 'Properties' then 'Settings' then 'Advanced' from the 'Settings' tab of the 'Display Properties' window. The DPI setting cannot be set to 'large'; set it to normal or small.

## Getting Started

### Installation Procedure

The F-Series Service Tool software can be downloaded and installed from the Woodward Internet site ([www.woodward.com/software](http://www.woodward.com/software)). The service tool is based on Woodward Toolkit software (standard version) included with the service tool installation. End users with a professional version of Toolkit (V3.6 or newer) already installed should skip installing the standard version.

Two F-Series Service Tools are provided for the different actuator types:

- F-Series Throttle (FST) Service Tool – 14-pin version
- F-Series Throttle (FSTP & Mod Actr) Service Tool – 23-pin versions

### What to do Next

After the software is installed, install the correct programming harness and connect a serial communications cable between the transceiver RS-232 port and an unused serial port on your computer. Power must be applied to the F-Series control for the Service Tool to connect.

Run the appropriate Service Tool program and select an available comm. port. Connect to the F-Series control by clicking the connect button on the tool bar.

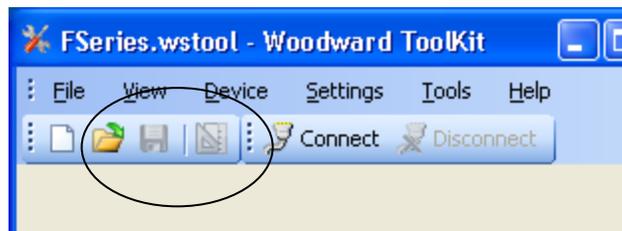


Figure 5-4. Connect to Device

Once connected to the control, the screen view will populate with current values and the status bar will display 'Connected on COM x' (lower left corner of tool).



Figure 5-5. Connected Status Indication

The application type (FSTP, Mod Act), of the control, is displayed on the Overview screen.

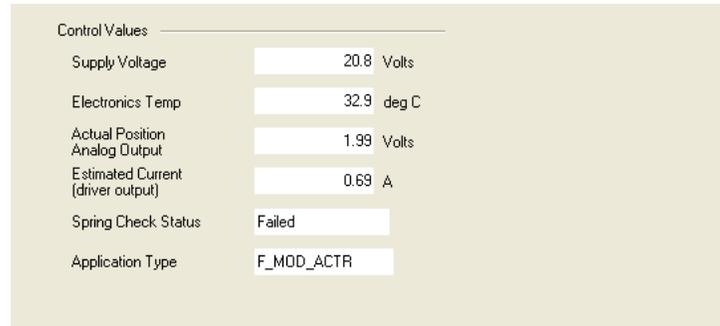


Figure 5-6. Application Type Indication

The Application firmware version can be verified by clicking on the Details button on the bottom of the screen. The Application Id is the firmware version of the connected device. This window is closed by clicking on the Details button again.

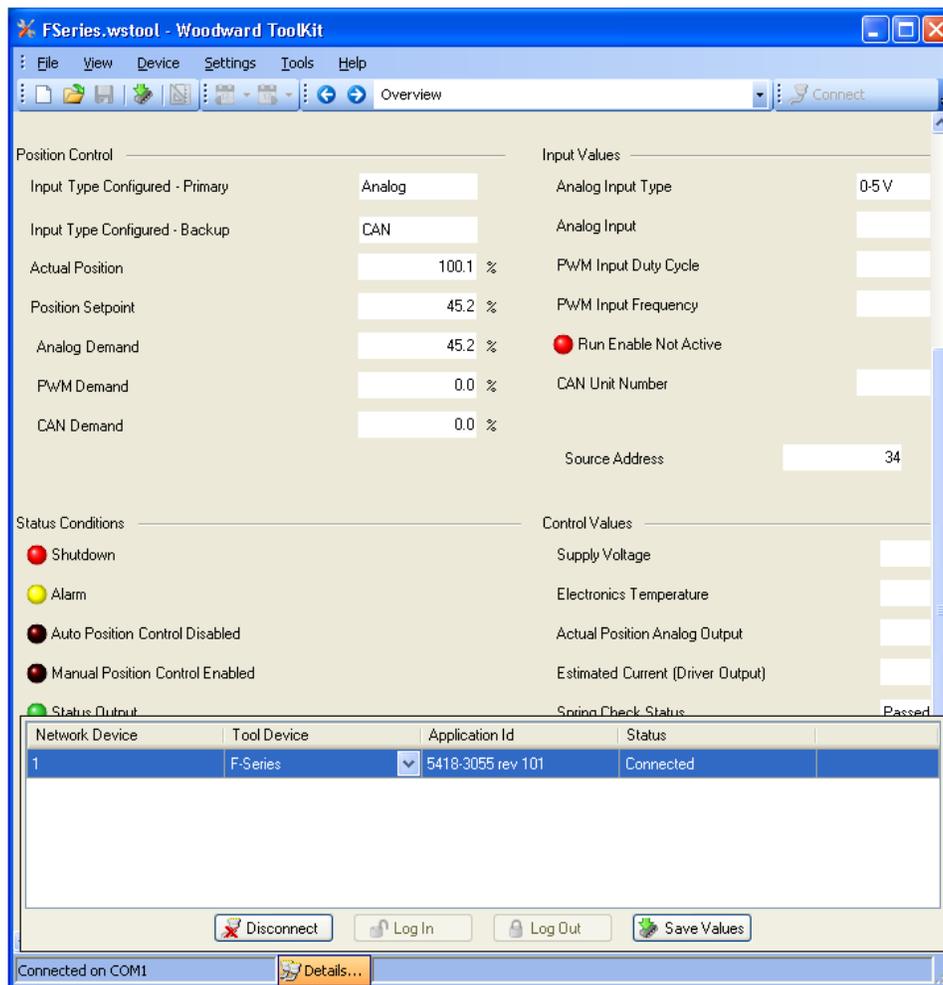


Figure 5-7. Communications Window

The following window appears if the Service Tool cannot find the correct service interface definition (sid) file to communicate with the device. If this occurs, the device is not compatible with the Service Tool version. The latest versions can be downloaded at [www.woodward.com](http://www.woodward.com).

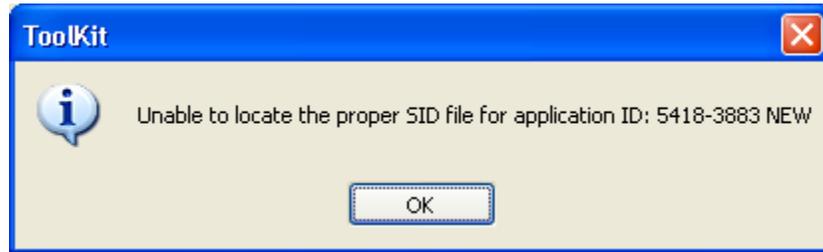


Figure 5-8. Improper SID Window

To set this up initially, select Options under the Tools menu.

## Service Tool Help

Online Service Tool help is available and included with the installation of the Service Tool product. Help can be accessed from the Service Tool 'Help' menu located on the Main Window.

## Service Tool Security

There are no password security levels provided by the F-Series Service Tool.

## Troubleshooting the Driver

All Service Tools have four screens for troubleshooting driver parameters:

- Overview (Figure 5-9)
- Shutdowns (Figure 5-10)
- Alarms (Figure 5-11)
- Position Trend (Figure 5-12)

The Modular Actuator model has one additional setup and tuning screen: Position Dynamics & Stops Settings (see Figure 5-18)

The FST model has fewer features than the FSTP and Modular Actuator versions. The FSTP model has fewer features than the Modular Actuator version. The Service Tool for each actuator version only displays values applicable to each particular actuator.

### **IMPORTANT**

Some screens shown in these instructions are for the more heavily populated Modular Actuator Service Tool. The FSTP version will have fewer parameters and screens. The parameter description will identify those parameters and screens not common to all models.

## Screen Navigation

Service Tool screens can be selected for viewing in a variety of ways:

- Pull Down Box on the tool bar
- Next/Previous Page buttons on the tool bar
- Page Up/Page Down keyboard keys.
- Navigation buttons

## Overview Screen

To view general F-Series control parameters, go to the Overview screen.

The screenshot shows the 'F-Series Programming and Configuration Tool' interface. The main window title is 'FSeries.wtool - Woodward Toolkit'. The toolbar includes 'File', 'View', 'Device', 'Settings', 'Tools', and 'Help'. A dropdown menu is open, showing 'Overview' selected. Below the toolbar, there are navigation buttons (left, right, home) and a 'View F-Series Online Screens' section with buttons for 'Edit/View Configuration', 'Overview', 'Shutdowns', 'Alarms', and 'Position Trend'. The main content area is divided into several sections:

- Position Control:**
  - Input Type Configured - Primary: PWM
  - Input Type Configured - Backup: CAN
  - Actual Position: 49.6 %
  - Position Setpoint: 49.6 %
  - Analog Demand: 0.0 %
  - PWM Demand: 49.6 %
  - CAN Demand: 0.0 %
- Input Values:**
  - Analog Input Type: 4-20 mA
  - Analog Input: 0.000 A or V
  - PWM Input Duty Cycle: 49.70 %
  - PWM Input Frequency: 1000.0 Hz
  - Run Enable Not Active (radio button selected)
  - CAN Unit Number: 1
  - Source Address: 34
- Status Conditions:**
  - Shutdown (red circle)
  - Alarm (yellow circle)
  - Auto Position Control Disabled (red circle)
  - Manual Position Control Enabled (red circle)
  - Status Output (green circle)
  - Hi Temp Derating Active (yellow circle)
  - Configuration Warning (yellow circle)
- Control Values:**
  - Supply Voltage: 24.2 V
  - Electronics Temperature: 25.5 °C
  - Actual Position Analog Output: 2.49 V
  - Estimated Current (Driver Output): 0.97 A
  - Spring Check Status: Not Performed
  - Application Type: FSTP
- Operating Status:** Primary Demand In Control (Backup Failed)

At the bottom, it shows 'Connected on COM1' and 'Copyright ©2011 - Woodward Governor Company. All rights reserved.'

Figure 5-9. Overview Screen

**Position Control Section****Input Type Configured - Primary**

Displayed value of the configured primary demand source (Analog, CAN, or PWM).

**Input Type Configured - Backup**

Displayed value of the configured backup demand source (Analog, CAN, or PWM).

**Position Setpoint**

Displayed value of the Position Setpoint – in percent.

**Actual Position**

Displayed value of the Actual Position – in percent.

**Analog Demand**

Displayed value of the Analog Input scaled to position demand before being limited between 0 % and 100 % – in percent.

**PWM Demand**

Displayed value of the PWM Input scaled to position demand before being limited between 0 % and 100 % – in percent.

**CAN Demand**

Displayed value of the CAN Input scaled to position demand before being limited between 0 % and 100 % – in percent.

**Status Conditions Section****Shutdown LED**

Indicates an active or shutdown condition when illuminated (Red). The cause of any shutdown is displayed on the shutdown screen.

**Alarm LED**

Indicates an active alarm condition when illuminated (Yellow). The cause of any alarm is displayed on the alarm screen.

**Auto Position Control Disabled LED**

Indicates automatic position control is disabled when illuminated (Red). See the Position Trend screen.

**Manual Position Control Enabled LED**

Indicates manual position control is enabled when illuminated (Red). See the Position Trend screen.

**Status Output LED**

Indicates an active status discrete output condition when illuminated (Green).

**Hi Temp Derating Active LED**

Indicates reduced actuator power output operation (due to detection of high actuator temperature) when illuminated (Yellow).

**Configuration Warning LED**

Indicates an active configuration warning condition when illuminated (Yellow).

## Input Values Section

### **Analog Input Type**

Displayed value of the Analog Input Type (4 mA to 20 mA or 0 V to 5 V [dc]).

### **Analog Input**

Displayed value of the Analog Input – in amps or volts dc.

### **PWM Input Duty Cycle**

Displayed value of the PWM Input Duty Cycle – in percent.

### **PWM Input Frequency**

Displayed value of the PWM Input Frequency – in hertz.

### **Run Enable not active LED**

Indicates the Run Enable input is not active (actuator output current is zero) when illuminated (Yellow).

### **CAN Unit Number**

Displayed value of the CAN Unit number based on the CAN ID Low and High Discrete inputs (1-4).

### **Source Address**

Displayed when CAN J1939 protocol is used. This is a value of the last successfully claimed CAN source address, may be different from configured source address if dynamic addressing is enabled.

### **Node Id**

Displayed when CANopen protocol is used. This is a value of currently used Node Id.

## Control Values Section

### **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.

### **Actual Position Analog Output**

Displayed value of the actual position analog output, in volts, as read by the processor.

### **Estimated Current (driver output)**

Displayed value of the estimated actuator coil current, in amperes, as calculated by the processor.

### **Spring Check Status**

Displayed value of the spring check results (Not Performed, Passed, Failed).

### **Application Type**

Displayed value of the control's firmware application (FST, FSTP, F\_MOD\_ACTR).

### **Operating Status**

Displayed value of the primary/backup demands, indicating which is in control.

## Shutdown and Alarm Indications

The Shutdowns and Alarms screens display the status of active and logged fault conditions. To view active or logged faults go to the Shutdowns and Alarms screens.

Active faults are those presently detected, or previously detected but latched and not reset. To clear active faults that are latched on, click the 'Reset Active Faults' button on the Shutdowns or Alarms screens. If configured as non-latching, active faults self-clear when the fault condition no longer exists.

A logged fault is one that has occurred but is no longer active or latched in the control. Logged faults are non-volatile and can only be cleared by clicking the 'Reset Logged Faults' button on the Shutdowns or Alarms screens.

## Shutdowns Screen

To view shutdowns, go to the Shutdowns screen. The Shutdowns screen displays the status (Red LEDs) of active or logged shutdown conditions.

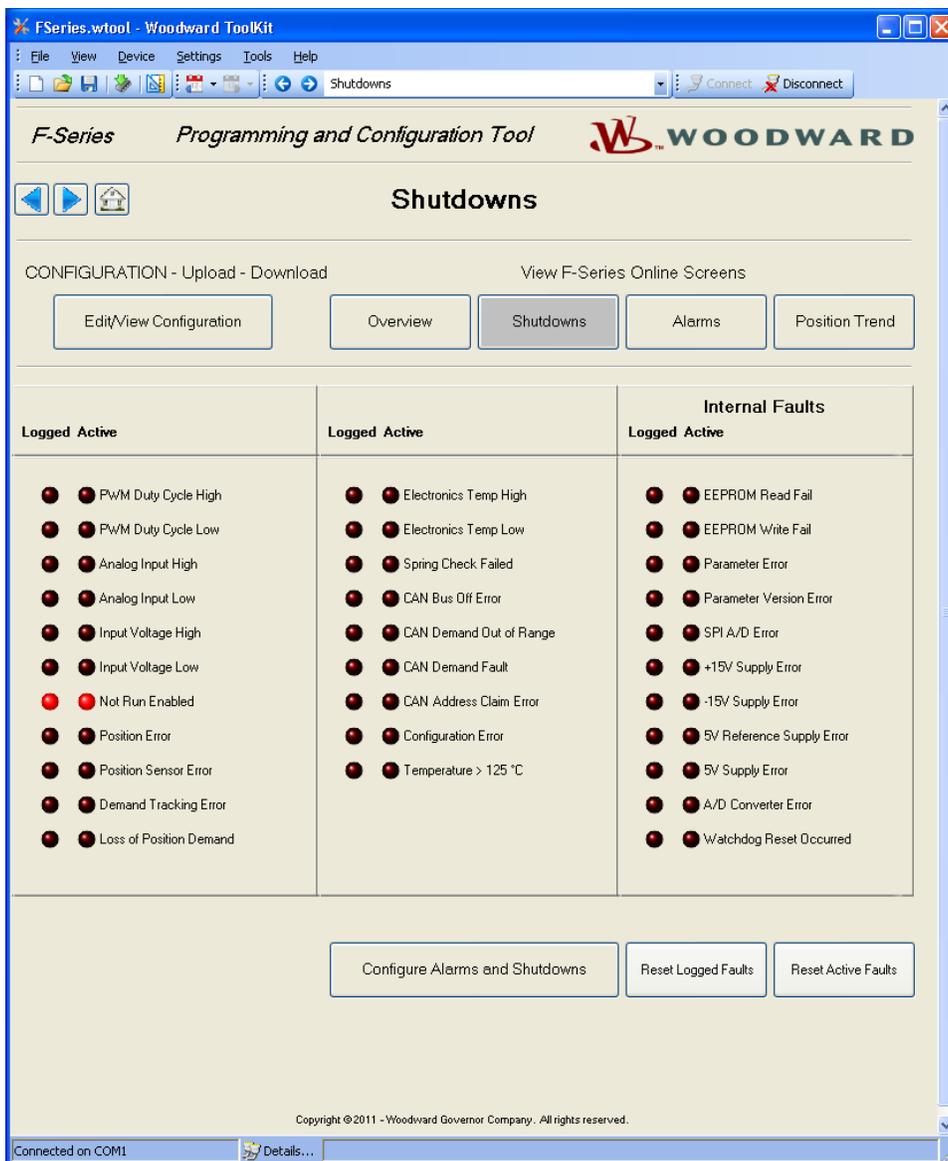


Figure 5-10. Shutdowns Screen

**IMPORTANT**

Refer to Chapter 4 for a complete listing and description of all the fault conditions.

## Alarms Screen

The Alarms screen displays the status (Yellow LEDs) of active or logged alarm conditions.

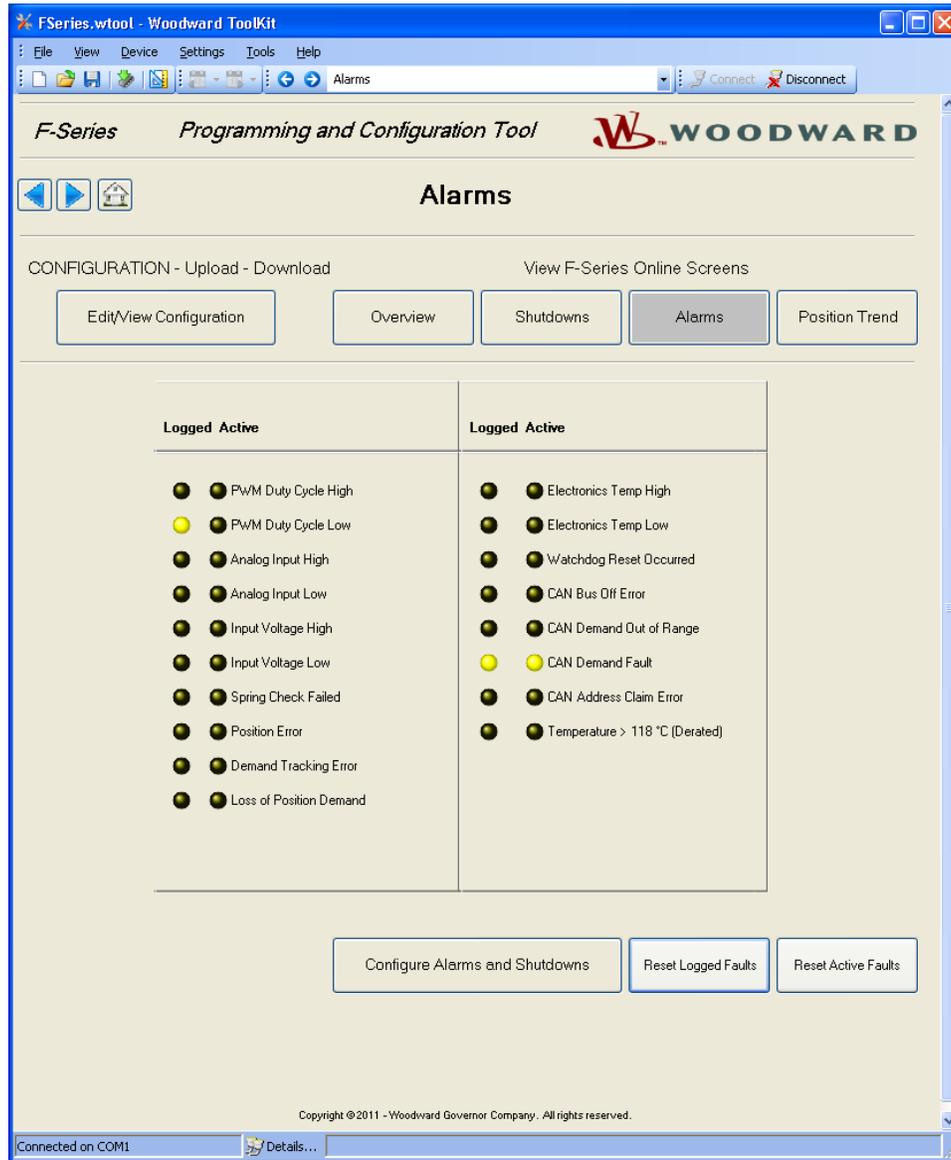


Figure 5-11. Alarms Screen

## Position Trend Screen

To view a trend of the Actual Position and Position Setpoint, go to the Trend screen. These trend parameters are fixed and include:

- Actual Position (Default range is 0 % to 100 %)
- Position Setpoint (Default range is 0 % to 100 %)
- Input Voltage (Default range is 0 V to 30 V [dc])
- Estimated Current (Default range is -4 A to +4 A)

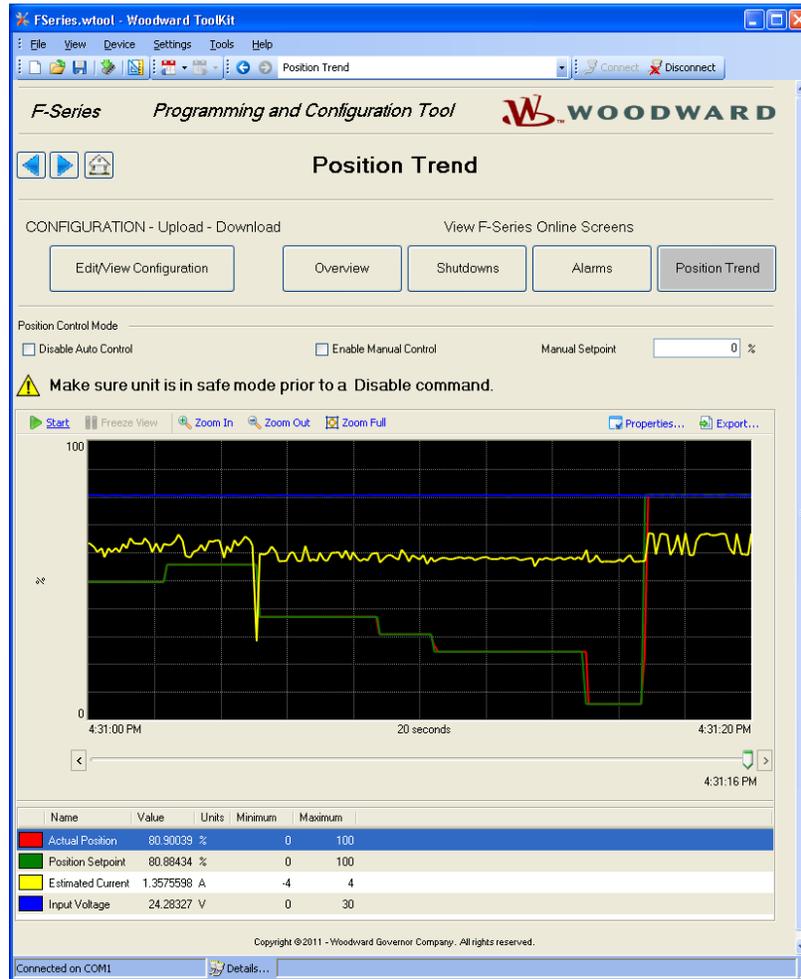


Figure 5-12. Position Trend Screen

### Start/Stop

Click the Start button to begin a position trend. Click the Stop button to freeze the currently displayed values. Clicking the Start button again erases the frozen values and begins trending current values again.

### Position Control Mode

Manual position control is provided on the trend screen to facilitate testing the actuator travel, linkage or valve setup and dynamic response.



**WARNING** Make sure unit is in a safe mode prior to disabling auto position control. Failure to comply with this recommendation can cause personal injury and/or property damage.

### Disable Auto Control

Checking Disable Auto Control Mode disables automatic position control causing the actuator to go limp (zero drive current) and allows manual position control.

Unchecking the Disable Auto Control Mode restores automatic position control and blocks manual position control.

**WARNING**

**Stay clear of the actuator output shaft and all attachments as sudden movement can occur at any time. Failure to comply with this recommendation can cause personal injury and/or property damage.**

### Enable Manual Control

Checking the Enable Manual Control check box enables manual position control when automatic position control is disabled. The actuator immediately drives to and follows the Manual Position Setpoint. Manual position control is blocked when automatic position control is not disabled.

### Manual Setpoint

When both the Disable Auto Control and Enable Manual Control check boxes are checked, the actuator position follows the Manual Position Setpoint.

To change the position setpoint, highlight the present value and type in a new value.

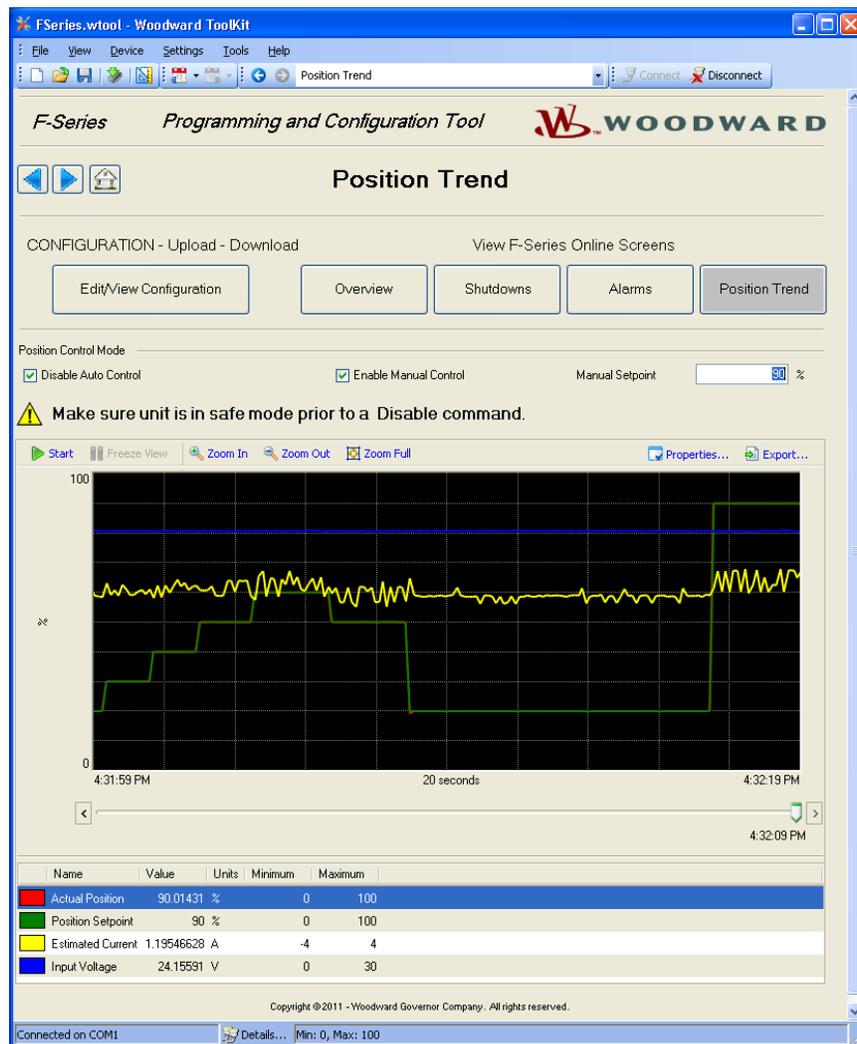


Figure 5-13. Position Trend Screen – Manual Control

## Properties

Trend properties can be changed. Click the Properties button to open the Trending Properties window (Figure 5-14). From this window the trend time span, sample rate, pen colors and high and low range scaling can be changed.

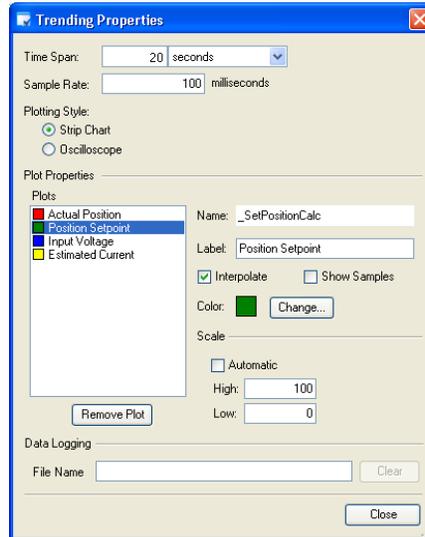


Figure 5-14. Trending Properties window

Checking the show samples option causes the trend plot points to be displayed as enclosed points on the displayed trend.

Click Color Change to select a different plot color for the highlighted plot (e.g., Position Setpoint).

Checking the automatic scale option dynamically sets the range at the maximum and minimum values measured during a trend run. Checking the automatic scale check box overrides the high and low range scaling settings. Unchecking uses the high and low settings. Click 'X' to close the Trend Properties pop up window.

## Export

Click the Export button to save file the values of the trend data points taken during the time period just prior to clicking the stop button (Figure 5-15a). The format of the file is html but it can be opened for analysis using other programs (example Excel Figure 5-15b).

Actual Position		Position Setpoint		Input Voltage		Estimated Current	
Seconds	%	Seconds	%	Seconds	V	Seconds	A
0	100.057998657227	0.0156252	100	0.0156252	26.4165496826172	0.0312504	0.999922037124634
0.0937512	100.057998657227	0.1093764	100	0.1093764	26.4165496826172	0.1250016	0.999922037124634
0.2031276	100.057998657227	0.2187528	100	0.2187528	26.4165496826172	0.2187528	0.999922037124634
0.312504	100.057998657227	0.312504	100	0.3281292	26.4165496826172	0.3281292	0.999922037124634
0.4218804	100.057998657227	0.4375056	100	0.4375056	26.4165496826172	0.4531308	0.999922037124634

Figure 5-15a. Trend Data Points (in web browser)

Time started: 5/23/2011 12:06							
Actual Position		Position Setpoint		Input Voltage		Estimated Current	
Seconds	%	Seconds	%	Seconds	V	Seconds	A
0	100.0579987	0.0156252	100	0.0156252	26.41654968	0.0312504	0.999922037
0.0937512	100.0579987	0.1093764	100	0.1093764	26.41654968	0.1250016	0.999922037
0.2031276	100.0579987	0.2187528	100	0.2187528	26.41654968	0.2187528	0.999922037
0.312504	100.0579987	0.312504	100	0.3281292	26.41654968	0.3281292	0.999922037
0.4218804	100.0579987	0.4375056	100	0.4375056	26.41654968	0.4531308	0.999922037
0.5312568	100.0579987	0.546882	100	0.546882	26.41654968	0.5625072	0.999922037
0.6406332	100.0579987	0.6562584	100	0.6562584	26.41654968	0.6718836	0.999922037

Figure 5-15b. Trend Data Points (in Excel)

## Creating a Custom Trend

Any control parameter can be trended by merely right clicking the value.

Control Values	
Supply Voltage	14.0 Volts
Electronics Temp	35.8 deg C
Actual Position	3.87 Volts
Analog Output	
Estimated Current (driver output)	1.30 A
Spring Check Status	Not Performed

Add to trend

Figure 5-16. Custom Trend

For example, right clicking the Estimated Current then clicking 'Add to trend' produces the following trend.

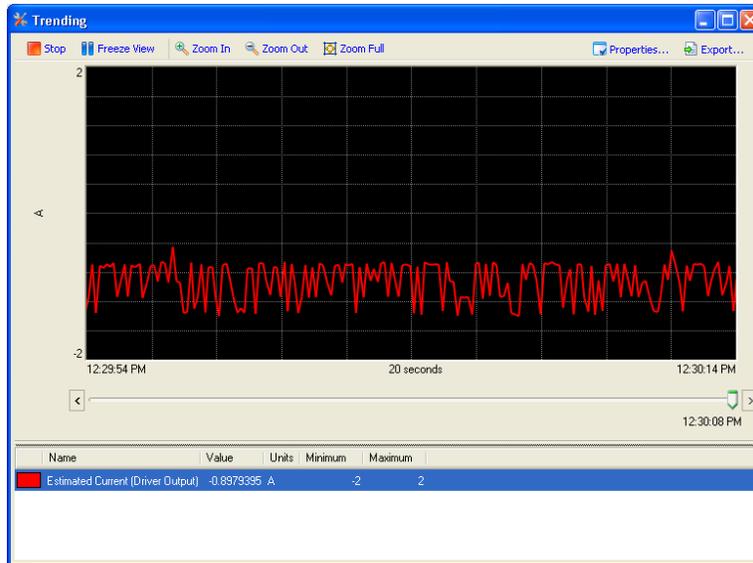


Figure 5-17. Custom Trend Example

The properties default range is automatic and the time span is 20 sec. Use the properties button to make any desired changes. Additional values can be added to this trend as desired by right-clicking other values. Custom trend values can be exported to a file. Zoom in, zoom out, and zoom full change the displayed time window while keeping the same data scaling.

## Position Setup Screen

(Modular Actuator only)

To setup and view the modular actuator position dynamics (inertia) and stops settings, go to the Position Setup screen.

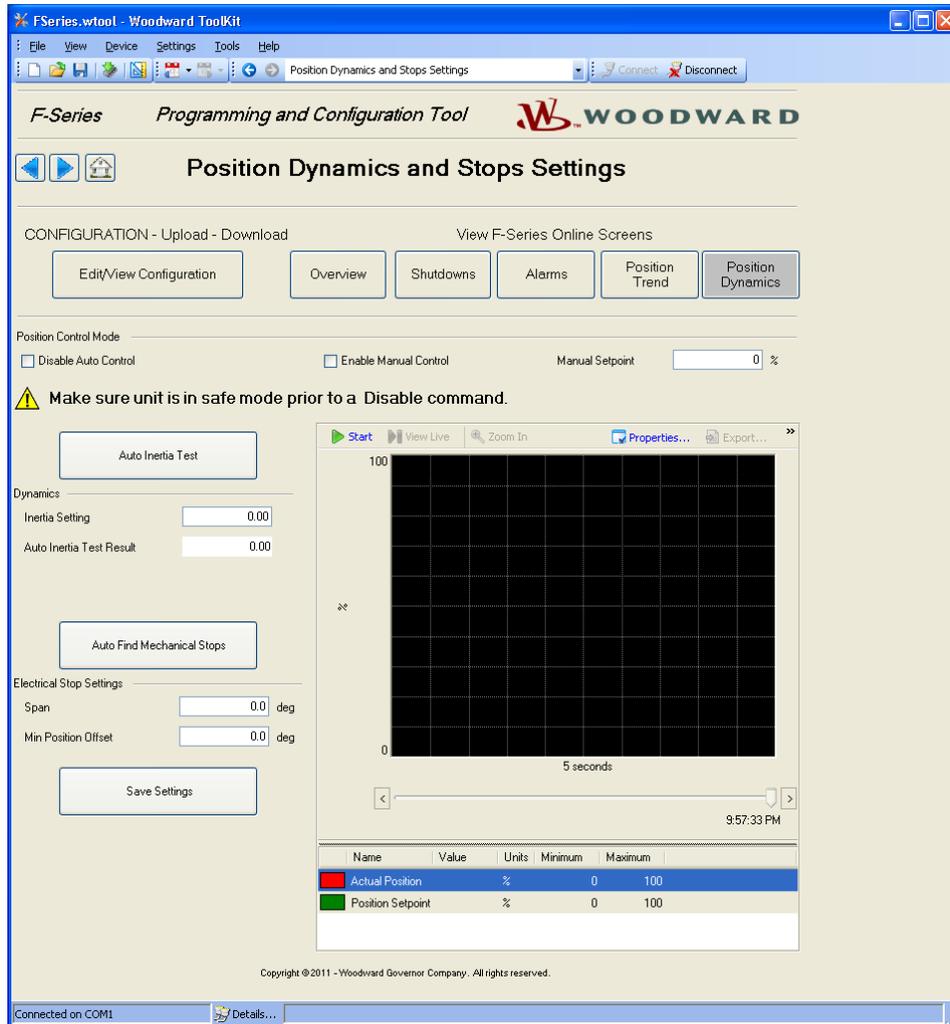


Figure 5-18. Position Setup Screen (Mod Act only)

**WARNING**

**An improperly calibrated control could cause an overspeed or other damage to the prime mover. To prevent possible serious injury from an overspeeding prime mover, read and follow this entire procedure before starting the prime mover.**

Automatic position control must be disabled in order to activate the settings shown on the Position Setup screen. Setting changes will not be effective and cannot be saved while operating in automatic position control.

When automatic position control is disabled, the actuator goes limp (zero drive current). Make sure the unit is in a safe mode (e.g., engine stopped, etc.) prior to selecting the Disable Auto Control check box.

**WARNING**

**Make sure unit is in a safe mode prior to disabling auto position control Failure to comply with this recommendation can cause personal injury and/or property damage.**

### Disable Auto Control

Checking Disable Auto Control Mode disables automatic position control, causes the actuator to go limp (zero drive current), enables the dynamics and stops settings, and allows manual position control.

Unchecking the Disable Auto Control Mode restores automatic position control and blocks manual position control, dynamics and stops settings, and the save position settings.



### WARNING

Stay clear of the actuator output shaft and all attachments as sudden movement can occur at any time. Failure to comply with this recommendation can cause personal injury and/or property damage.

### Enable Manual Control

Checking the Enable Manual Control check box enables manual position control when automatic position control is disabled. The actuator immediately drives to and follows the Manual Position Setpoint.

Manual position control is useful for stroking the actuator from the min and max positions to verify the actuator travel is correct, that the linkage moves freely and the stops are properly set. This feature is also useful for stroking the actuator to the desired end positions and reading the actual position in degrees to manually enter Span and Offset settings if desired.

Manual position control is also useful for stroking the actuator to view the dynamic response. Step changes can be made by setting the Manual position Setpoint to a high value then checking and unchecking the Enable Manual Control check box.

### Manual Setpoint

When both the Disable Auto Control and Enable Manual Control check boxes are checked, the actuator position follows the Manual Position Setpoint.

Adjustable range: 0 % to 100 %



### WARNING

The Modular Actuator inertia setting must be properly adjusted using the F-Series Service Tool prior to engine operation. Improper inertia setting can result in unpredictable actuator movement and possible personal injury or damage to equipment.

### Auto Inertia Test

To have the control automatically find the optimum Inertia Setting, click the Auto Inertia Test button. The control runs a brief inertia test and displays the resulting inertia value in the Auto Inertia Test Result. This tuning method is preferred and recommended.

### Inertia Setting

Displays the inertia value used by the position control. To manually change the Inertia Setting, highlight the present value and type in a new value. These settings are used by the control when they are entered. Adjustable range: 1-10

To save the modified Inertia Setting value to the control, click the Save Settings button. If the modified inertia value is not saved, the previous value will be restored on the next power cycle.

### Auto Inertia Test Result

Displays the inertia value from the Auto Inertia Test.

To save the Auto Inertia Test Result value to the control, click the Save Settings button. If the inertia test result value is not saved, the previous value will be restored on the next power cycle.

### Auto Find Mechanical Stops

To have the control automatically find the mechanical stop position settings (whether internal or external to the actuator), click the Auto Find Mechanical Stops button. This method of setting the stops position is preferred and recommended.

To save the stops position settings to the control, click the Save Settings button. If the stop position values are not saved, the previous values will be restored on the next power cycle.

### Min Position Offset

To manually set the actuator Min Position Offset, highlight the present value and type in a new value. Adjustable range: 0–72 degrees

To save the modified Min Position Offset value to the control, click the Save Settings button. If the modified offset value is not saved, the previous value will be restored on the next power cycle.

**WARNING**

**External mechanical stops must be provided in the linkage system. Do not use the internal actuator stops to limit output shaft travel. The internal actuator stops are provided for actuator setup purposes only.**

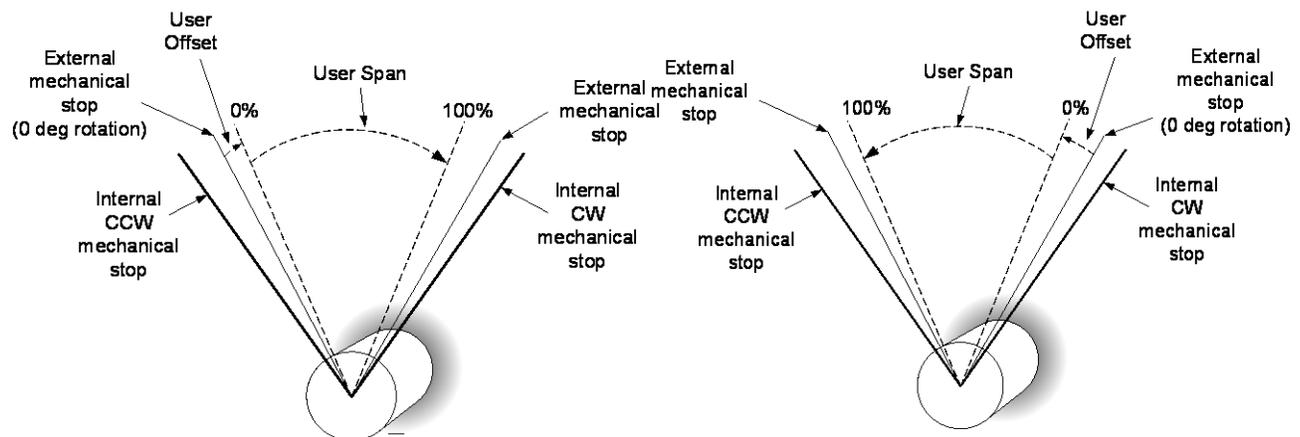


Figure 5-19a. Stops Setup for CW Operation

Figure 5-19b. Stops Setup for CCW Operation

**IMPORTANT**

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

**Span**

To manually set the actuator Span, highlight the present value and type in a new value.

To save the modified Span value to the control, click the Save Settings button. If the modified span value is not saved, the previous value will be restored on the next power cycle. If a span is entered that would cause the actuator to try to move beyond the mechanical stop, the span value is automatically limited to keep the 0 % to 100 % stroke range within the mechanical stops.

Adjustable range: 1-72 degrees

**NOTICE**

The Modular Actuator Inertia and Stop settings are only saved temporarily until the user presses the Save Settings button. If modified values are not saved, the previous values will be restored and used by the control on the next power cycle.

**Actual Position Feedback**

The Actual Position is displayed in percent and degrees travel text boxes. A trend of the Actual Position and Position Setpoint is also provided for viewing the dynamic response. Trend properties can be set and data points can be exported to a file as described earlier for the Position Trend screen.

# Chapter 6. Configuration

## Overview

The F-Series control is configured using the Service Tool. Refer to Chapter 5 for Service Tool installation and connection instructions.

The F-Series control can be configured either on-line or off-line. On-line configuration can only be performed when the Service Tool is connected to the F-Series control. Off-line configuration can be done at any time. On-line and off-Line configuration settings do not take effect until they are loaded into the control.

### **IMPORTANT**

Many F-Series actuators are delivered pre-configured and calibrated with OEM specific settings. These units do not require the use of the Service Tool. However, the Service Tool is a valuable troubleshooting aid.

### **NOTICE**

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

### OEM Configuration File Data

The OEM can save configuration file specific data with the service tool. A notes text field is provided on each configuration screen that can be used to store data for each configuration such as:

- Customer
- Engine Type
- Application Type
- Notes

### Configuring the Unit—On-Line

Unit On-Line configuration is summarized as follows:

1. Connect to the F-Series using the associated Service tool.
2. On the Overview page select the "Edit/View Configuration" button. Allow time for the PC Service tool to download the parameter values (a second or two).
3. Navigate to the parameters using the buttons displayed on the screen and modify as needed.
4. Load the parameters to the device by selecting the "Apply" button located at the bottom right corner of the screen.

### Configuring the Unit—Off-Line

Unit Off-Line configuration is summarized as follows:

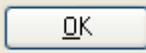
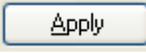
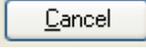
1. Open a new or saved Settings File
2. Edit the configuration settings.
3. Do a 'Save' to keep the same configuration filename OR do a 'Save As' to create a new configuration file.
4. When convenient, connect to the F-Series control and Load the configuration settings to the control.

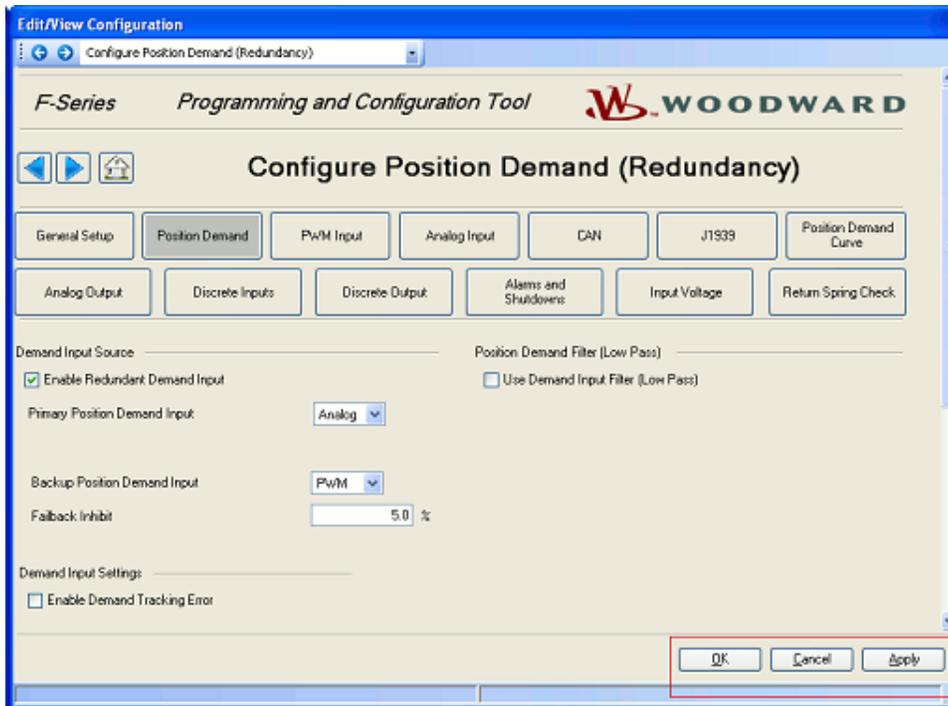
### **IMPORTANT**

New controls are supplied with a configuration. These configurations may consist of default settings or OEM specific settings. Creating a 'New Settings from SID Defaults' is not recommended and not described. Modifying, saving and loading an existing configuration is described.

## Configuring the Unit using Edit/View Configuration Button

Pressing Edit/View Configuration Button when Service Tool is connected to the control opens Settings Editor with currently used settings. From this window, the user can monitor settings or modify them.

-  - to apply changes and exit editor
-  - to apply changes (no exit)
-  - to exit editor with no changes



## Creating a Configuration Settings File

The existing F-Series control configuration settings can be viewed by connecting the service tool to the control, reading the settings, saving the settings to a file then opening the saved file. For service tool instructions, see Chapter 5.

A settings file can be created on-line (connected to control) or off-line (not connected). To create a settings file using Service Tool default settings, click 'Settings' on the Service Tool menu bar then 'New from SID Specification Defaults'. To create a settings file based on the control's current values, click 'Settings' on the Service Tool menu bar then 'Save from Device to File'.

This starts a Save Setting Wizard to save the F-Series control settings to a configuration settings file. You will be prompted for a File name. These settings can be saved to an existing file or, by entering a new file name, to a new file.

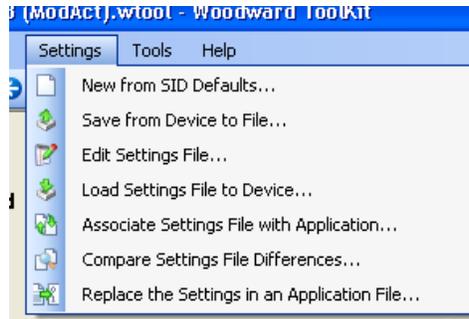


Figure 6-1. Settings Menu Options

## Opening Configuration Settings Files

Settings Files can be opened to view configuration settings, edit settings, 'save' (or 'save as') settings and download settings to the control.

To open the Settings Files, click 'Settings' on the F-Series Service Tool menu bar then select 'Edit Settings File'. From the list of names, simply double click the desired file name. This opens a Settings Editor screen for viewing or editing the configuration settings (for example, Figure 6-2, Configure PWM Input).

## Configuration Parameters

The number of Settings Editor screens varies between the different control types— FST, FSTP and Modular Actuator. These settings editor screens are used to set the configuration parameters.

The following screens may be displayed. Screens, content, and available functionality vary with firmware version.

- Configure General Setup (*modular actuator only*)
- Configure Position Demand
- Configure PWM Input
- Configure Position Demand Curve
- Configure Analog Output
- Configure CAN
- Configure J1939 (*5418-3055, 5418-3056 or newer only*)
- Configure Discrete Inputs
- Configure Discrete Output
- Configure Alarms & Shutdowns
- Configure Input Voltage
- Configure Return Spring Check

Screen navigation can be performed using the on-screen left- and right-arrow icons, the screen drop-down, or by selecting the screen name pushbutton.

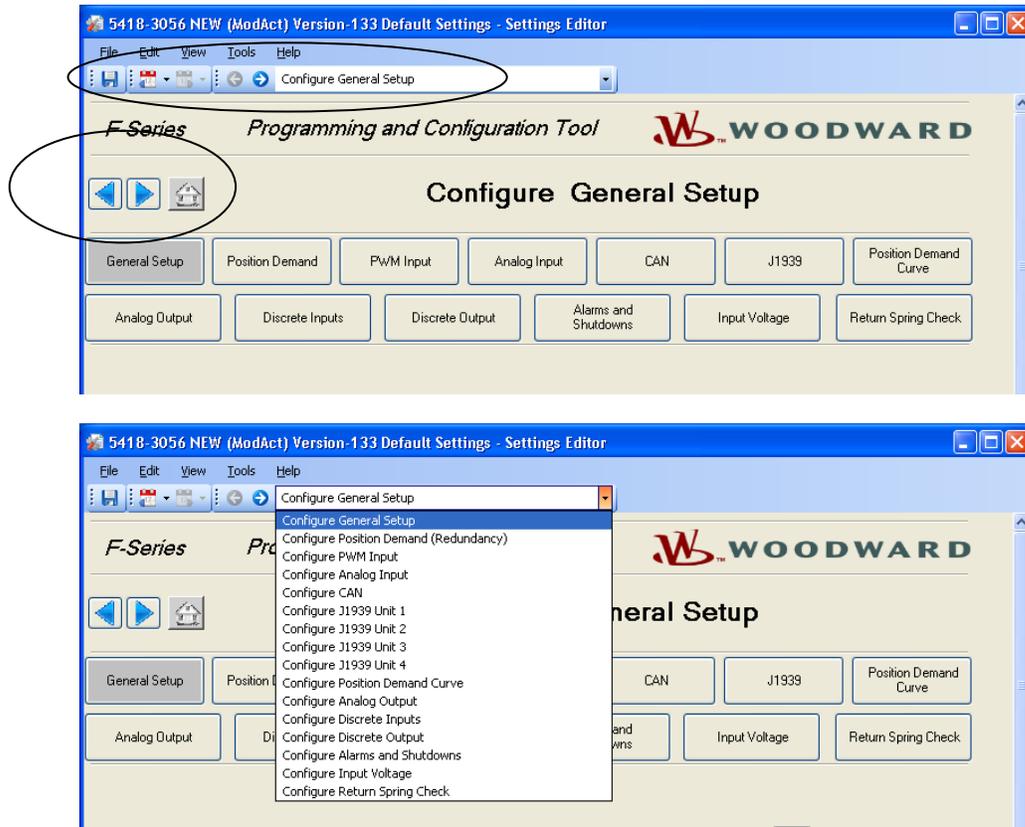
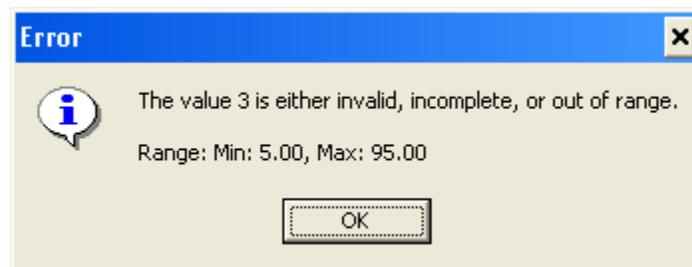


Figure 6-2. Screen Navigation Options

The tuning range of a selected parameter is displayed on the screen status bar. Attempts to enter values outside the parameter minimum and maximum range will not be accepted and an error message is displayed



### Configure General Setup (Modular Actuator Only)

The Configure General Setup screen provides settings for the shaft direction of rotation setup, shutdown direction, dynamics (Inertia) and min and max stop holding current.

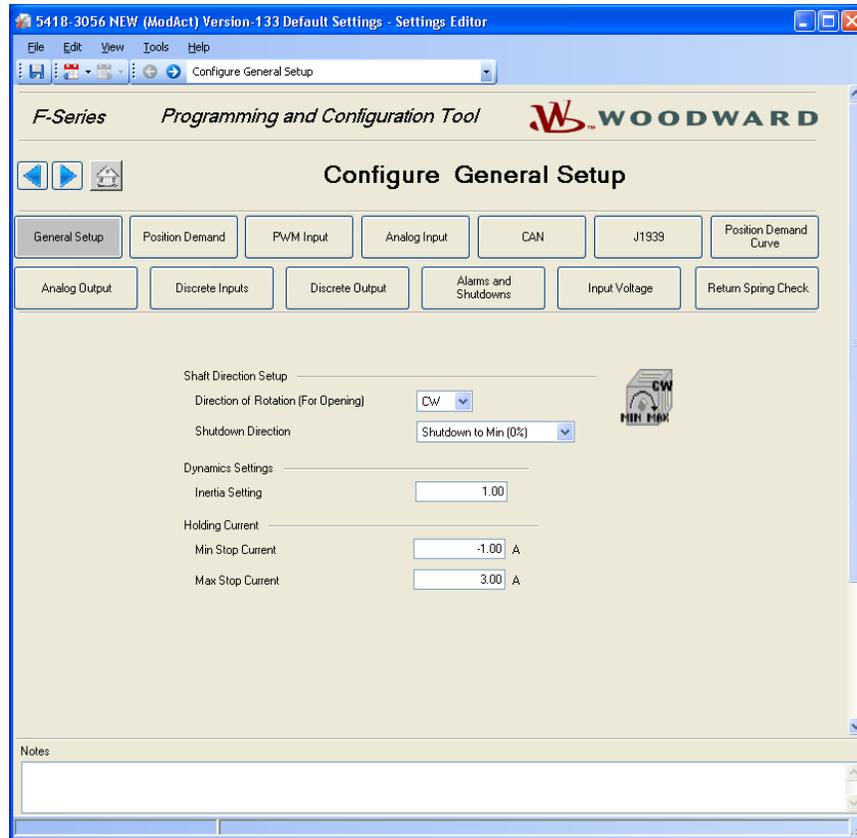


Figure 6-3. Configure General Setup (Modular Actuator Only)

### Shaft Direction Setup section

#### Direction of Rotation (for Opening)

- **CW**—Sets the actuator rotation as clockwise for opening (increasing position demand).
  - **CCW**—Sets the actuator rotation as counterclockwise for opening (increasing position demand).
- Default = CW.

<b>IMPORTANT</b>	<b>Actuator rotation is determined while looking into the actuator shaft end:</b>	
	 <b>Clockwise</b>	 <b>Counter-Clockwise</b>

#### Shutdown Direction

Sets the position the actuator moves to when shutdown. Options: Shutdown to Min (0 %), Shutdown to Max (100 %), Shutdown to Limp (available only in 5418-3056), default=Min.

## Dynamics Settings Section

### **Inertia Setting**

Sets the Modular Actuator system inertia for the control dynamics. 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.

If the optimum Inertia Setting is unknown, initially set this value at 1.0, then follow inertia setting instructions described with the Position Setup screen found in Chapter 5.

Adjustable range 1-10, default =1.0.

## Holding Current Section

### **Min Stop Current**

Sets the minimum holding current when the actuator is near the min mechanical stop. Adjustable range: – 4.0 A to 0.0 A, default = –1.

### **Max Stop Current**

Sets the maximum holding current when the actuator is near the max mechanical stop. Adjustable range: 0.0 A to 4.0 A, default =3.

## **Configure Position Demand**

The configure Position Demand screen provides demand input selection, demand redundancy, and demand filtering setting. There are two variations of functionality available, each with different settings. Firmware versions 5418-2724, 5418-2725 and 5418-3834 are non-redundant position demand versions; 5418-3055, 5418-3056 and newer are redundant position demand versions. See screen captures below for examples.

■ Note: Analog Demand is not available in firmware 5418-9520.

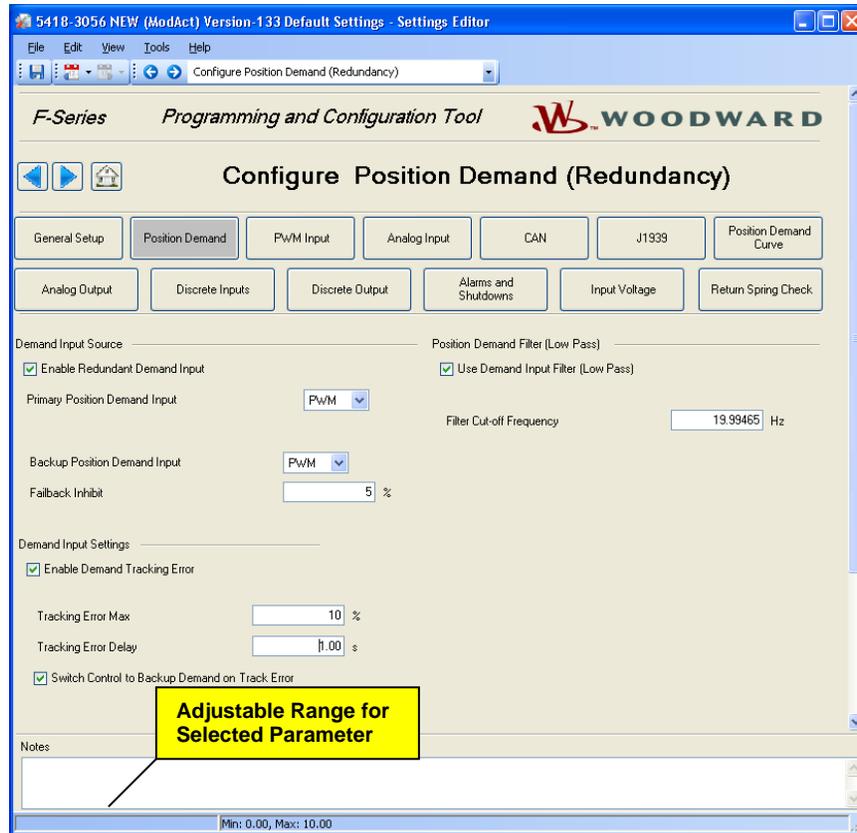


Figure 6-4a. Configure Position Demand (redundant versions)

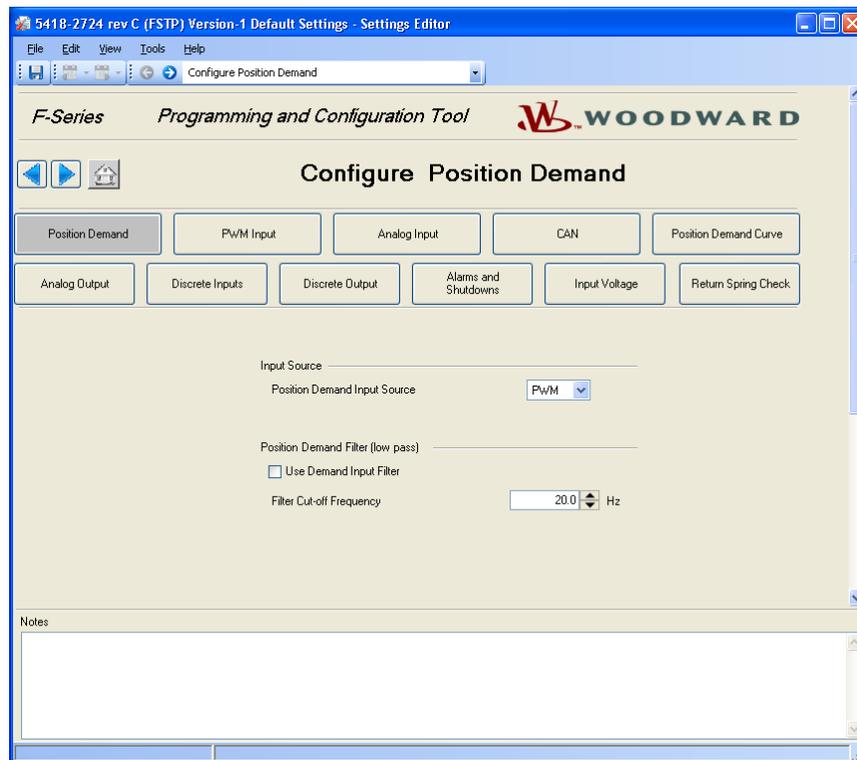


Figure 6-4b. Configure Position Demand (non-redundant versions)

**Demand Input Source Section****Enable Redundant Demand Tracking Fault -**

Selection of the demand input as either single (unchecked) or redundant (checked). Default: unchecked

**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: PWM

**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.

Allowed values: PWM, Analog, CAN Default: PWM

**Failback Inhibit - *(only displayed if configured for Redundant Demand Inputs)***

When the backup demand is in control (after primary has failed and is restored), 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 %

**Input Source - *(non-redundant applications only – 5418-2724, -2725, or -3834 firmware)***

Sets the position demand source as either the PWM input or the Analog input.

Adjustable range: PWM, Analog, CAN – default PWM.

**Demand Input Settings Section *(only displayed if configured for Redundant Demand Inputs)*****Enable Demand Tracking Fault**

Demand Tracking Fault selector which monitors the two demand inputs and verifies they are tracking each other within the defined window settings. 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 (sec) – *(only displayed if Tracking Error is used)***

Delay for tracking error fault.

Allowed values: 0–10 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 the demands differ as determined by the tracking error detection, 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

## Position Demand Filter (Low Pass) Section

### Use Demand Input Filter (Low Pass)

Check to filter the position demand input. Uncheck to ignore the filter.  
Default: not used.

### Filter Cut-off Frequency *(only displayed if Use Demand Input Filter is selected)*

Sets the position demand filter cut-off frequency.  
Adjustable range: 1 to 20 Hz, default 20.

## Configure PWM Input

The configure PWM input screen provides settings for the PWM input scaling and fault thresholds.

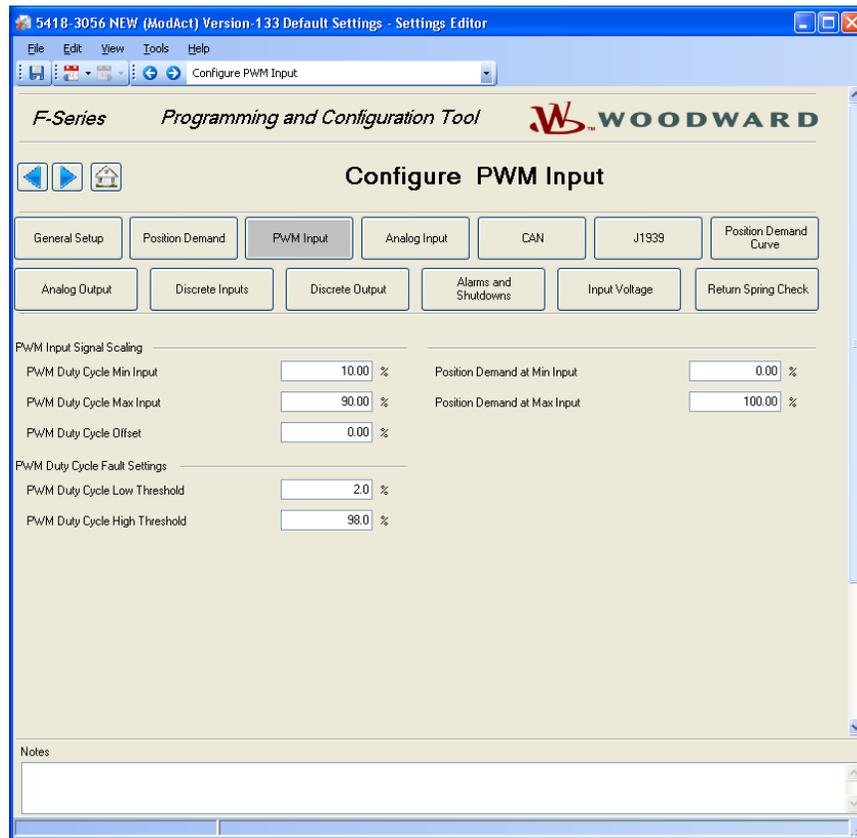


Figure 6-5. Configure PWM Input

## PWM Input Scaling section

### PWM Duty Cycle Min Input

Sets the PWM Duty Cycle, in percent, that corresponds to the Position Demand at Min Input setting. Setting the minimum duty cycle higher than the maximum is allowed to provide for a reverse acting signal as needed.

Adjustable range: 5 % to 95 %, default 10.

### PWM Duty Cycle Max Input

Sets the PWM Duty Cycle, in percent, that corresponds to the Position Demand at Max Input setting. Adjustable range: 5 % to 95 %, default 90.

**PWM Duty Cycle Offset** – (only available in 5418-3055 or 5418-3056 and newer)

Duty Cycle offset that is added to the input to compensate for differences from the commanded signal. This setting is provided to compensate for duty cycle variations in PWM input frequencies, voltages, and types.

Adjustable range: –20 % to +20 %, default 0.

**Position Demand at Min Input**

Scales the position demand, in percent, for the configured PWM Duty Cycle Min Input setting. Adjustable range: 0 % to 100 %, default 0.

**Position Demand at Max Input**

Scales the position demand, in percent, for the configured PWM Duty Cycle Max Input setting. Adjustable range: 0 & to 100 %, default 100.

**PWM Input Scaling section****PWM Duty Cycle Low Threshold**

Sets the PWM duty cycle, in percent, which triggers a PWM Duty Cycle Low fault indication. Adjustable range: 2 % to 50 %, default 2.

**PWM Duty Cycle High Threshold**

Sets the PWM duty cycle, in percent, which triggers a PWM Duty Cycle High fault indication. Adjustable range: 50 % to 98 %, default 98.

**Configure Analog Input**

The configure analog input screen provides settings for the analog input type, analog position demand scaling and fault thresholds.

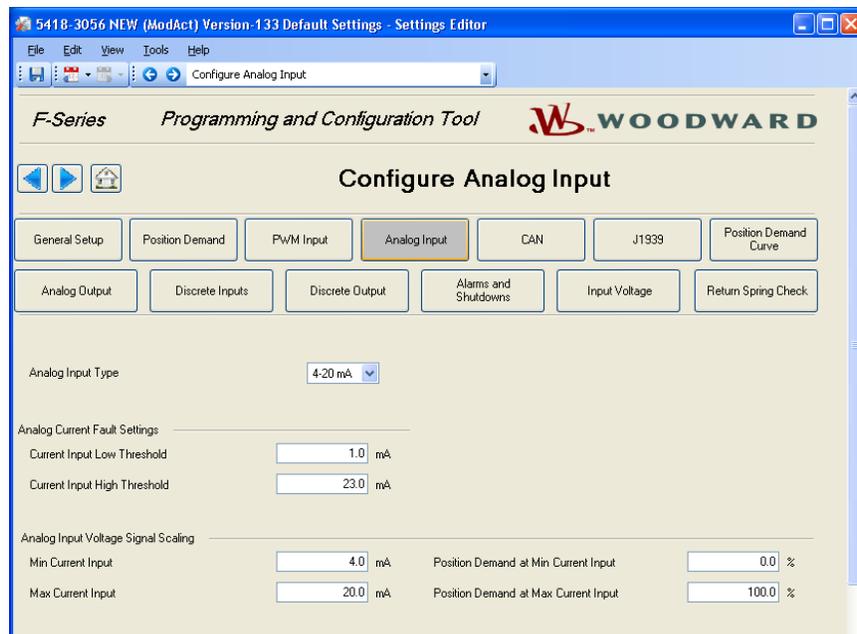


Figure 6-6. Configure Analog Input

### Analog Input Type

Sets the position demand analog input type as either a 4 mA to 20 mA input or a 0 V to 5 V (dc) input. Adjustable range: 0 V to 5 V, 4 mA to 20 mA, default 4 mA to 20 mA.

#### **IMPORTANT**

A hardware jumper must be configured to match the analog input type configured in the software. A jumper must be installed between the two 'Analog Input 4 mA to 20 mA Select' pins when a 4 mA to 20 mA analog input is connected and must be removed when a 0 V to 5 V (dc) analog input is connected.

### Analog Input Fault Settings section

#### **Current Input Low Threshold**

Sets the current, in milliamps, which triggers an analog input low fault indication. Adjustable range: 0 mA to 24 mA, default 1.

#### **Current Input High Threshold**

Sets the current, in milliamps, which triggers an analog input high fault indication. Adjustable range: 0 mA to 24 mA, default 23.

#### **Voltage Input Low Threshold**

Sets the voltage, in V (dc), which triggers an analog input low fault indication. Adjustable range: 0.0 V to 5.0 V, default 0.1.

#### **Voltage Input High Threshold**

Sets the voltage, in V (dc), which triggers an analog input high fault indication. Adjustable range: 0.0 V to 5.0 V, default 4.9.

### Analog Input Signal Scaling section

#### **Min Current Input**

Sets the current, in milliamps, that corresponds to the Position Demand at Min Current Input setting. Setting the minimum higher than the maximum is allowed to provide for a reverse acting signal as needed. Adjustable range: 0 mA to 24 mA, default 4.

#### **Max Current Input**

Sets the current, in milliamps, that corresponds to the Position Demand at Max Current Input setting. Adjustable range: 0 mA to 24 mA, default 20.

#### **Position Demand at Min Current Input**

Scales the position demand, in percent, for the configured Min Current Input setting. Adjustable range: 0 % to 100 %, default 0.

#### **Position Demand at Max Current Input**

Scales the position demand, in percent, for the configured Max Current Input setting. Adjustable range: 0 % to 100 %, default 100.

#### **Min Voltage Input**

Sets the voltage, in V (dc), that corresponds to the Position Demand at Min Voltage Input setting. Adjustable range: 0.0 V to 5.0 V, default 0.5.

#### **Max Voltage Input**

Sets the voltage, in V (dc), that corresponds to the Position Demand at Max Voltage Input setting. Adjustable range: 0.0 V to 5.0 V, default 4.5.

**Position Demand at Min Voltage Input**

Scales the position demand, in percent, for the configured Min Voltage Input setting. Adjustable range: 0 % to 100 %, default 0.

**Position Demand at Max Voltage Input**

Scales the position demand, in percent, for the configured Max Voltage Input setting. Adjustable range: 0 % to 100 %, default 100.

**Configure CAN**

The configure CAN screen provides settings for the Controller Area Network (CAN) communications port.

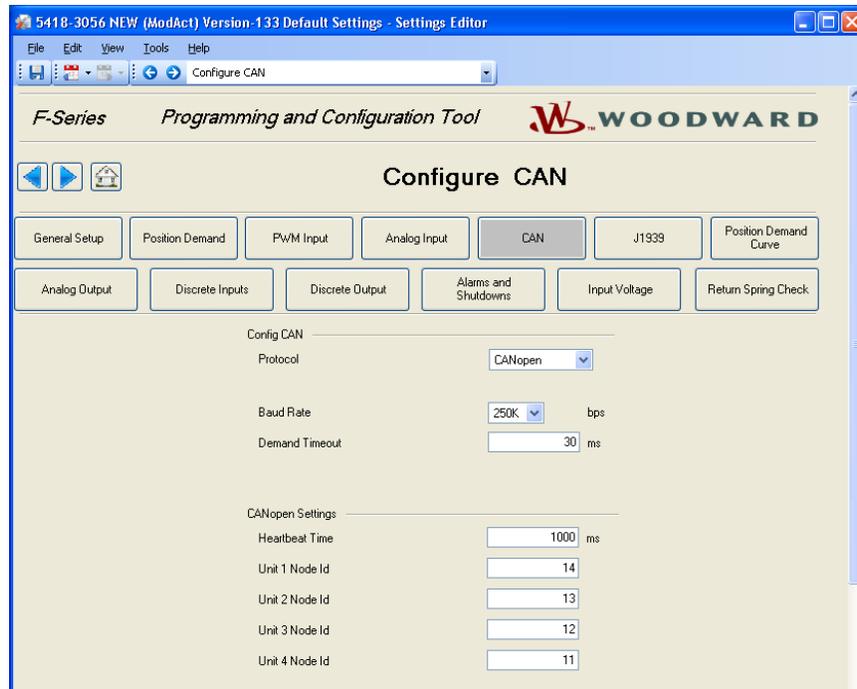


Figure 6-7. Configure CAN Input (CANopen settings)

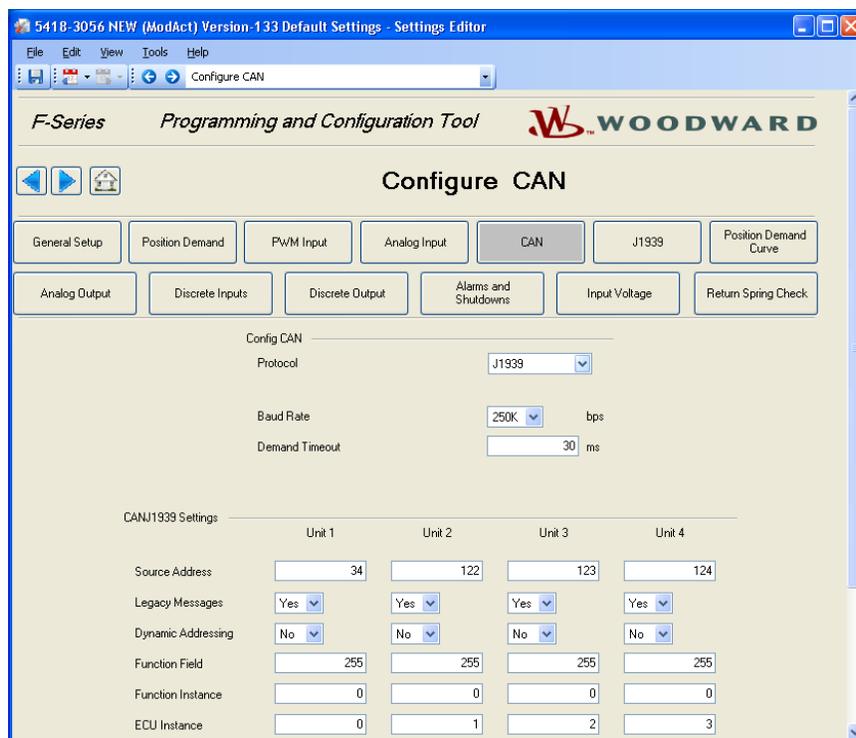


Figure 6-8. Configure CAN Input (J1939 settings)

### Config CAN section

#### **CAN Protocol**

Sets the CAN protocol. Set to Not Used to completely disable CAN communications or to J1939 or CANopen. Adjustable range: CAN Not Used, J1939, CANopen, default CAN Not Used. The section below will change depending on the protocol choice.

#### **Baud Rate**

Sets the CAN baud rate. Adjustable range: 125K, 250K, 500K, or 1000K bps, default 250K.

#### **Demand Timeout**

Sets the maximum time, in ms, between receiving the CAN messages which contains the position demand data before a CAN Fault will be annunciated. This setting is valid when the Input Type is set to CAN.

Resolution: 10 ms. Adjustable range: 10–10,000 ms, default 30.

### CANopen Settings section - (only displayed when CANopen is configured)

#### **Heartbeat Time**

Sets the heartbeat producer rate, in ms, for the CANopen Heartbeat object message. Set to zero to disable the Heartbeat message. Resolution: 10 ms. Adjustable range: 0–10,000 ms, default 1000.

#### **Unit 1 Node Id**

Configures the CANopen Node Id for unit #1 as selected by the CAN ID discrete inputs. Adjustable range: 1-31, default 14.

**Unit 2 Node Id**

Configures the CANopen Node Id for unit #2 as selected by the CAN ID discrete inputs. Adjustable range: 1-31, default 13.

**Unit 3 Node Id**

Configures the CANopen Node Id for unit #3 as selected by the CAN ID discrete inputs. Adjustable range: 1-31, default 12.

**Unit 4 Node Id**

Configures the CANopen Node Id for unit #4 as selected by the CAN ID discrete inputs. Adjustable range: 1-31, default 11.

**CAN J1939 Settings section** - *(only displayed when J1939 is configured)*

Example J1939 applications and SAE application information is provided in Appendix B.

**Source Address**

Sets the J1939 source address for each harness code address (Unit 1-4).  
Allowed values: 0-253 Defaults: 34, 122, 123, 124

**Legacy Messages**

When set to yes, legacy (as used in the initial versions of the F-Series) J1939 messages are used. When set to 'no' the CAN messages are fully configurable with settings provided on the Configure J1939 page.  
Adjustable range: No, Yes, default Yes.

**Dynamic Addressing**

When set to Yes, allows dynamic address claiming. The first address attempted is the configured source address. If that fails, claiming attempts continue starting at SA=128 and increasing to SA=160. The first successfully claimed address will be retained and saved so that the next power-up cycle will automatically begin by trying to claim the last successfully saved address.  
Adjustable range: No, Yes, default No.

**Function Field**

Sets the J1939 Name function field for each harness code address (Unit 1-4).  
Allowed values: 0-255 Default: 255 (Unspecified)

**Function Instance**

Sets the J1939 Name function instance for each harness code address (Unit 1-4). Allowed values: 0-31  
Default: 0 (First Instance)

**ECU Instance**

Sets the J1939 Name ECU instance field for each harness code address (Unit 1-4). Allowed values: 0-7  
Defaults: 0, 1, 2, 3

**Configure J1939**

*(not available in 5418-2724, 5418-2725, or 5418-3834 firmware versions)*

These four pages provide settings for the diagnostics support and data message configuration (SPN, PGN, data location, priority and update rate). A separate page is provided for each J1939 CAN ID (i.e. Unit 1-4). Configuration is only available for J1939 non-legacy mode.

Examples and detailed explanations are provided in Appendix B. The default values (used only when Legacy mode is not used), correspond as:

- Unit 1: Engine Compressor Bypass – Instance 1
- Unit 2: Engine Throttle Valve – Instance 1
- Unit 3: Engine Fuel Rack
- Unit 4: Engine Turbocharger Wastegate – Instance 1

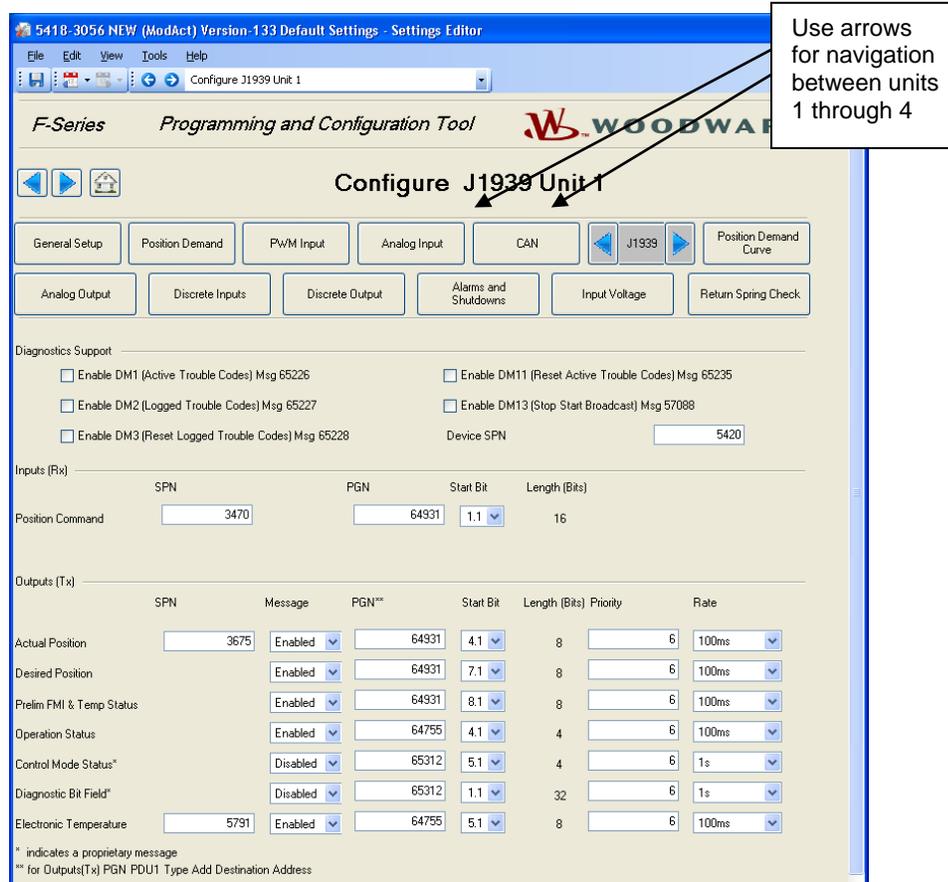


Figure 6-9. Configure CAN J1939

### Diagnostics Support section

#### **Enable DM1 (Active Trouble Codes) Msg 65226**

Enables DM1 messages to be sent 1/sec with active diagnostics. Default unchecked.

#### **Enable DM2 (Logged Trouble Codes) Msg 65227**

Enables DM2 messages to be sent upon request with previously active diagnostics. Default unchecked.

#### **Enable DM3 (Reset Logged Trouble Codes) Msg 65228**

Enables DM3 support for resetting previously active fault history. Default unchecked.

#### **Enable DM11 (Reset Active Trouble Codes) Msg 65235**

Enables DM11 support for resetting active faults. Default unchecked.

#### **Enable DM13 (Stop Start Broadcast) Msg 57088**

Enables DM13 support for quiet mode to be used typically when programming other devices on the network. Default unchecked.

**Device SPN**

Sets the device SPN (19-bits) for DM1 and DM2 usage. Used specifically for Internal Fault, Spring check Failed, Configuration Error, Demand Tracking Fault and Loss of Position Demand. Allowed values: 0-524287, should be unique within Unit x. Defaults: 5420, 5419, 5418, 5421

**Inputs (Rx) section****Position Command settings**

These settings are only used when CAN is configured as a primary or backup position demand input (see Configure Position Demand page).

**SPN:** Allowed values: 0-524287, should be unique within Unit x. Defaults: 3470, 3464, 633, 5386. Used specifically for CAN Demand and CAN Bad Signal errors.

**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Defaults: 64931, 61466, 61466, 61486

**Start Bit:** Allowed values: 1.1, 2.1, 3.1, 4.1, 5.1, 6.1, 7.1. PGN data must not overlap. Defaults: 1.1, 1.1, 5.1, 1.1  
**Length:** 16

**Run/Stop Command settings**

These settings are only visible when the Run Enable Input is configured as a CAN input (see Discrete Input page). This is a 2-bit proprietary SPN providing run/stop (Keyswitch) functionality.

**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Defaults: 65312, 65312, 65312, 65312

**Start Bit:** Allowed values: 1.1, 1.3, 1.5, 1.7, 2.1, 2.3, 2.5, 2.7, 3.1, 3.3, 3.5, 3.7, 4.1, 4.3, 4.5, 4.7, 5.1, 5.3, 5.5, 5.7, 6.1, 6.3, 6.5, 6.7, 7.1, 7.3, 7.5, 7.7, 8.1, 8.3, 8.5, 8.7. PGN data must not overlap. Defaults: 6.1, 6.3, 6.5, 6.6

**Length:** 2

**Outputs (Tx) section****Actual Position data settings**

**SPN:** Allowed values: 0-524287, should be unique within Unit x. Defaults: 3675, 51, 1442, 1188. Used specifically for Position Error.

**Message:** Values: Disabled, Enabled Default: Enabled

**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Defaults: 64931, 65266, 65153, 65174. For PGN PDU1 type, add destination address under which message shall be sent.

**Start Bit:** Allowed values: 1.1, 2.1, 3.1, 4.1, 5.1, 6.1, 7.1, 8.1. PGN data must not overlap. Default: 4.1, 7.1, 5.1, 1.1  
**Length:** 8

**Priority:** Allowed values: 0-7. Priority must be identical within a PGN. Default: 6

**Rate:** Allowed values: 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, On Request. Rate must be identical within a PGN. Default: 100 ms

**Desired Position data settings**

**Message:** Values: Disabled, Enabled Default: Enabled

**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Defaults: 64931, 64754, 65153, 65174. For PGN PDU1 type, add destination address under which message shall be sent.

**Start Bit:** Allowed values: 1.1, 2.1, 3.1, 4.1, 5.1, 6.1, 7.1, 8.1. PGN data must not overlap. Default: 7.1, 7.1, 7.1, 6.1  
**Length:** 8

**Priority:** Allowed values: 0-7. Priority must be identical within a PGN. Default: 6

**Rate:** Allowed values: 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, On Request. Rate must be identical within a PGN. Default: 100 ms

**Prelim FMI & Temp Status data settings****Message:** Values: Disabled, Enabled Default: Enabled**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Defaults: 64931, 64754, 64754, 65174. For PGN PDU1 type, add destination address under which message shall be sent.**Start Bit:** Allowed values: 1.1, 2.1, 3.1, 4.1, 5.1, 6.1, 7.1, 8.1. PGN data must not overlap. Default: 8.1, 2.1, 5.1, 7.1**Length:** 8**Priority:** Allowed values: 0-7. Priority must be identical within a PGN. Default: 6**Rate:** Allowed values: 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, On Request . Rate must be identical within a PGN. Default: 100 ms**Operation Status data settings****Message:** Values: Disabled, Enabled Default: Enabled**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Default: 64755, 64755, 64754, 64753. For PGN PDU1 type, add destination address under which message shall be sent.**Start Bit:** Allowed values: 1.1, 1.5, 2.1, 2.5, 3.1, 3.5, 4.1, 4.5, 5.1, 5.5, 6.1,6.5, 7.1, 7.5, 8.1, 8.5 . PGN data must not overlap. Defaults: 4.1, 7.1, 8.1, 2.1**Length:** 4**Priority:** Allowed values: 0-7. Priority must be identical within a PGN. Default: 6**Rate:** Allowed values: 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, On Request . Rate must be identical within a PGN. Default: 100 ms**Control Mode data settings**

Settings for the Control Mode data. This is a proprietary SPN consisting of 4 bits of data.

**Message:** Values: Disabled, Enabled Default: Disabled**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Default: 65312, 65312, 65312, 65312. For PGN PDU1 type, add destination address under which message shall be sent.**Start Bit:** Allowed values: 1.1, 1.5, 2.1, 2.5, 3.1, 3.5, 4.1, 4.5, 5.1, 5.5, 6.1,6.5, 7.1, 7.5, 8.1, 8.5. PGN data must not overlap. Defaults: 5.1, 1.1, 5.1, 5.1**Length:** 4**Priority:** Allowed values: 0-7. Priority must be identical within a PGN. Default: 6**Rate:** Allowed values: 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, On Request . Rate must be identical within a PGN. Default: 1 s**Diagnostic Bit Field data settings**

Settings for the diagnostics bit data. This is a proprietary SPN consisting of 32 bits of data.

**Message:** Values: Disabled, Enabled Default: Disabled**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Default: 65312, 65312, 65312, 65312. For PGN PDU1 type, add destination address under which message shall be sent.**Start Bit:** Allowed values: 1.1, 2.1, 3.1, 4.1, 5.1. PGN data must not overlap. Defaults: 1.1, 5.1, 1.1, 1.1**Length:** 32**Priority:** Allowed values: 0-7. Priority must be identical within a PGN. Default: 6**Rate:** Allowed values: 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, On Request. Rate must be identical within a PGN. Default: 1 s**Electronics Temperature data settings****SPN:** Allowed values: 0-524287, should be unique within Unit x. Default: 5791, 5783, 5785, 5788. Used Specifically for Temperature Sensor Failed, Derating Active (>118 °C), Zero Drive Current (>125 °C)**Message:** Values: Disabled, Enabled Default: Enabled**PGN:** Allowed values: 0-131071. Shall not be a reserved PGN, see listing in Configuration Check section. Default: 64755, 64713, 64713, 64753. For PGN PDU1 type, add destination address under which message shall be sent.**Start Bit:** Allowed values: 1.1, 2.1, 3.1, 4.1, 5.1, 6.1, 7.1, 8.1 . PGN data must not overlap. Defaults: 5.1, 1.1, 3.1, 6.1**Length:** 8

**Priority:** Allowed values: 0-7. Priority must be identical within a PGN. Default: 6

**Rate:** Allowed values: 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, On Request. Rate must be identical within a PGN. Defaults: 100 ms, 1 s, 1 s, 100 ms

## Configure Position Demand Curve

This screen provides position demand curve configuration settings.

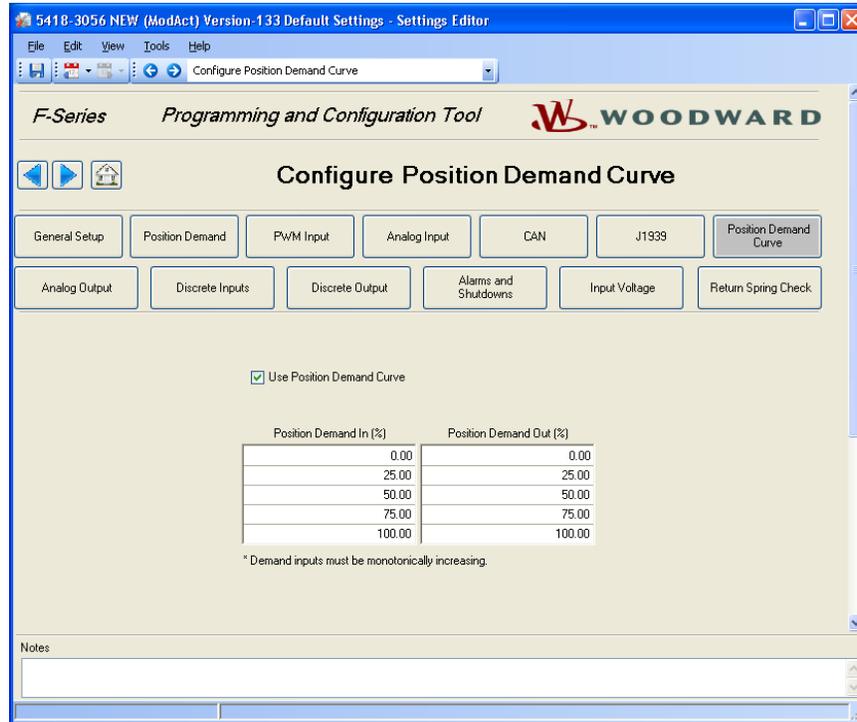


Figure 6-10. Configure Position Demand Curve

### Use Position Demand Curve

Check this box to use the position demand curve settings. Uncheck this box to ignore the position demand curve settings. Default: not used.

### Position Demand In (%)

Sets position demand input breakpoints (%) for the demand curve. Each breakpoint [5] value must be larger than the previous and less than the next value. Adjustable range: 0 % to 100 %, must be monotonically increasing. Defaults 0, 25, 50, 75, 100.

### Position Demand Out (%)

Sets the position demand output percentage [5] for the configured position demand input breakpoint (%). Adjustable range: 0 % to 100 %, defaults 0, 25, 50, 75, 100.

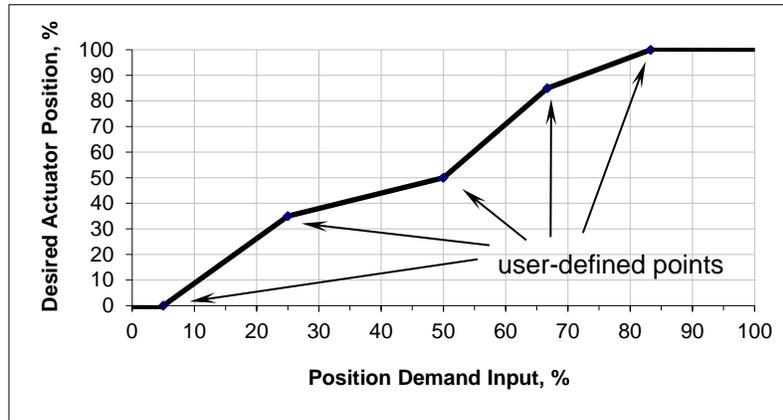


Figure 6-11. Position Demand Curve Example

**IMPORTANT**

When the optional non-linear position demand curve is configured, the TPS is corrected to account for the effect of the curve, so that the TPS should still normally match the position demand input. Be sure the TPS output (if used) is applied correctly for this configuration.

**Configure Analog Output**

This screen provides settings for scaling the TPS analog output.

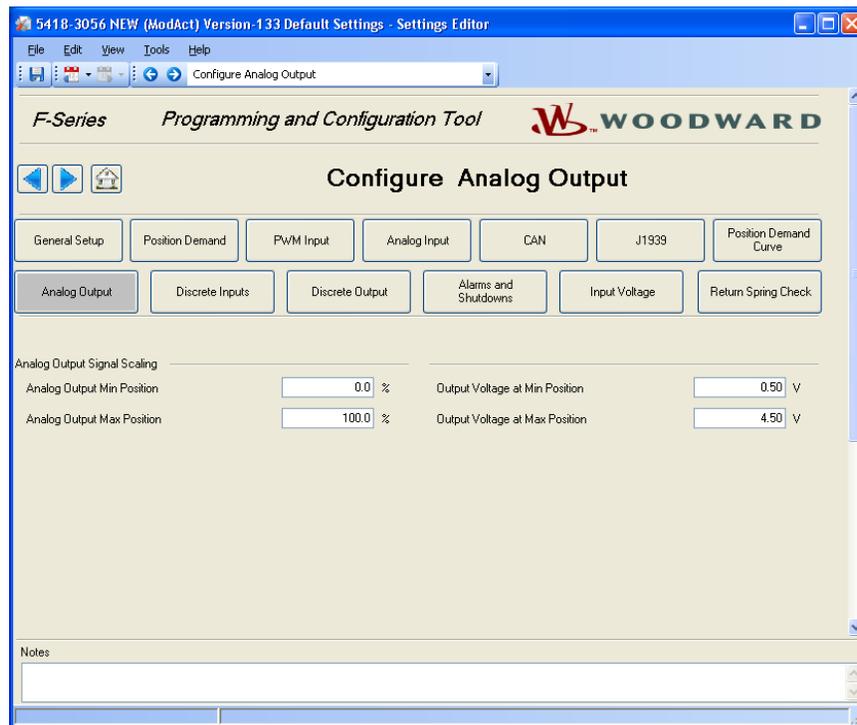


Figure 6-12. Configure Analog Output

### Analog Output Min Position

Sets the actuator position, in percent, that corresponds to the Output Voltage at Min Position setting. Adjustable range: 0 % to 100 %, default 0.

### Analog Output Max Position

Sets the actuator position, in percent, that corresponds to the Output Voltage at Max Position setting. Adjustable range: 0 % to 100 %, default 100.

### Output Voltage at Min Position

Scales the output voltage, in V (dc), for the configured Analog Output Min Position setting. Adjustable range: 0 V to 4.70 V (dc), default 0.5.

### Output Voltage at Max Position

Scales the output voltage, in V (dc), for the configured Analog Output Max Position setting. Adjustable range: 0 V to 4.70 V (dc), default 4.5.

## Configure Discrete Inputs

The configure discrete input screen provides settings for the run enable and CAN ID inputs.

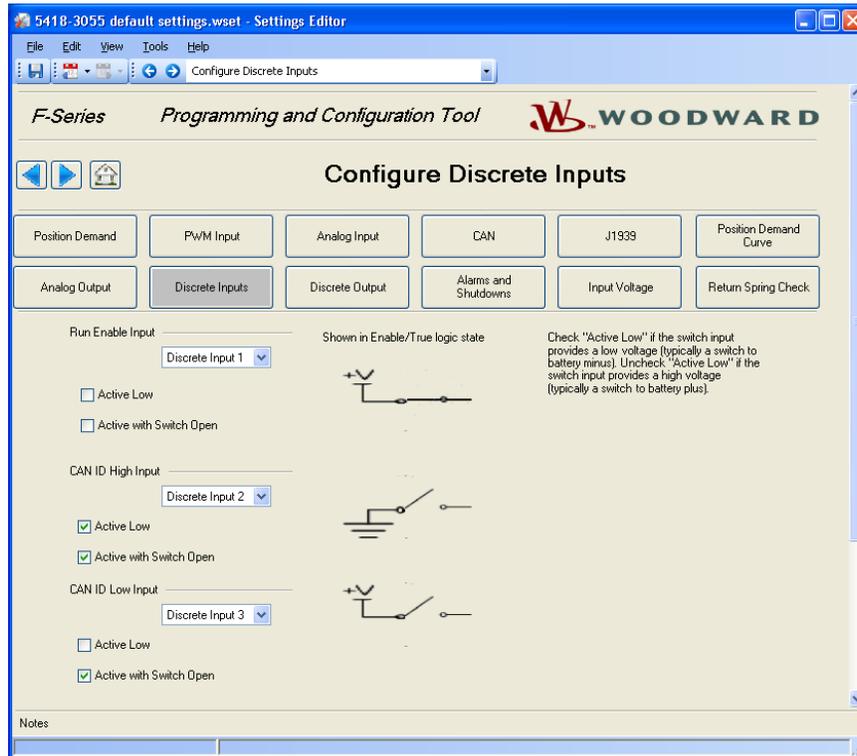


Figure 6-13. Configure Discrete Inputs

### Run Enable Input

Sets up the run enable discrete input.

- **Assignment**—Allowed values are Not Used, Discrete Input 1, CAN.
  - **Not Used**—Ignores the run input and sets the software to always run. This is the default setting.
  - **Discrete Input**—Requires input wiring on Discrete Input 1
  - **CAN**—Enable CANopen or J1939 see corresponding configuration pages.

- **Active Low**—Uncheck if the switch input provides a high voltage (typically a switch to battery positive) or check if the switch input provides a low voltage (typically a switch to battery minus).
  - **Active with Switch Open**—Uncheck to activate the Run Enable Input with a closed switch contact or check to activate with an open contact.
- Default: Not Used, active high, active closed.

#### CAN ID High Input

Sets up the CAN ID High discrete input.

- **Assignment**—Allowed values are Discrete Input 2 and Discrete Input 3. Default is Discrete Input 3.
- **Active Low**—Uncheck if the switch input provides a high voltage (typically a switch to battery positive) or check if the switch input provides a low voltage (typically a switch to battery minus).
- **Active with Switch Open**—Uncheck to activate the input with a closed switch contact or check to activate with an open contact.

#### CAN ID Low Input

Sets up the CAN ID Low discrete input.

- **Assignment**—Allowed values are Discrete Input 2 and Discrete Input 3. Default is Discrete Input 2.
- **Active Low**—Uncheck if the switch input provides a high voltage (typically a switch to battery positive) or check if the switch input provides a low voltage (typically a switch to battery minus).
- **Active with Switch Open**—Uncheck to activate the input with a closed switch contact or check to activate with an open contact.

Default: active high, active closed.

### IMPORTANT

The CAN ID discrete inputs are read at power up, changes to configuration settings or input state will not take effect until the next power cycle.

## Configure Discrete Output

The configure discrete output screen provides settings for the relay output action and the relay status output selections.

### WARNING

It is recommended that the Status Discrete Output be configured for the 'Normally On' 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.

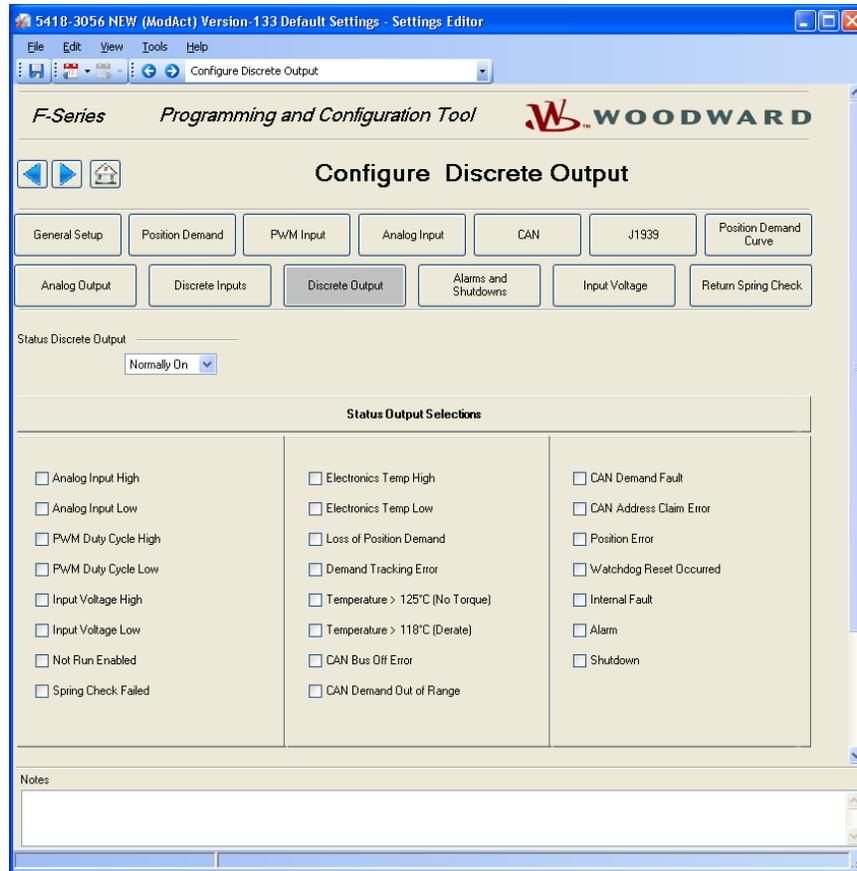


Figure 6-14. Configure Discrete Output

### Status Discrete Output

Sets the discrete output action to be Always Off, Normally On or Normally Off.

- **Normally On**—Sets the relay driver to a normally on state that turns off with any of the selected faults.
- **Normally Off**—Sets the relay driver to a normally off state that turns on with any of the selected faults.

Default = Normally On.

 <b>WARNING</b>	<p><b>It is recommended that all faults be configured to activate the Status Discrete Output, this ensures maximum fault annunciation.</b></p>
--	--

### Status Output Selections

The list of faults displayed can be individually selected to activate the Status Discrete Output. Any of the selected faults, when faulted, will either turn the output off if configured Normally On or will turn the output on if configured Normally Off. Checking the Alarm and Shutdown boxes will cause the relay output to activate when any selected alarm or shutdown occurs. Default: all options unselected.

Notice: Even if the diagnostic condition is not enabled (See Configure Alarms and Shutdowns) it can still operate the Discrete Output.

## Configure Alarms & Shutdowns

This screen provides alarm & shutdown configuration settings.

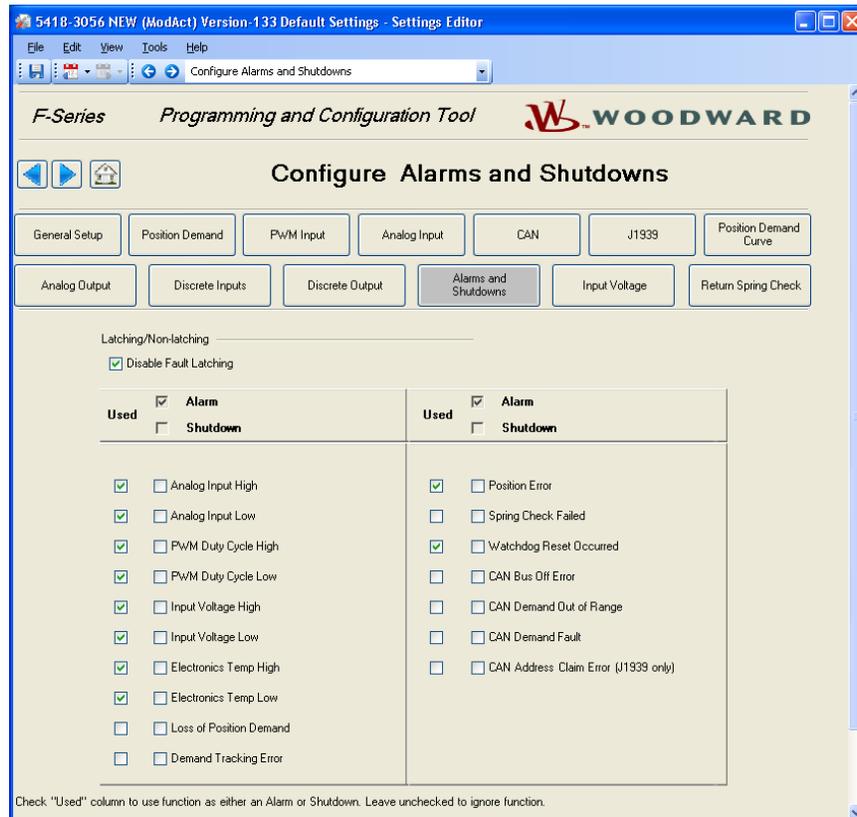


Figure 6-15. Configure Alarms & Shutdowns

### Used

For each of the faults from the list, check the Used checkbox to use the adjacent fault condition as either an alarm or shutdown. Uncheck the Used checkbox to ignore the adjacent fault condition.



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

### Alarm (Checked) or Shutdown (Unchecked)

Set the desired action for each of the used faults from the list (unused faults are ignored). Adjustable range: Alarm, Shutdown

- Check to set the fault condition as an alarm. Setting the selection as an Alarm allows the unit to attempt to continue running.
- Uncheck to set the fault condition as a shutdown. Setting the selection as a Shutdown will position the output in the configured position upon fault. The Modular actuator shutdown position is user configurable. The FST and FSTP shutdown position is factory configured only.

For details on each fault condition, refer to the Fault section of the Description of Operation, Chapter 4.

## Configure Input Voltage

The configure input voltage screen provides settings for the input voltage fault settings.

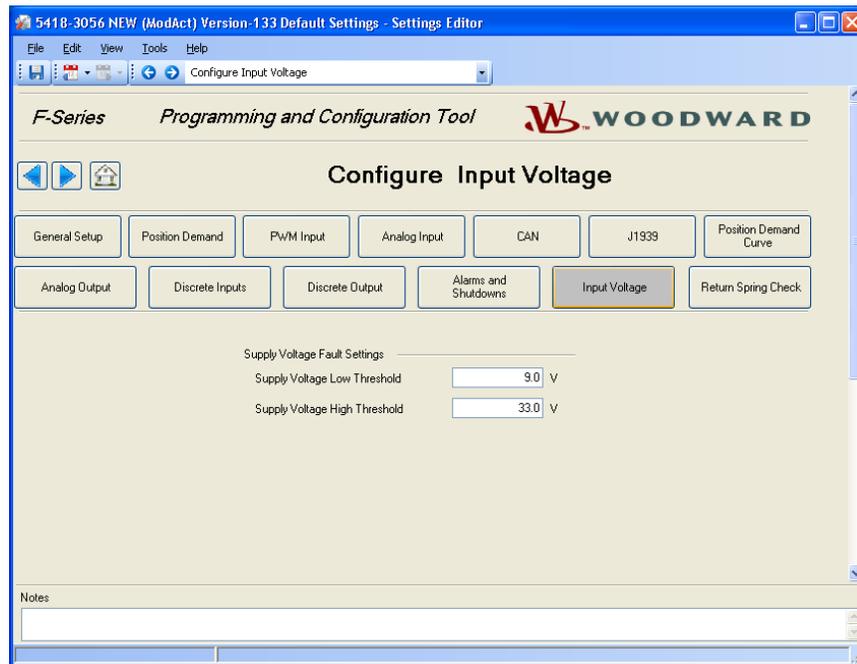


Figure 6-16. Configure Input Voltage

### Supply Voltage Low Threshold

Sets the voltage, in V (dc), which triggers an input voltage low fault indication. Adjustable range: 6 V to 18 V (dc), default 9.

### Supply Voltage High Threshold

Sets the voltage, in V (dc), which triggers an input voltage high fault indication. Adjustable range: 12 V to 36 V (dc), default 33.

## Configure Return Spring Check

This screen provides the return spring check configuration settings.

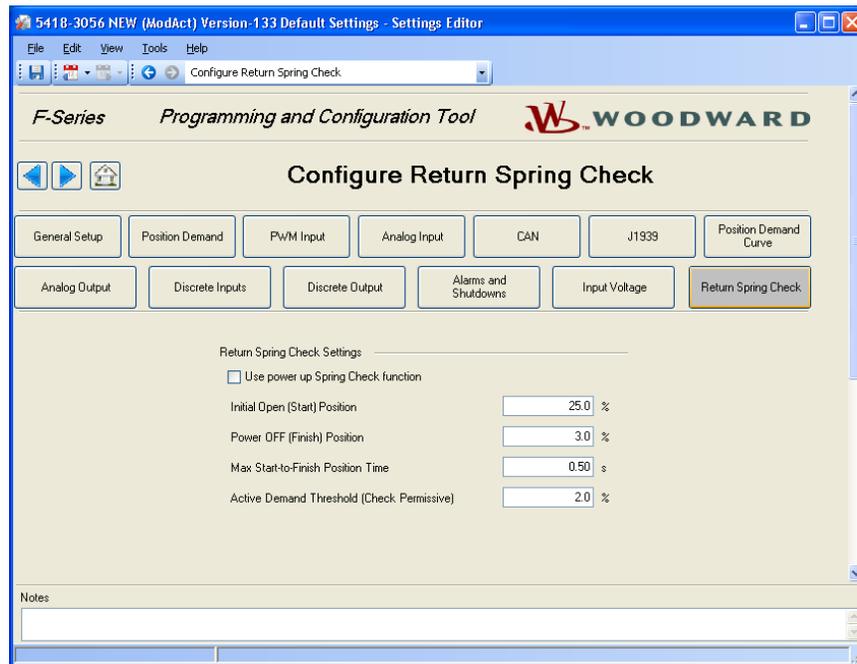


Figure 6-17. Configure Return Spring Check

### Use power up Spring Check function

Check this box to use the spring check function.

Uncheck this box to ignore the spring check function.

Default: not used.

### Initial Open (Start) Position

Sets the initial position (%) the output shaft moves to at power up. This is also the position used to 'Start' the spring check function.

Adjustable range: 0 % to 100 %, default 25.

### Power OFF (Finish) Position

Sets the final position (%) to which the output shaft must return when powered off. Adjustable range: 0 % to 100 %, default 3.

### Max Start-to-Finish position time

Sets the duration (sec.) for the spring check function from 'Start' to 'Finish'. Adjustable range: 0.05 to 5.00 seconds, default 0.5.

- The spring check status displayed on the Overview screen will show 'Passed' if the 'Finish' position is reached before this time expires.
- The spring check status displayed on the Overview screen will show 'Failed' if the 'Finish' position is not reached before this time expires or if the 'Start' position is not reached in 200 ms or less.

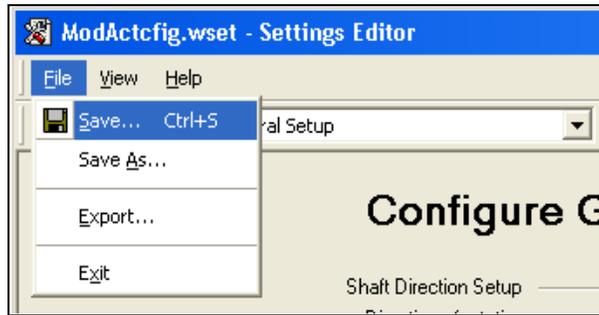
### Active Demand Threshold (Check Permissive)

Sets the level at which the position demand (%) is considered valid. If a valid position demand is present (above the threshold level) the actuator will immediately follow the position demand and ignore the spring check function. The spring check status will show 'Not Performed'.

If the application is spring 'open', it is assumed the demand will normally be at 100 % position command. In this case the Active Demand Threshold/Permissive must be set to a value greater than the Initial Open (Start) Position (98 %) and the position demand must be greater than this setting at power up to permit the spring check test to run. Adjustable range: 0 % to 100 %, default 2.

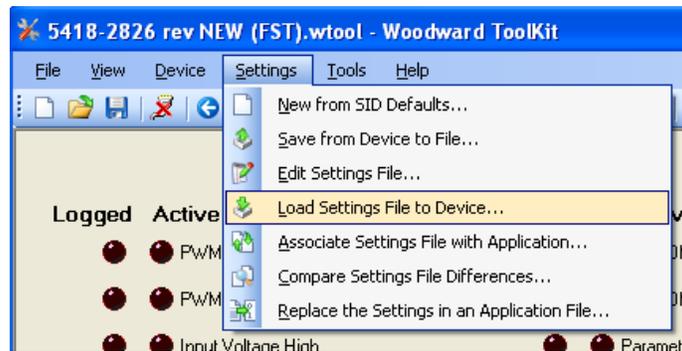
## Save the Configuration Settings File

Once all configuration setting have been made in the Settings Editor, click 'File' on the Settings Editor menu bar and select 'Save' to overwrite the existing Settings File or select 'Save As' to create a new configuration Settings File. You will be prompted for a new file name.



## Load the Configuration Settings to the Control

Once all configuration settings have been saved to a Settings File, the settings can be loaded to the F-Series control. From the main tool, select 'settings' then 'Load Settings File to Device' on the F-Series Service Tool menu bar. This will start a wizard to assist in the loading process.



A Load Settings window opens (figure 6-18). After the settings have been loaded into the control and saved, they are checked. If no issues are found, a successful load message is displayed (figure 6-19). Configuration Error and Configuration Warning messages indicate settings that must or should be addressed, respectively (figure 6-20). A configuration error is a shutdown condition and the F-Series will not run until the problem is corrected. A configuration warning is indicates a problem with the settings but not severe enough to prohibit operation of the device. Configuration check details are provided in the next section.

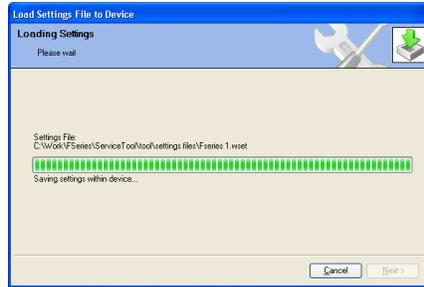


Figure 6-18. Load Settings Window

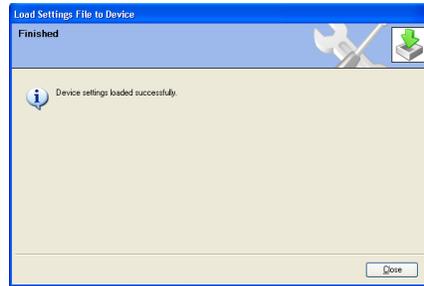


Figure 6-19. Load Settings Finished – No Errors

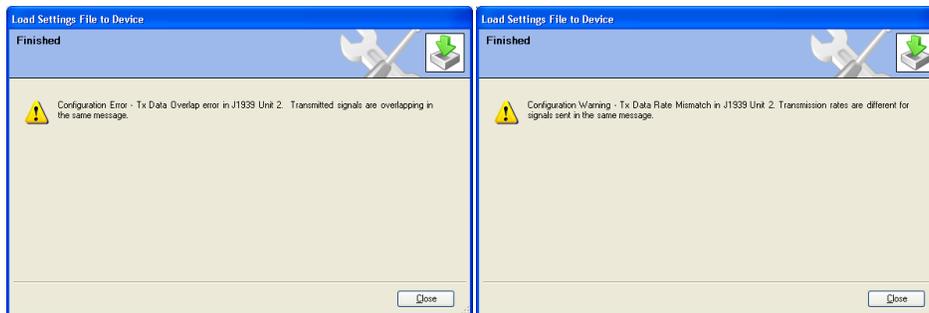


Figure 6-20. Load Settings Error Dialog

## Configuration Checks (Errors and Warnings)

This section contains a complete listing of the configuration errors and warnings provided in the F-Series. When settings are loaded into the control, they are sanity checked for validity. If issues are discovered with the settings, they are indicated as either an Error or a Warning. An error condition sets a Configuration Error shutdown diagnostic fault and the unit will not run until this is corrected. A warning condition indicates something that should be addressed but is not severe enough to prevent device operation. Status of the Configuration Warning is provided on the Overview tab in the Status Conditions section.

Configuration check summary:

- Configuration Error - Rx PGN error in J1939 Unit x
- Configuration Error - Rx Data Overlap error in J1939 Unit x.
- Configuration Error - Tx PGN error in J1939 Unit x
- Configuration Error - Tx Data Overlap error in J1939 Unit x
- Configuration Warning - Tx Data Rate Mismatch in J1939 Unit x
- Configuration Warning - Tx Priority Mismatch in J1939 Unit x
- Configuration Warning - SPN Duplication in J1939 Unit x
- Configuration Warning - Rx PGN Invalid in J1939 Unit x

Configuration check details are listed below. A configuration error is a shutdown condition and the F-Series will not run until the problem is corrected. A configuration warning indicates a problem with the settings but not severe enough to prohibit operation of the device. When multiple errors exist, only one is displayed at a time. Configuration errors have priority over warnings.

Each CAN Unit (1-4) is checked individually. Since only one set of CAN data is active at a time, all configuration checks are within a specific unit's settings - not unit-to-unit. Messages that are disabled are not checked. Selecting legacy mode (see Configure CAN) removes the CAN configurability and eliminates configuration issues for that unit.

## Reserved PGN Listing

The following PGNs are not allowed:

- \*60928 (0xEE00) reserved for Address Claimed
- 65226 (0xFECA) reserved for DM1 - Active Diagnostic Trouble Codes
- 65227 (0xFECB) reserved for DM2 - Previously Active Diagnostic Trouble Codes
- 65228 (0xFECC) reserved for DM3 - Diagnostics Data Clear/Reset for Previously Active DTCs
- 65235 (0xFED3) reserved for DM11 - Diagnostic Data Clear/Reset for Active DTCs
- \*57088 (0xDF00) reserved for DM13 - Stop Start Broadcast
- \*60416 (0xEC00) reserved for Transport Protocol – Connection Management
- \*60160 (0xEB00) reserved for Transport Protocol – Data Transfer
- \*59904 (0xEA00) reserved for PGN Request Message
- \*59392 (0xE800) reserved for Acknowledgment Message
- 65242 (0xFEDA) reserved for Software Identification
- 64965 (0xFDC5) reserved for ECU Identification Information

\*No PDU Specific values are allowed for the selected PDU Format. For example, values of 60928 through 61183 (0xEE00..0xEEFF) are all PGNs that are prohibited and will result in a configuration error.

### **NOTICE**

**All Configuration Errors should be corrected. Failure to correct all errors can result in a latent shutdown condition.**

**In addition, it is good practice to correct all Configuration Warnings.**

## Configuration Check Details

1. **Configuration Error - Rx PGN error in J1939 Unit x. Configured PGN in received frame is a reserved one.**

The reserved PGN listing is provide above. Selecting a PGN included in this listing will result in a configuration error.

2. **Configuration Error - Rx Data Overlap error in J1939 Unit x. Start bit settings result in signals that overlap in the same message.**

Indicates that the Position Command and Run/Stop Command are in the same message and are overlapping based on the start bit settings. This condition results in a configuration error.

- 3. Configuration Error - Tx PGN error in J1939 Unit x. Configured PGN in transmitted frame is a reserved one.**

Selecting a PGN from the reserved PGN listing (provided above) will result in a configuration error.

- 4. Configuration Error - Tx Data Overlap error in J1939 Unit x. Transmitted signals are overlapping in the same message.**

An overlap of data within a PGN is prohibited and will result in a configuration error. The start bit selects the location of the data within the PGN's 8-byte (64 bit) message. The format used for the start bit is byte.bit with a range of 1-8. Data length values are provided on the settings editor screen (see Configure J1939 Unit 1..4). As an example the 8-bit actual position indication with start bit 4.1 would occupy the 4th byte of the data message (4.1 through 4.8).

- 5. Configuration Warning - Tx Data Rate Mismatch in J1939 Unit x. Transmission rates are different for signals sent in the same message.**

The data rates within any PGN must be the same or will result in a configuration warning. The settings should be corrected to ensure the expected update rate is used.

- 6. Configuration Warning - Tx Priority Mismatch in J1939 Unit x. Priority settings are different for signals sent in the same message.**

The priority settings within any PGN must be the same or will result in a configuration warning. The settings should be corrected to ensure the expected message priority value.

- 7. Configuration Warning - SPN Duplication in J1939 Unit x. Configured SPN values are not unique.**

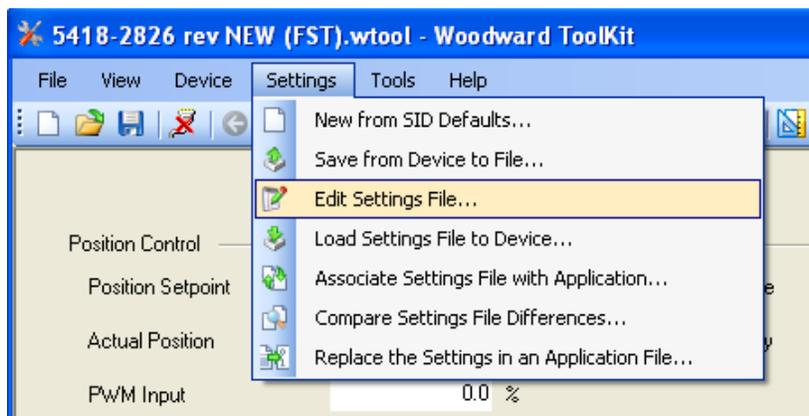
Within each CAN unit (1-4), all SPN values should be unique or will result in a configuration warning. The SPN values are used in the DM1 and DM2 diagnostic messages.

- 8. Configuration Warning - Rx PGN Invalid in J1939 Unit x. Receive Data PGN is PDU 1 type but with specified address. Do not specify the address for Rx PGNs.**

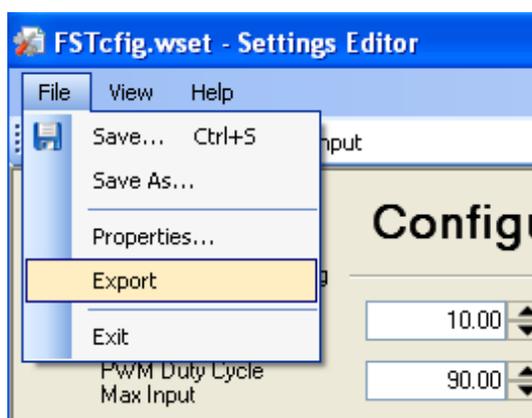
The receive PGN is invalid for a PDU1 type message. Note that PDU1 Format range is 0-239 (0xEF) and PDU2 format range is 240-255. Selecting a PDU1 type PGN requires the PDU Specific field to be 0. Selection of a value other than zero will result in a configuration warning when a PDU1 type is set.

## Exporting the Settings File Configuration

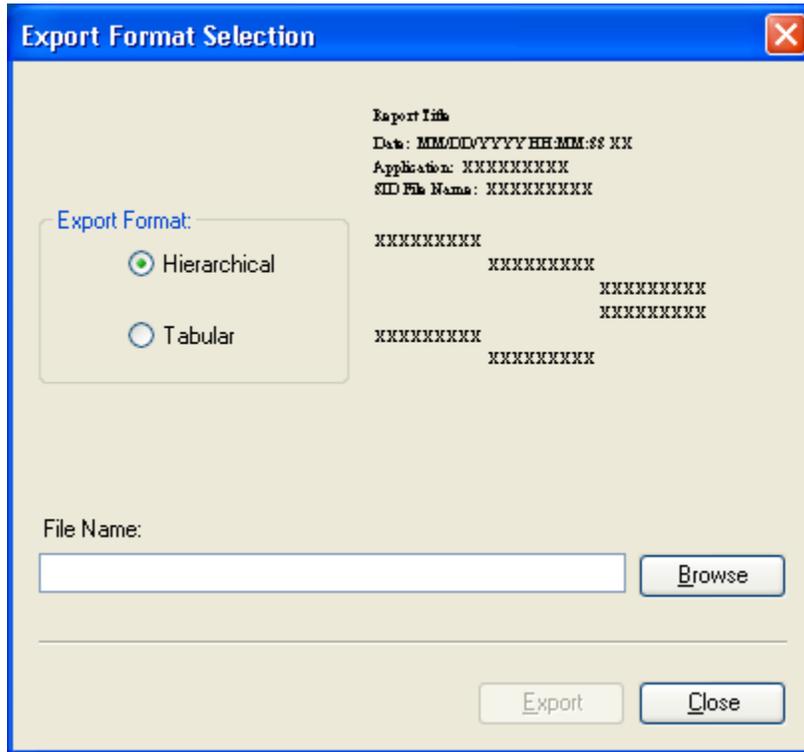
A Settings File configuration can be exported to an \*.htm document file (e.g., FSTcfig.htm). This provides for listing the configuration settings, printing a hard copy of the settings or e-mailing the control settings.



To select settings file to be exported, from the main tool, select 'Settings' then 'Edit Settings File' on the F-Series Service Tool menu bar and choose proper settings file.



Once the Settings Editor screen opens, select "File, Export" on the menu bar. The export format can be selected as either hierarchical or tabular. Select Browse for the file name and location selection window. Select Close to cancel.



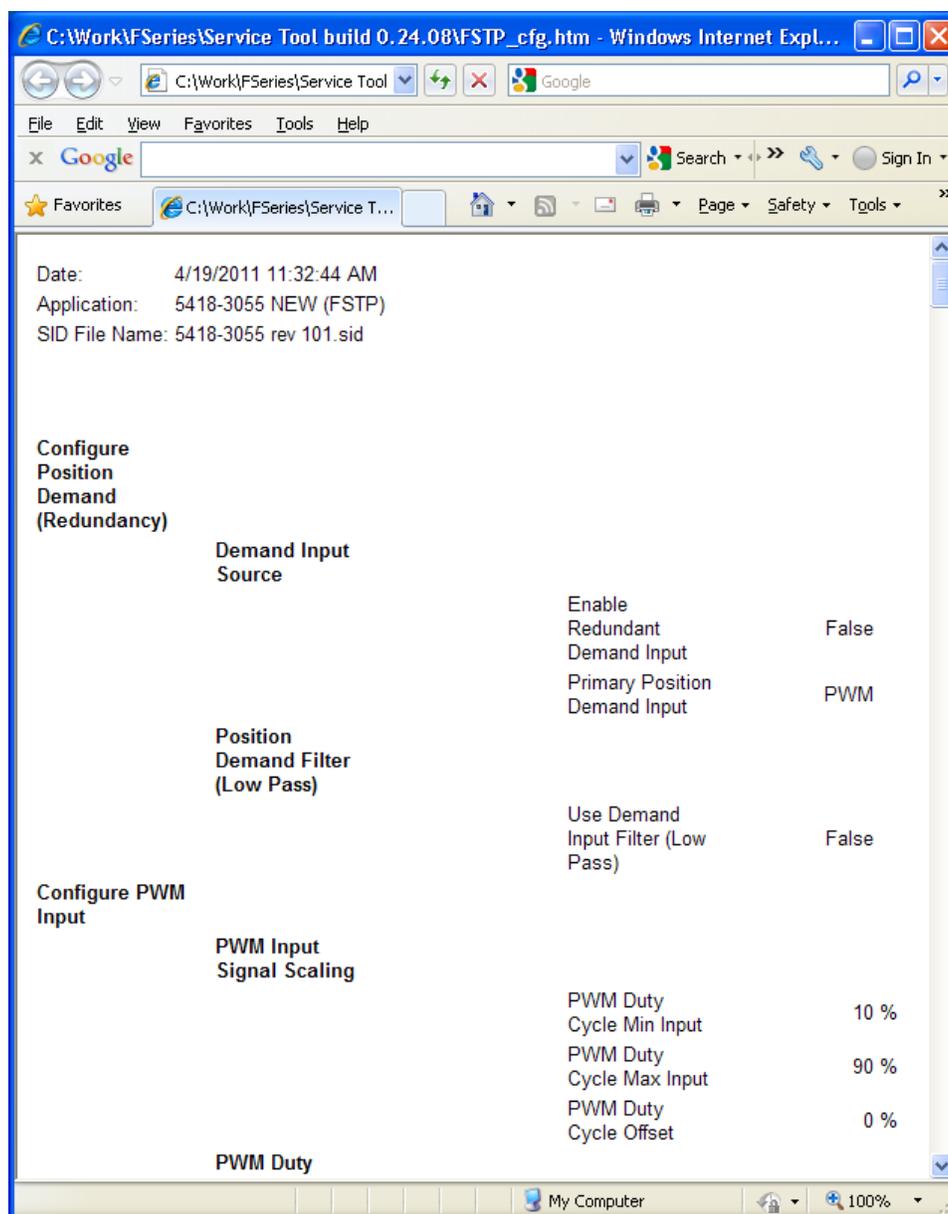


Figure 6-21. Configuration Document Hierarchical Example

Date: 4/19/2011 11:35:04 AM  
 Application: 5418-3055 NEW (FSTP)  
 SID File Name: 5418-3055 rev 101.sid

Configure Position Demand (Redundancy)	Demand Input Source	Enable Redundant Demand Input	False
Configure Position Demand (Redundancy)	Demand Input Source	Primary Position Demand Input	PWM
Configure Position Demand (Redundancy)	Position Demand Filter (Low Pass)	Use Demand Input Filter (Low Pass)	False
Configure PWM Input	PWM Input Signal Scaling	PWM Duty Cycle Min Input	10 %
Configure PWM Input	PWM Input Signal Scaling	PWM Duty Cycle Max Input	90 %
Configure PWM Input	PWM Input Signal Scaling	PWM Duty Cycle Offset	0 %
Configure PWM Input	PWM Duty Cycle Fault Settings	PWM Duty Cycle Low Threshold	2 %
Configure PWM Input	PWM Duty Cycle Fault Settings	PWM Duty Cycle High Threshold	98 %

Figure 6-22. Configuration Document Tabular Example

# Chapter 7.

## 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 actuator failures.

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 that the application has been engineered and tested thoroughly.

There are four parts to the troubleshooting section:

- General Troubleshooting
- Engine/Generator Troubleshooting
- Alarm/Shutdown Diagnostic Flags Troubleshooting
- Input/Output (I/O) Troubleshooting



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.



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 overpressure shutdown device may also be needed for safety, as appropriate.



Due to typical noise levels in engine environments, hearing protection should be worn when working on or around the F-Series actuator.



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.

## 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 linkage/valve move through its proper stroke smoothly?
- Does the linkage/valve travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the valve fully seat (closed)?
- Does the valve fully open?

## Engine/Generator Troubleshooting

Problem	Possible Cause	Suggested Test/Correction
Engine does not start.	Power not applied to control  Run Enable not closed  Incorrect configuration in control  Fault detected in control.  Stuck throttle/frozen shaft	Test for +12/24 V between +12/24 V pin and ground pin.  Verify status of input. Measure input. Verify input and configuration using Service Tool.  Using Service Tool, read configuration from control and evaluate parameters for correction.  Using Service Tool, read faults from control. Verify/correct any shutdown conditions.  Move throttle by hand. Assess smoothness, friction, and return spring force.
The actuator is not opening the control valve during engine cranking.	No demand input is present at the actuator.  The control is configured for the wrong opening direction.  The Run Enable input is not enabled.  The control has detected a shutdown situation and has not been reset.  There is no power supplied to the control.	Verify Demand input from controller.  Check linkage setup.  Make sure the run enable input, if configured for use, is made active. Check wiring.  Reset the control by cycling power to the control, hitting reset on the Service Tool, or toggling the run enable switch.  Check fuse, wiring, and battery voltage.
The engine over speeds on start-up.	The control is setup for the wrong opening direction.  Speed setting too high within the controlling speed control.  Improper configured valve position relative to demand input.  An overshoot in speed is caused by speed control.  The overspeed trip level is set incorrectly.	Check linkage setup.  Verify speed control setpoint  Verify valve demand configuration.  Speed control dynamic settings or acceleration ramp rate are overly responsive. Tune the speed control  Verify the overspeed trip setting.

Problem	Possible Cause	Suggested Test/Correction
Engine starts, but shuts down on error.	Error detected by control.	Verify the exact cause of the error using the Service Tool.
Unable to develop full power.	Non-indexed linkage slipped on shaft.  Fault detected in control.  Improper configured valve position relative to demand input.	Manually verify full travel of throttle plate.  Using Service Tool, view status of fault codes. Take appropriate action for active faults.  Verify position settings within the configuration file.
Not controlling at desired position setpoint.	PWM input signal inaccuracy.  Wiring fault or ground loop.  Analog input signal inaccuracy.  Output shaft is bound or sticking.  Incorrect dynamics Incorrect position calibration  Scaling mismatch  Running on backup demand	Measure input duty cycle and convert to percentage. Verify controller signal using Service Tool. If different, adjust the PWM input scaling in the Settings Editor.  Check the wiring. Look for loose connections and disconnected or misconnected cables and connections. Remove all wiring except the position demand and power input and verify operation/functionality.  As applicable, measure the analog demand voltage or current to verify that it is at the expected value in the range of 0 to 5 V or 4 mA to 20 mA. Use the service tool to verify that analog input is being read correctly.  Move output shaft by hand. Assess smoothness, friction, and return spring force.  Follow the procedures in chapter 6 for verifying both the dynamics and the position calibration  Verify the value of the position setpoint using the Service Tool. Verify the configured scaling of the demand inputs.  Verify the demand source using the Service Tool.
Discrete output not working.	Wiring fault.  Configuration.	Check the wiring leading to pin 23 for open connections or misconnections.  Verify that pin 23 is not connected directly to input power or ground.  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").

Problem	Possible Cause	Suggested Test/Correction
Service Tool not communicating—'Establishing Connection on Com x' status indicated.	<p>Power not applied to control</p> <p>Wiring fault.</p> <p>Incorrect cable used or converter missing.</p> <p>The Service tool is disconnected.</p> <p>The wrong communication port has been selected.</p>	<p>Disconnect starter motor solenoid. Disconnect harness from actuator. Test for +12/24 V between +12/24 V pin and ground pin.</p> <p>Check pins TTL TX, TTL RX and Ground for loose or misconnected wiring connections.</p> <p>Converter interconnect cable must be straight-through and have all 9 pins connected. In-line TTL to RS-232 converter required. See Chapter 5 for details.</p> <p>Verify harness setup and connections (see Chapter 4).</p> <p>Check that Service Tool is running.</p> <p>Check fuse, wiring, and battery voltage.</p> <p>Connect the service tool by using the connect icon or 'Device Connect' menu selection.</p> <p>Verify the port setting is correct.</p>
Service Tool not communicating—'Error message displayed on PC when trying to connect.	Old version of Service Tool or file corruption or bad install.	Re-install Service Tool. Get the latest version from the Woodward web site ( <a href="http://www.woodward.com/software">www.woodward.com/software</a> ).
Power supply fluctuation (if using a switching power supply instead of battery power).	Flyback energy on the Batt(+) input can interfere with some switching power sources.	Add a forward-biased power diode in series with the Batt(+) input of the F-Series. Use at least a 6 A, fast recovery diode.

## Troubleshooting Diagnostic Fault Flags

Error Flag	Description	Possible Source	Possible Action
Analog Input High	The analog input is higher than the configured diagnostic limits.	Analog input is driven outside of the diagnostic high limit.  Diagnostic limit is setup incorrectly.  Analog wiring is shorted to a power source like the battery plus.  Jumper setting is wrong for the input type	Check signal and fix incorrect signal level.  Set correct diagnostic limit in the F-Series control.  Correct wiring problem.  Add or remove the jumper to match the input signal type.
Analog Input Low	The analog input is lower than the configured diagnostic limits.	Analog input is driven outside of the diagnostic low limit.  Diagnostic limit is set up incorrectly.  Analog wiring is shorted to a low signal like battery minus.  Analog signal wiring is lost.  The control that is driving the analog input is turned off or damaged.  Jumper setting is wrong for the input type	Check signal and fix incorrect signal level.  Set correct diagnostic limit in the F-Series control.  Correct wiring problem.  Correct wiring connection.  Turn on control or check external controls manual for troubleshooting.  Add or remove the jumper to match the input signal type.
Input Voltage High	The power supply voltage is higher than the configured diagnostic limits.	Bad or damaged battery.  Defective battery charging system.  Incorrect settings of power supply voltage level.	Replace battery.  Fix battery charging system.  Set correct voltage levels on power supply.
Input Voltage Low	The Power supply voltage is lower than the configured diagnostic limits.	Defective battery charging system.  Power supply wiring too long or too thin. Control will flag low voltage during higher power uses.  Incorrect setting of power supply voltage levels.	Fix battery charging system.  Make sure wiring is of the correct thickness and length according to manual.  Set correct voltage levels on power supply.
Electronics Temperature High	The temperature inside the control is higher than allowed by specifications.	The F-Series actuator has been placed in an environment that is too hot.  The internal temperature sensor is defective. Check the temperature of the unit and compare this to the service tool value of the electronics temperature to determine this.	Lower temperature by adding cooling, heat shielding, moving the unit, etc.  Return unit to Woodward for repair.
Electronics Temperature Low	The temperature inside the control is lower than allowed by specifications.	F-Series actuator has been place in an environment that is too cold.  The internal temperature sensor is defective. Check the temperature of the unit and compare this to the service tool value of the electronics temperature to determine this.	Increase temperature by adding heat.  Return unit to Woodward for repair.

Error Flag	Description	Possible Source	Possible Action
Not Run Enabled	Control detected that the Run Enable discrete in is not active.	Incorrect or intermittent wiring problem.  Incorrect configuration.	Check wiring for bad or lost connection.  Verify configuration. Check Run Enable Input setting. Active Open or Active Closed setting and Active Low or High settings.
Position Error	Indicates demanded position and the actual position are outside hard coded diagnostic limits.	Binding or excessive friction in the actuator linkage, or stops are set inside the desired range of travel.	Check all mechanical linkages and stops.
Demand Tracking Error	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.
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)
PWM Duty Cycle High	The PWM Duty Cycle is higher than the configured diagnostic limits.	PWM Duty Cycle is driven outside of the diagnostic high limit.  Diagnostic limit is setup incorrectly.	Check signal and fix incorrect signal level.  Set correct diagnostic limit in the F-Series control.
PWM Duty Cycle Low	The PWM Duty Cycle is Lower than the configured diagnostic limits.	PWM Duty Cycle is driven outside of the diagnostic low limit. Incorrect or intermittent wiring problem.  Diagnostic limit is setup incorrectly.	Check signal and fix incorrect signal level.  Set correct diagnostic limit in the F-Series control.
CAN Bus Off	The CAN port is detected in the Bus Off condition.	Incorrect or intermittent wiring problem.  Incorrect or missing termination resistors.  Electrical problems within the controller or unit.	Check wiring for broken or loose connection.  Verify proper termination resistors at the ends of the CAN network.  Possible problem with the F-Series, although additional testing recommended before returning to Woodward.

Error Flag	Description	Possible Source	Possible Action
CAN Demand Fault	The CAN demand value received was detected above 100 % (0x9C40).	<p>CAN demand is missing (no signal) or is too slow (slower than the Demand Timeout setting), or the value received is above 0xFAFF</p> <p>Incorrect F-Series Number.</p> <p>ECM is not sending Demand messages, or is not sending to the correct F-Series number.</p> <p>CAN termination problem.</p> <p>CAN wiring problem.</p> <p>CAN noise problem.</p> <p>CANbus incompatibility with ECM, e.g., baud rate.</p> <p>CAN traffic overload.</p>	<p>Verify correct configuration (demand timeout). Verify CANbus communication and connections.</p> <p>Check the CAN ID inputs to the valve.</p> <p>Verify that the ECM is powered up and sending valid demand messages, and that the correct F-Series ID numbers are selected.</p> <p>Check if the CANbus has the right termination resistor connected at both ends of the bus.</p> <p>Check the CAN wiring for shorts, open connections, interchanged connections, and intermittent contacts.</p> <p>Verify that the CAN wiring is installed according to the installation instruction</p> <p>Verify ECM CANbus compatibility.</p> <p>Verify that there is not excessive CAN traffic that has higher priority than the F-Series demand message.</p>
CAN Demand Out of range	The CAN demand value received was detected above 100 % (0x9C40).	<p>Incorrect value sent from ECM.</p> <p>CAN noise problem.</p> <p>CAN wiring problem.</p>	<p>Verify ECM limits the values sent to the F-Series to be within the specified 0 % to 100 % range.</p> <p>Verify that the CAN wiring is installed according to the installation instruction.</p> <p>Check the CAN wiring for shorts, open connections, interchanged connections, and intermittent contacts.</p>
CAN Address Claim Error	This J1939 fault is set if the control's address cannot be claimed on the CANbus.	<p>Another unit on the bus with the same id with a higher priority.</p> <p>No other units on the CANbus.</p> <p>CAN wiring problem.</p>	<p>Verify correct CAN ID discrete input state, and unit number selection. Verify Source Addresses of units communicating on the bus, resolve conflict.</p> <p>Verify CANbus communication and connections. Check wiring for broken or loose connection.</p> <p>Check the CAN wiring for shorts, open connections, interchanged connections, and intermittent contacts.</p>

Error Flag	Description	Possible Source	Possible Action
Configuration Error	The loaded settings file has improper settings.	Invalid or corrupt settings	Using the service tool, check and fix configuration settings and reload them into device.
Configuration Warning	The loaded settings file has improper settings.	Invalid or corrupt settings	Using the service tool, check and fix configuration settings and reload them into device.
Temperature > 118 °C (Derated)	The internally monitored electronics temperature has exceeded 118 °C. Performance may be reduced.	High device temperature.  Possible failed or intermittent temperature sensor.	Monitor temperature using the service tool. Verify reasonable value as compared to ambient temperature of the device.  Provide cooling for device.  Return unit to Woodward for repair.
Temperature > 125 °C	The internally monitored electronics temperature has exceeded 125 °C. Drive current is zero, limp.	High device temperature.  Possible failed or intermittent temperature sensor.	Monitor temperature using the service tool. Verify reasonable value as compared to ambient temperature of the device.  Provide cooling for device.  Return unit to Woodward for repair.
Internal Shutdown	All internal shutdowns will set this flag	The F-Series actuator is defective	Return unit to Woodward for repair.
Main EE PROM Write Failure	The software can't write to the EEPROM.	The F-Series actuator is defective	Return unit to Woodward for repair.
Main EE PROM Read Failure	The software can't read from the EEPROM.	The F-Series actuator is defective	Return unit to Woodward for repair.
Parameter Error	The software has detected a checksum error on one of the parameter blocks.	The F-Series control software was upgraded with an incompatible parameters set.  The F-Series actuator is defective.	Return unit to Woodward for repair.
Parameter Version Error	The version of the parameter set is incorrect.	The F-Series actuator is defective.	Return unit to Woodward for repair.
5 V Supply Error	The 5 V power supply is defective.	The F-Series actuator is defective.	Return unit to Woodward for repair.
5 V Reference Supply Error	The A/D Converter reference voltage is defective.	The F-Series actuator is defective.	Return unit to Woodward for repair.
+15 V Supply Error	The +15 V power supply is defective.	The F-Series actuator is defective.	Return unit to Woodward for repair.
-15 V Supply Error	The -15 V power supply is defective.	The F-Series actuator is defective.	Return unit to Woodward for repair.
A/D Converter Error	The 12 bit A/D converter is defective.	The F-Series actuator is defective.	Return unit to Woodward for repair.
SPI A/D Error	The 12 bit A/D converter is defective.	The F-Series actuator is defective.	Return unit to Woodward for repair.
Watchdog Reset Occurred	The watchdog has reset the F-Series control.	The software is disrupted by EMI or an internal component failure.	Clear logged fault indication and monitor for recurrence.  Return unit to Woodward for repair.
Position Sensor Failed	Indicates the internal position sensor is outside hard coded diagnostic limits.	Internal failure of position sensor.	Return unit to Woodward for repair.

## Chapter 8.

# Product Support and Service Options

**IMPORTANT** There are no user-serviceable parts on the F-Series actuator.

### Product Support Options

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

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which 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 current list of Woodward Business Partners is available at [www.woodward.com/local-partner](http://www.woodward.com/local-partner)

### Product Service Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-09-0690) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- 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 is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-09-0690).

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.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

**Flat Rate Repair:** Flat Rate Repair is available for the majority of standard 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. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-09-0690) on replaced parts and labor.

**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 and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-09-0690). 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 authorization 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 offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- 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. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

**Product Training** is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our 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 many of our worldwide locations or 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/local-partner](http://www.woodward.com/local-partner).

## Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at <https://www.woodward.com/support>, which also contains the most current product support and contact information.

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		Products Used in Engine Systems		Products Used in Industrial Turbomachinery Systems	
<u>Facility</u>	<u>Phone Number</u>	<u>Facility</u>	<u>Phone Number</u>	<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800	Brazil	+55 (19) 3708 4800	Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515	China	+86 (512) 8818 5515	China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510	Germany	+49 (711) 78954-510	India	+91 (124) 4399500
India	+91 (124) 4399500	India	+91 (124) 4399500	Japan	+81 (43) 213-2191
Japan	+81 (43) 213-2191	Japan	+81 (43) 213-2191	Korea	+82 (32) 422-5551
Korea	+82 (32) 422-5551	Korea	+82 (32) 422-5551	The Netherlands	+31 (23) 5661111
Poland	+48 (12) 295 13 00	The Netherlands	+31 (23) 5661111	Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811	United States	+1 (970) 482-5811	United States	+1 (970) 482-5811

## 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.) \_\_\_\_\_

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### Control/Governor Information

#### Control/Governor #1

Woodward Part Number & Rev. Letter \_\_\_\_\_

Control Description or Governor Type \_\_\_\_\_

Serial Number \_\_\_\_\_

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#### 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 A.

# Acronyms/Abbreviations

AUX	Auxiliary
CAN	Control area network
CCW	Counterclockwise
CRC	Cyclic redundancy check
CW	Clockwise
DA	Destination Address
EEPROM	Electrically erasable programmable read-only memory
EMC	Electromagnetic compatibility
GUI	Graphic user interface
I/O	Inputs/outputs
ITB	Integrated throttle body
F-SERIES ACTUATOR	Woodward modular bi-directional actuator with integral position feedback control and driver
FST	F-Series throttle
FSTP	F-Series throttle Plus
LED	Light emitting diode
MWP	Maximum working pressure
OEM	Original equipment manufacturer
PC	Personal computer
PDU	Protocol Data Unit
PF	PDU Format
PGN	Parameter Group Number
PS	PDU Specific
PWM	Pulse-width modulated
RS-232	A communications standard
SA	Source Address
SID	Service interface definition
SPI A/D	Serial peripheral interface analog/digital
SPI D/A	Serial peripheral interface digital/analog
SPN	Suspect Parameter Number
TPS	Throttle position sensor

## Appendix B.

# SAE J1939 Profiles

The SAE J1939 protocol defines many SPNs (Suspect Parameter Numbers) and PGNs (Parameter Group Numbers) in part 71 for engine applications. Finding the relevant ones for a given application can take time. For convenience, the common applications for an F-Series are summarized here along with the correct way to configure the F-Series to use these public messages.

### J1939 Configuration Example

This example is provided to aid in understanding the relationship of the settings to the J1939 standard. There are two main J1939 components to set up in the F-Series, the unit identification (ACL NAME) and the data (SPN)/messages (PGN).

#### Unit Identification settings

**(Address Claimed Message NAME, PGN 60928)**

A device's name must be unique; no two devices may share the same name on a vehicle network. The F-Series provides four configurable components of the address claimed name data: the source address, function field, function instance, and ECU instance. The remaining components are fixed values that cannot be changed.

For convenience, the J1939 common actuator definitions are repeated below. The J1939 standard is updated frequently so the information provided below may not represent the latest however SAE is careful to allow backward compatibility.

#### **Source Address:**

18 (Fuel System)	May be used with Function 15
34 (aux valve control or engine air system valve)	May be used with Function 142, 143, 147, or 148

#### **Function Field:**

15	Fuel System - Controls fuel flow from the tank to the filter to the engine and back
142	Turbocharger Compressor Bypass
143	Turbocharger Wastegate
144	Throttle
146	Fuel Actuator (Rack Actuator)
147	Engine Exhaust Gas Recirculation
148	Engine Exhaust Backpressure
255	Unspecified

**Function Instance:** A value of 0 corresponds to 'first', and a value of 1 would be used for the second instance. When multiple actuators of the same type are used to control multiple of the same type of device, then each must have a unique Function (The first instance relates to the Left bank or first in the flow path).

**ECU Instance:** A value of 0 corresponds to 'first', and a value of 1 would be used for the second instance. When multiple actuators of the same type are used to control the same device, then each must have a unique ECU Instance.

Configuration of these settings is provided on the Configure CAN screen of the service tool (see Figure 6-8).

## Message Setup

The SAE J1939 standard defines the message (PGN) and its content (SPNs). The F-Series provides data values (like actual position) that can be enabled/disabled, placed in appropriate PGNs, and the data locations (start bit) may be defined. In addition, the message priority and transmission rate are configurable. This scheme provides fully-configurable messaging with predefined data.

Figure B-1 shows how the components from the standard are mapped to the configuration tool settings for the position command message [Input (Rx)].

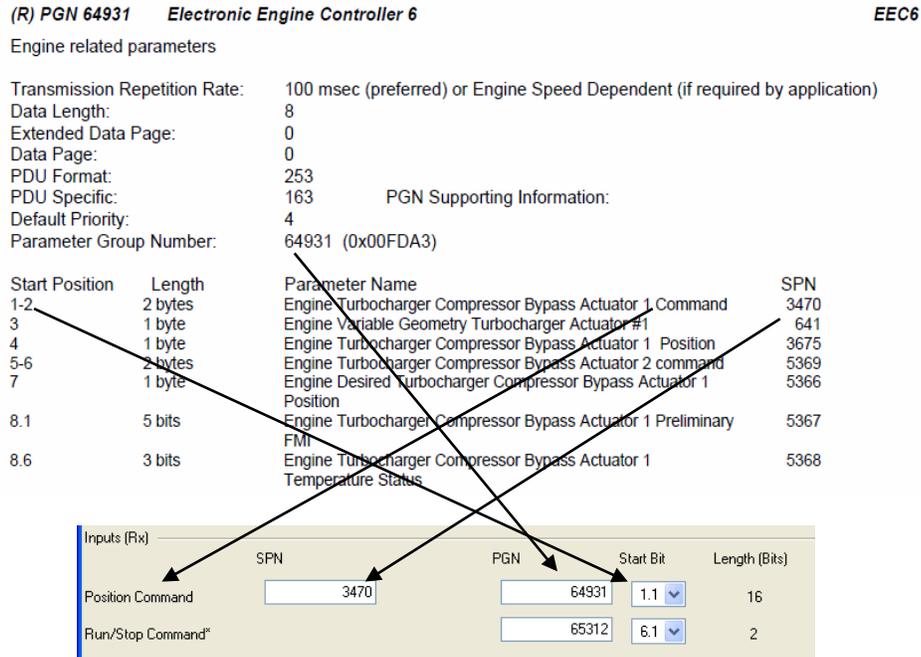


Figure B-1. Position Command Mapping

Figure B-2 shows how the components from the standard are mapped to the configuration tool settings for the actual position reported [Output (Tx)]. Other components are similar.

(R) PGN 64931 Electronic Engine Controller 6

EEC6

Engine related parameters

Transmission Repetition Rate: 100 msec (preferred) or Engine Speed Dependent (if required by application)  
 Data Length: 8  
 Extended Data Page: 0  
 Data Page: 0  
 PDU Format: 253  
 PDU Specific: 163 PGN Supporting Information:  
 Default Priority: 4  
 Parameter Group Number: 64931 (0x00FDA3)

Start Position	Length	Parameter Name	SPN
1-2	2 bytes	Engine Turbocharger Compressor Bypass Actuator 1 Command	3470
3	1 byte	Engine Variable Geometry Turbocharger Actuator #1	641
4	1 byte	Engine Turbocharger Compressor Bypass Actuator 1 Position	3675
5-6	2 bytes	Engine Turbocharger Compressor Bypass Actuator 2 command	5369
7	1 byte	Engine Desired Turbocharger Compressor Bypass Actuator 1 Position	5366
8.1	5 bits	Engine Turbocharger Compressor Bypass Actuator 1 Preliminary FMI	5367
8.6	3 bits	Engine Turbocharger Compressor Bypass Actuator 1 Temperature Status	5368

Outputs (Tx)	SPN	Message	PGN#	Start Bit	Length (Bits)	Priority	Rate
Actual Position	3675	Enabled	64931	4.1	8	6	100ms
Desired Position		Enabled	64931	7.1	8	6	100ms
Prelim FMI & Temp Status		Enabled	64931	8.1	8	6	100ms
Operation Status		Enabled	64755	4.1	4	6	100ms
Control Mode Status*		Disabled	65312	5.1	4	6	1s
Diagnostic Bit Field*		Disabled	65312	1.1	32	6	1s
Electronic Temperature	5791	Enabled	64755	5.1	8	6	100ms

Figure B-2. Actual Position Mapping

## Turbocharger Compressor Bypass

The Turbocharger Compressor Bypass Actuator defined in J1939 has two instances (normally for left and right bank) already defined in the standard. The tables below summarize which PGNs and SPNs relate to these actuators. The Byte Location, Priority, and Rate as well as the NAME components are provided as defined in the standard to aid configuration.

### Turbocharger Compressor Bypass Instance 1

PGN	SPN	Name	Byte	Priority	Rate
64931	3470	Engine Turbo Compressor Bypass Actuator 1 Control Command	1-2	Rcv	Rcv
64931	3675	Engine Turbo Compressor Bypass Actuator 1 Position	4	4	100 ms
64931	5366	Engine Turbo Compressor Bypass Actuator 1 Desired Position	7	4	100 ms
64931	5367	Engine Turbo Compressor Bypass Actuator 1 Preliminary FMI	8.1	4	100 ms
64931	5368	Engine Turbo Compressor Bypass Actuator 1 Temperature Status	8.6	4	100 ms
64755	5449	Engine Turbo Compressor Bypass Actuator 1 Operation Status	4.1	6	100 ms
64755	5791	Engine Turbo Compressor Bypass Actuator 1 Temperature	5	6	100 ms

**Turbocharger Compressor Bypass Instance 2**

PGN	SPN	Name	Byte	Priority	Rate
64931	5369	Engine Turbo Compressor Bypass Actuator 2 Control Command	5-6	Rcv	Rcv
64755	5388	Engine Turbo Compressor Bypass Actuator 2 Position Engine Desired Turbo Compressor Bypass Actuator 2	1	6	100 ms
64755	5389	Position Engine Turbo Compressor Bypass Actuator 2 Preliminary	2	6	100 ms
64755	5390	FMI Engine Turbo Compressor Bypass Actuator 2 Temperature	3.1	6	100 ms
64755	5391	Status Engine Turbo Compressor Bypass Actuator 2 Operation	3.6	6	100 ms
64755	5450	Status Engine Turbo Compressor Bypass Actuator 2 Temperature	4.5	6	100 ms
64755	5792	Engine Turbo Compressor Bypass Actuator 2 Temperature	6	6	100 ms

NAME Component	Instance 1	Instance 2
Function Field	142	142
Function Instance	0	1
ECU Instance	0	0
Source Address	34	34
Device SPN	5420	NA

**Turbocharger Wastegate**

The Turbocharger Wastegate Actuator defined in J1939 has two instances (normally for left and right bank) already defined in the standard. The tables below summarize which PGNs and SPNs relate to these actuators. The Byte Location, Priority, and Rate as well as the NAME components are provided as defined in the standard to aid configuration.

**Turbocharger Wastegate Instance 1**

PGN	SPN	Name	Byte	Priority	Rate
61486	5386	Engine Turbocharger Wastegate Actuator 1 Control Command	1-2	Rcv	Rcv
65174	1188	Engine Turbocharger Wastegate Actuator 1 Position	1	6	100 ms
65174	5370	Engine Turbocharger Wastegate Actuator 1 Desired Position	6	6	100 ms
65174	5371	Engine Turbocharger Wastegate Actuator 1 Preliminary FMI	7.1	6	100 ms
65174	5372	Engine Turbocharger Wastegate Actuator 1 Temperature Status	7.6	6	100 ms
64753	5451	Engine Turbocharger Wastegate Actuator 1 Operation Status	2.1	6	100 ms
64753	5788	Engine Turbocharger Wastegate Actuator 1 Temperature	6	6	100 ms

**Turbocharger Wastegate Instance 2**

PGN	SPN	Name	Byte	Priority	Rate
61486	5387	Engine Turbocharger Wastegate Actuator 2 Control Command	3-4	Rcv	Rcv
65174	1189	Engine Turbocharger Wastegate Actuator 2 Position	2	6	100 ms
65174	5373	Engine Desired Turbocharger Wastegate Actuator 2 Position	8	6	100 ms
64753	5384	Engine Turbocharger Wastegate Actuator 2 Preliminary FMI Engine Turbocharger Wastegate Actuator 2 Temperature	1.1	6	100 ms
64753	5385	Status	1.6	6	100 ms
64753	5452	Engine Turbocharger Wastegate Actuator 2 Operation Status	2.5	6	100 ms
64713	5787	Engine Turbocharger Wastegate Actuator 2 Temperature	5	6	100 ms

NAME Component	Instance 1	Instance 2
Function Field	143	143
Function Instance	0	1
ECU Instance	0	0
Source Address	34	34
Device SPN	5421	NA

**Throttle**

The Throttle Valve Actuator defined in J1939 has two instances (normally for left and right bank) already defined in the standard. The tables below summarize which PGNs and SPNs relate to these actuators. The Byte Location, Priority, and Rate as well as the NAME components are provided as defined in the standard to aid configuration.

**Throttle Instance 1**

PGN	SPN	Name	Byte	Priority	Rate
61466	3464	Engine Throttle Valve 1 Control Command	1-2	Rcv	Rcv
65266	51	Engine Throttle Valve 1 Position	7	6	100 ms
64754	5374	Engine Desired Throttle Valve 1 Position	1	6	100 ms
64754	5375	Engine Throttle Valve 1 Preliminary FMI	2.1	6	100 ms
64754	5376	Engine Throttle Valve 1 Temperature Status	2.6	6	100 ms
64754	5445	Engine Throttle Valve 1 Operation Status	7.1	6	100 ms
64713	5783	Engine Throttle Valve 1 Temperature	1	6	100 ms

**Throttle Instance 2**

PGN	SPN	Name	Byte	Priority	Rate
61466	3465	Engine Throttle Valve 2 Control Command	3-4	Rcv	Rcv
65266	3673	Engine Throttle Valve 2 Position	8	6	100 ms
64754	5377	Engine Desired Throttle Valve 2 Position	3	6	100 ms
64754	5378	Engine Throttle Valve 2 Preliminary FMI	4.1	6	100 ms
64754	5379	Engine Throttle Valve 2 Temperature Status	4.6	6	100 ms
64754	5446	Engine Throttle Valve 2 Operation Status	7.5	6	100 ms
64713	5784	Engine Throttle Valve 2 Temperature	2	6	100 ms

NAME Component	Instance 1	Instance 2
Function Field	144	144
Function Instance	0	1
ECU Instance	0	0
Source Address	34	34
Device SPN	5419	NA

## Gaseous Fuel Valve

The Fuel Valve Actuator defined in J1939 has two instances (normally for left and right bank) already defined in the standard. The tables below summarize which PGNs and SPNs relate to these actuators. The Byte Location, Priority, and Rate as well as the NAME components are provided as defined in the standard to aid configuration.

### Gas Fuel Valve Instance 1

PGN	SPN	Name	Byte	Priority	Rate
61466	633	Engine Fuel Valve 1 Control Command	5-6	Rcv	Rcv
65153	1442	Engine Fuel Valve 1 Position	5	7	Req
65153	1765	Engine Fuel Valve 1 Desired Position	7	7	Req
64754	5380	Engine Fuel Valve 1 Preliminary FMI	5.1	6	100 ms
64754	5381	Engine Fuel Valve 1 Temperature Status	5.6	6	100 ms
64754	5447	Engine Fuel Valve 1 Operation Status	8.1	6	100 ms
64713	5785	Engine Fuel Valve 1 Temperature	3	6	100 ms

### Gas Fuel Valve Instance 2

PGN	SPN	Name	Byte	Priority	Rate
61466	1244	Engine Fuel Valve 2 Control Command	7-8	Rcv	Rcv
65153	1443	Engine Fuel Valve 2 Position	6	7	Req
65153	1766	Engine Desired Fuel Valve 2 Position	8	7	Req
64754	5382	Engine Fuel Valve 2 Preliminary FMI	6.1	6	100 ms
64754	5383	Engine Fuel Valve 2 Temperature Status	6.6	6	100 ms
64754	5448	Engine Fuel Valve 2 Operation Status	8.5	6	100 ms
64713	5786	Engine Fuel Valve 2 Temperature	4	6	100 ms

NAME Component	Instance 1	Instance 2
Function Field	146	146
Function Instance	0	1
ECU Instance	0	0
Source Address	18	18
Device SPN	5418	NA

## Fuel Rack Actuator

The Fuel Rack Actuator defined in J1939 has a single instances already defined in the standard. The tables below summarize which PGNs and SPNs relate to this actuator. The Byte Location, Priority, and Rate as well as the NAME components are provided as defined in the standard to aid configuration.

PGN	SPN	Name	Byte	Priority	Rate
			16		
61466	633	Engine Fuel Actuator 1 Control Command	bits	5-6	Rcv
65153	1442	Engine Fuel Actuator 1 Position	8 bits	5	Req
65153	1765	Engine Desired Fuel Actuator 1 Position	8 bits	7	Req
64754	5380	Engine Fuel Actuator 1 Preliminary FMI	5 bits	5.1	100 ms
64754	5381	Engine Fuel Actuator 1 Temperature Status	3 bits	5.6	100 ms
64754	5447	Engine Fuel Actuator 1 Operation Status	4 bits	8.1	100 ms

NAME Component	Instance 1
Function Field	15
Function Instance	0
ECU Instance	0
Source Address	18
Device SPN	834

## Exhaust Backpressure Actuator

The Exhaust Backpressure Actuator defined in J1939 has a single instances already defined in the standard. The tables below summarize which PGNs and SPNs relate to this actuator. The Byte Location, Priority, and Rate as well as the NAME components are provided as defined in the standard to aid configuration.

PGN	SPN	Name	Byte	Priority	Rate
61486	649	Engine Exhaust Back Pressure Control Command	1-2	Rcv	Rcv
64753	5625	Engine Exhaust Back Pressure Actuator 1 Position	3	6	100 ms
64753	5789	Engine Exhaust Back Pressure Actuator 1 Desired Position	7	6	100 ms
64753	5626	Engine Exhaust Back Pressure Actuator 1 Preliminary FMI	4.1	6	100 ms
64753	5627	Engine Exhaust Back Pressure Actuator 1 Temperature Status	4.6	6	100 ms
64753	5628	Engine Exhaust Back Pressure Actuator 1 Operation Status	5.1	6	100 ms
64753	5790	Engine Exhaust Back Pressure Actuator 1 Temperature	8	6	100 ms

## EGR Actuator

The EGR (Exhaust Gas Recirculation ) Actuator defined in J1939 has four instances already defined in the standard. The tables below summarize which PGNs and SPNs relate to these actuators. The Byte Location, Priority, and Rate as well as the NAME components are provided as defined in the standard to aid configuration. The Actual Position feedback is omitted from the tables below because it is formatted as a 16-bit value in the standard but the F-Series uses an 8-bit value (the EGR actuator is unique compared to all others in J1939). A proprietary PGN is needed to send back the actual position.

### EGR Actuator Instance 1

PGN	SPN	Name	Byte	Priority	Rate
64981	2791	Engine EGR 1 Actuator 1 Control Command	5-6	Rcv	Rcv
64715	5763	Engine EGR 1 Actuator 1 Preliminary FMI	1.1	6	100 ms
64715	5764	Engine EGR 1 Actuator 1 Temperature Status	1.6	6	100 ms
64715	5765	Engine EGR 1 Actuator 1 Temperature	2	6	100 ms
64715	5766	Engine EGR 1 Actuator 1 Desired Position	3	6	100 ms
64715	5771	Engine EGR 1 Actuator 1 Operation Status	7.1	6	100 ms

### EGR Actuator Instance 2

PGN	SPN	Name	Byte	Priority	Rate
64879	3821	Engine EGR 1 Actuator 2 Control Command	1-2	Rcv	Rcv
64715	5767	Engine EGR 1 Actuator 2 Preliminary FMI	4.1	6	100 ms
64715	5768	Engine EGR 1 Actuator 2 Temperature Status	4.6	6	100 ms
64715	5769	Engine EGR 1 Actuator 2 Temperature	5	6	100 ms
64715	5770	Engine EGR 1 Actuator 2 Desired Position	6	6	100 ms
64715	5772	Engine EGR 1 Actuator 2 Operation Status	7.5	6	100 ms

### EGR Actuator Instance 3

PGN	SPN	Name	Byte	Priority	Rate
64762	5264	Engine EGR 2 Actuator 1 Control Command	1-2	Rcv	Rcv
64714	5773	Engine EGR 2 Actuator 1 Preliminary FMI	1.1	6	100 ms
64714	5774	Engine EGR 2 Actuator 1 Temperature Status	1.6	6	100 ms
64714	5775	Engine EGR 2 Actuator 1 Temperature	2	6	100 ms
64714	5776	Engine EGR 2 Actuator 1 Desired Position	3	6	100 ms
64714	5781	Engine EGR 2 Actuator 1 Operation Status	7.1	6	100 ms

### EGR Actuator Instance 4

PGN	SPN	Name	Byte	Priority	Rate
64762	5265	Engine EGR 2 Actuator 2 Control Command	3-4	Rcv	Rcv
64714	5777	Engine EGR 2 Actuator 2 Preliminary FMI	4.1	6	100 ms
64714	5778	Engine EGR 2 Actuator 2 Temperature Status	4.6	6	100 ms
64714	5779	Engine EGR 2 Actuator 2 Temperature	5	6	100 ms
64714	5780	Engine EGR 2 Actuator 2 Desired Position	6	6	100 ms
64714	5782	Engine EGR 2 Actuator 2 Operation Status	7.5	6	100 ms

<b>NAME Component</b>	<b>Instance 1</b>	<b>Instance 2</b>	<b>Instance 3</b>	<b>Instance 4</b>
Function Field	147	147	147	147
Function Instance	0	1	2	3
ECU Instance	0	0	0	0
Source Address	34	34	34	34
Device SPN	NA	NA	NA	NA

# Appendix C.

## F-Series Control Specifications

### General Specifications

Power Supply	12/24 V systems (10 V to 32 V [dc]), reverse polarity protection
Power Source Capacity	10 A minimum
Power Consumption	24 W steady-state, 98 W instantaneous during transient
Travel	70 ±2 degrees
Torque	Steady State: 1.36 N·m (1.0 lb-ft) at 105 °C, 12 V (dc) Transient: 2.71 N·m (2 lb-ft) at 105 °C, 12 V (dc)
Throttle (ITB) Sizes	35 mm, 48 mm, 60 mm, 68 mm, and 75 mm
Mass/Weight	33 mm ITB = 5.0 kg (11.1 lb) 48 mm ITB = 4.9 kg (10.8 lb) 60 mm ITB = 4.7 kg (10.4 lb) 68 mm ITB = 4.5 kg (10.0 lb) 75 mm ITB = 6.3 kg (13.8 lb) Modular Actuator = 3.9 kg (8.7 lb)
Position Feedback	0.5 V to 4.5 V (dc), configurable in software
Connector Orientation	4 versions at 90° rotation intervals
Modular Actuator Load Inertia	Ranges from 0 (bare shaft) to 0.0025 kg·m <sup>2</sup>

### Performance

Positioning Accuracy (actual position relative to position demand)	±4 % full stroke for all input types after effects from –40 °C to +85 °C board temperature ±7 % full stroke all input types above 85 °C board temperature
Positioning Repeatability	<= 1 % of full stroke
Power-Up Time	< 1 s
10 % to 90 % step Slew Time	55 ms (at 12 V [dc], room temperature, no external load)
Overshoot	< 2 %
1 % Settling Time	200 ms
Bandwidth	>= 10 Hz at –3 db, ±0.5 % of full scale >= 14 Hz at –3 db, ±2 % of full scale
No-load Steady State Limit Cycle	< 0.25 degree p-p (at 12 V [dc], room temperature)

### Environment

Ambient Operating Temperature	–40 °C to +105 °C (–40 °F to +221 °F)
ITB Flowing Medium Temperature	–40 °C to +105 °C (–40 °F to +221 °F)
Storage Temperature	–40 °C to +125 °C (–40 °F to +257 °F)

EMC	EN61000-6-2 (2005): Immunity for Industrial Environments EN61000-6-4 (2007): Emissions for Industrial Environments ISO 10605 (2001): ESD Immunity for Packaging and Handling, $\pm 4$ kV contact discharge ISO 11452-4 (2005): Conducted RF Immunity (BCI method), 1 MHz to 200 MHz, 100 mA induced current ISO 11452-2 (2004): Radiated RF Immunity, 200 MHz to 1 GHz @ 100 V/m, 1 GHz to 2 GHz @ 30 V/m CISPR 25 (2002): Radiated RF Emissions, 30 MHz to 1 GHz, 2004/104/EC and ECE Regulation 10 limits ISO 7637-2 (2004): Conducted Transient Immunity Pulse 1c, Disconnect of Inductive Loads Pulse 2a, Sudden Interruption of Series Current Pulse 3a, Negative Switching Spikes Pulse 3b, Positive Switching Spikes Pulse 4, Starter Motor Engagement Disturbance Pulse 5a, 24 V Load Dump <b>NOTE:</b> Pulse 2b is not required since dc motors will not be wired in parallel with the switched battery input
Humidity	US MIL-STD 810D, 507.2, Procedure III (60 °C, 95 % RH), Lloyd's Register of Shipping Humidity Test 1 and Det Norske Veritas Damp Heat per Woodward Procedure 4-04-6230
Salt Fog	SAE J1455, 4.3
Dust Exposure	SAE J1455, 4.7
Chemical Resistance	SAE J1455, 4.4.3 (except water immersion testing)
Shock	40 G, 11 ms duration saw-tooth pulse Per Woodward Procedure 3-04-6231, MS1
Vibration	Random: 0.3 G <sup>2</sup> /Hz, 10 Hz to 2000 Hz (22.1 Grms) 3 h/axis per Woodward Procedure 3-04-6231, RV3
Drop Test	SAE J1455, Section 4.10.3.1
Thermal Shock	SAE J1455, 4.1.3.2. Modified, -40 °C to +105 °C and 20 cycles
Ingress Protection	IP56 per IEC 60529, (dust ingress, water ingress)
Immersion and Splash, Steam Cleaning and Pressure Washing	SAE J1455, 4.4.3 (submerged, frozen, thawed) SAE J1455, 4.5 (steam cleaning and pressure wash)
HALT Testing	Units driven to failure with simultaneous loading through vibration, temperature and humidity and evaluated for improvements.

## Reliability

Integrated Product: The target B10 life in the field is 35,000 hours at 60 °C ambient and steady state operation.

## Regulatory Compliance

(See page iv.)

## I/O Specifications

### Power Supply Input

Parameter	Value
Max Input Power	~24 W (32 V [dc] at 0.75 A)
Input Voltage Range	7 V to 32 V (dc)
Transient Suppression	54 V to 58 V (dc) during surge and load dump up to 200 ms
Hold Up Time	<b>NOTE:</b> Depends on operating conditions. 0.4 ms at 12 V (dc) with max load 2.7 ms at 24 V (dc) with max load
Jump Start	40 V (dc) max.
Battery Voltage Monitor	Voltage divider circuit read directly from the power bus that feeds the H-Bridge
Configurable fault range	Low voltage = 6 V to 18 V (dc). High voltage = 12 V to 36 V (dc)

### PWM Demand Input

Parameter	Value
PWM Input Type	Low-Side and Push-Pull (differential input)
PWM Amplitude Range	4 V to 32 V p-p
Specified Frequency Range	300 Hz to 2000 Hz
Max Allowed Frequency	5000 Hz
PWM Detection Threshold	1.15 V (dc) nominal
PWM Hysteresis	0.6 V to 1.7 V (dc)
Duty Cycle Scaling	Configurable in software. See Chapter 6
Isolation	None
Input Impedance	10 k $\Omega$ all modes
Resolution	12 bits up to 1953 Hz The duty cycle and frequency are read with reduced resolution at higher frequencies
Accuracy	$\pm 1$ % all modes at 32 V and frequencies < 1000 Hz $\pm 2$ % all modes at 32 V and frequencies > 1000 Hz <b>NOTE:</b> Low-Side detection accuracy could depend on integrity of signal source.
Pull-Up Level	5 V through 4.99 k $\Omega$
I/O Execution Rate	600 $\mu$ s
Calibration	Configurable in software. See Chapter 6.
Loss of Signal	<153 Hz. Sets Duty Cycle and Frequency to zero.
Out of Range Duty Cycle	Configurable in software. See Chapter 6.

## Analog (TPS) Output

Parameter	Value
Output Type	0.5 V to 4.5 V (dc)
Output Scaling	Configurable in Software. See Chapter 6.
Isolation	None
Response Time Min to Max	~ 4 ms (0.5 V [dc] steady-state to settling at 4.5 V [dc])
Position Output Update Rate	9.6 ms
Filter Cutoff Frequency	1000 Hz at 3 dB pass band attenuation
Final Low Pass Filter	1 ms (fo = 169 Hz)
Transient Protection	According to EMC norm
Impedance at Output Pin	20 k $\Omega$
Accuracy of Position Output	$\pm 1$ % FS over entire operating temperature range
Calibration Method	Factory calibrated to maintain 1 % accuracy
Overvoltage Protection	Output protected against 32 V (dc), steady-state. Also protected from direct short to ground.
Minimum Impedance	2500 $\Omega$ to ensure $\pm 1$ % accuracy. Accuracy will degrade with larger loads (less impedance).

## Serial Communication Service Port

Parameter	Value
Isolation	None
Baud Rate	Fixed 38.4 K baud
Electrical Interface	Outputs are TTL level. Requires external transceiver for conversion to RS-232 levels for proper communication.
FST Pinout	Tx = pin 3, Rx = pin 8, Gnd = pin 11
FSTP & Modular Actuator Pinout	Tx = pin 3, Rx = pin 11, Gnd = pin 15
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
Isolation	None
Baud Rate	J1939: 250 Kbps; CANopen: configurable from 250 K to 1 Meg
Electrical Interface	CAN Hi and CAN Lo differential transmit/receive
Type	F-Series supports CAN2.0B and SAE J1939-11
FSTP & Modular Actuator Pinout	CAN Hi = pin 13 CAN Lo = pin 21 CAN Shld= pin 14
Maximum Cable Length	30 m
Cable Type	Two-conductor shielded cable according to SAE J1939-11

## Discrete Output

Parameter	Value
Output Type	Low-side driver
Max Voltage at Output Pin	40 V (dc)
Max Current through Switch	500 mA
Max On-State Saturation Voltage at Max Current	1 V (dc)
Max Off-State Leakage Current at 24 V (dc)	8 $\mu$ A
Activating Latency	<1 ms
I/O Execution Rate	9.6 ms
Output Action	Configurable in software. See Chapter 6.
Output Selections	Configurable in software. See Chapter 6.
Driving Inductive Loads Protection	Yes, internally protected low-side switch. Utilizes circuitry that will open the contact when output contacts are short-circuited. Self-resetting when fault is removed.

## Discrete Inputs

Parameter	Value
Input Type	General Purpose
Input Assignments	Input 1 = Configurable as Run Enable or Not Used Input 2 = Configurable as CAN ID High or Low Input 3 = Configurable as CAN ID High or Low
Input Voltage Range	0 V to 10 V (dc)
Reference	3.3 V
Input Thresholds	> 5.85 V (dc) = "High" < 3.25 V (dc) = "Low"
Open Terminal Voltage	1.35 V $\pm$ 0.06 V (dc)
Max Input Voltage	32 V
Resolution	10 bit
I/O Execution Rate	9.6 ms
Isolation	None. Use with external relay or other dry contact.
Accuracy	<0.5 %
Drift	<0.1 % over a 100 degree C range
Anti-Aliasing Filter	1 pole at 15.9 kHz (10 ms)
Input Current	1.5 mA @ 32 V (dc), 35 $\mu$ A @ 10 V (dc)

## Analog Input

Parameter	Value
Input Type	0 V to 5 V (dc), 4 mA to 20 mA differential input
Input Range Selection	Jumper required to activate 4 mA to 20 mA range
Input Scaling	Configurable in software. See Chapter 6.
Voltage Input Range	-3 V to +5 V (dc)
Current Input Range	0 mA to 26 mA
Isolation	None
Transient Protection	According to EMC norm
Common Mode Impedance	> 200 k $\Omega$ to circuit common
Common Mode Voltage Range	$\pm 270$ V. Will be evaluated up to 50 V CM
Common Mode Rejection	86 dB
Anti-Aliasing Filter	A single pole at 470 $\mu$ s (338 Hz)
Resolution	12 bit with a 5 V reference
Voltage Input Accuracy	$\pm 0.2$ % at 25 $^{\circ}$ C
Voltage Input Drift	< 0.1 % FS
Current Input Accuracy	$\pm 0.6$ % at 25 $^{\circ}$ C
Current Input Drift	< 0.25 % FS
Linearity	1 % FS over specified operating range
I/O Execution Rate	600 $\mu$ s
Calibration Method	2-point linear software calibration. See Chapter 6.
Out of Range Signal	Configurable in software. See Chapter 6.
Over Voltage Protection	32 V (dc) continuous
Over Current Protection	140 mA continuous at 25 $^{\circ}$ C
Reverse Polarity Protection	Voltage Input, 5 V continuous Current Input, 24 mA continuous at 25 $^{\circ}$ C
Out of Range Analog Input	Configurable in software. See Chapter 6.

## Internal Electronics Temperature Sensor

Parameter	Value
Accuracy	$\pm 2$ $^{\circ}$ C at 25 $^{\circ}$ C $\pm 3$ $^{\circ}$ C over full 165 $^{\circ}$ C range
Scaling	Fixed at factory
Temperature Fault Levels	Configurable in software. See Chapter 6.
I/O Execution Rate	9.6 ms

## 5 V Sensor Supply Output

Parameter	Value
Tolerance	$\pm 0.5$ % of 5 V full-scale over the full temperature range

## Aux Power Out

Parameter	Value
Output Voltage	Equals Input Voltage and is internally referenced to the discrete return.
Max output current	4 A

## Actuator Response

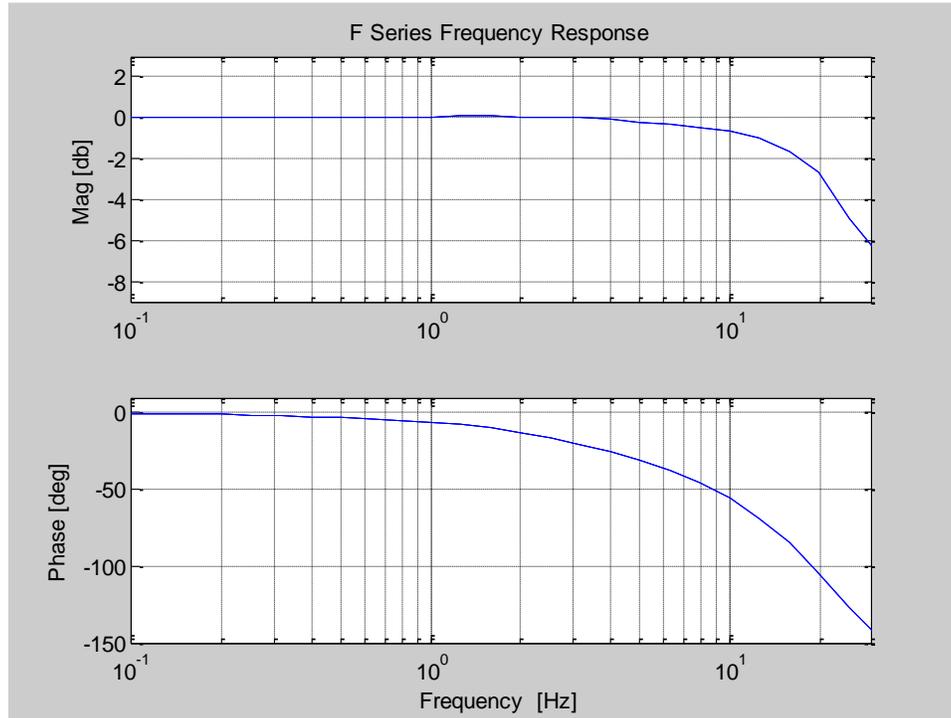


Figure B-3. Typical Bode Plot of F-Series Actuator Response

## Revision History

### Changes in Revision E—

- Added J1939 CAN Demand Crosstalk and notice box to Warnings and Notices page.
- Added note, “Firmwares 5418-3834, 5418-7289, 5418-9520 are proprietary. Some features perform differently than documented here” (page 9).
- Added note, “In firmware 5418-9520, Analog Demand is not available” (pages 12, 32, 40, 101).

### Changes in Revision D—

- Corrected summary of off-line configuration (page 88)

### Changes in Revision C—

- Corrected input power pin to pin 16, not pin 10 (page 16)

### Changes in Revision B—

- Corrected flow equation (page 4)

### Changes in Revision A—

- Updated descriptions in Position Control Section (p. 75)
- Updated Figures 5-1, 5-7, 5-9

# Declarations

## DECLARATION OF CONFORMITY

**Manufacturer's Name:** WOODWARD GOVERNOR COMPANY (WGC)  
**Manufacturer's Address:** 1000 E. Drake Rd.  
 Fort Collins, CO, USA, 80525  
**Model Name(s)/Number(s):** F-Series Actuator and Integrated Throttle Body  
**Conformance to Directive(s):** 2004/108/EC COUNCIL DIRECTIVE of 15 December  
 2004 on the approximation of the laws of the Member  
 States relating to electromagnetic compatibility and all  
 applicable amendments.  
**Applicable Standards:** EN61000-6-4, (2007): EMC Part 6-4: Generic Standards -  
 Emissions for Industrial Environments  
 EN61000-6-2, (2005): EMC Part 6-2: Generic Standards -  
 Immunity for Industrial Environments

We, the undersigned, hereby declare that the equipment specified above conforms to the above  
 Directive(s).

### MANUFACTURER

Signature



Sam Coleman

Full Name

Compliance Engineering Supervisor

Position

WGC, Fort Collins, CO, USA

Place

21 August 2009

Date

00336-04-EU-02-02

## Declaration of Incorporation

Woodward Governor Company  
 1000 E. Drake Road  
 Fort Collins, Colorado 80525  
 United States of America

**Product: F-Series Actuator and Integrated Throttle Body**  
**Part Number: 8235-600, 8235-602, 8235-618 and similar**

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 the following EU Directives as they apply to a component:

**98/37/EC (Machinery)**

This product is intended to be put into service only upon incorporation into an apparatus/system that itself will meet the requirements of the above Directives and bears the CE mark.

### MANUFACTURER

Signature	
Full Name	<b>Sam Coleman</b>
Position	<b>Compliance Engineering Supervisor</b>
Place	<b>WGC, Fort Collins, CO, USA</b>
Date	<b>21 August 2009</b>

00336-04-EU-02-03

We appreciate your comments about the content of our publications.

Send comments to: [industrial.support@woodward.com](mailto:industrial.support@woodward.com)

Please reference publication **26600**.



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