WOODWARD

Product Manual 26355
(Revision K, 11/2014)
Original Instructions

F-Series Throttle (FST)
Integrated Throttle Body

F-Series ITB 33/48/60/68/75
14-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.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

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Proper Use

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

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

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 Out-of-date translations are marked with ⚠.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

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

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Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

⚠WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

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.

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 all 14-pin F-Series position-control models with software 5418-2723 and 5418-2745. The software version can be identified on the Service Tool by clicking on the Details button on the bottom of the screen (Application ID).

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

The F-Series Throttle (FST) has a 14-pin connector and only accepts a PWM (pulse-width modulated) position demand. The PWM input type can be wired for Push-Pull or Low-Side (High-Side is possible but requires external customer-provided circuitry). The monitored duty cycle and frequency will be set to zero (0) when a failed PWM signal is detected.

The F-Series Throttle Plus (FSTP) and Modular Actuator versions have additional capabilities and additional I/O, utilizing 23-pin connectors. A discrete output and CAN communication are available in the FSTP and Modular Actuator versions. They accept PWM, CAN, 0 V to 5 V (dc), or 4 mA to 20 mA position demands, and support demand redundancy (primary/backup) with fail-over and fall-back logic. For additional information on the FSTP and Modular Actuator versions, see Woodward manual 26600.

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.

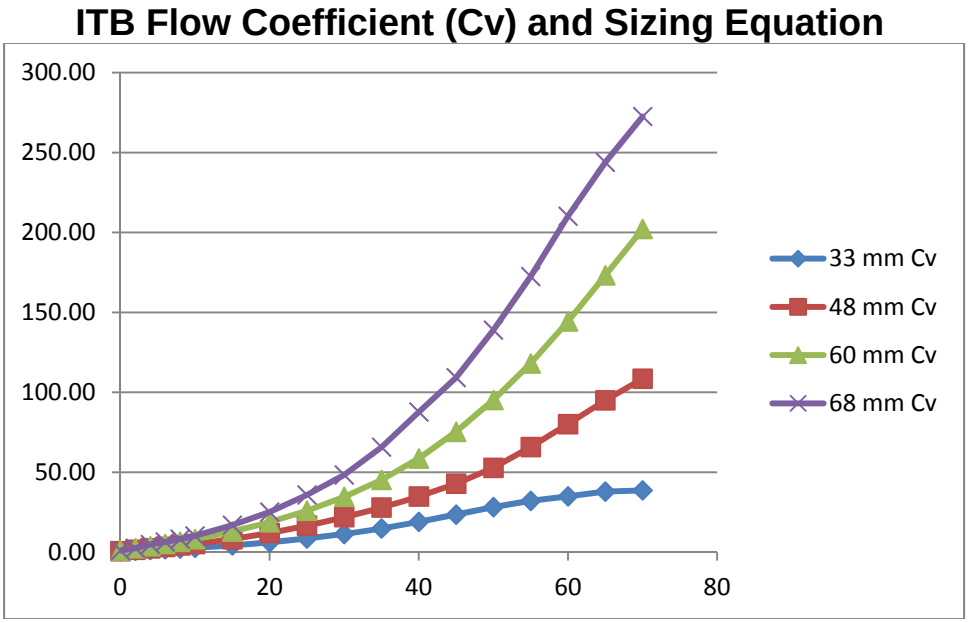

Figure 1-1. F-Series ITB Flow Coefficient (Cv) Curves

	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:

$$Cv = Q * .00978 * (G * T / ((P1–P2) * K)) ^ 0.5$$

Where:
Q = Flow (lb/Hr) (1 lb = 0.4535924 kg)
G = Specific gravity of fluid (Use 1.0 for air & 0.6 for Nat Gas)
T = Absolute temperature (460 + °F)
P1 = Inlet pressure (psia)
P2 = Discharge pressure (psia)
K = P2 if P1–P2 is less than 10 % of P1
= P1 if P1–P2 is 25 % or more of P1
= (P1+P2)/2 if P1–P2 is in between 10 % and 25 % of P1

P2 must be Greater than 0.53 * P1 (or flow becomes choked).
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 PWM Input**
  - PWM Duty Cycle Max & Min Input (%)
  - PWM Output at Max & Min Input (%)
  - PWM Fault Settings (Duty Cycle Low & High Thresholds) (%)
- **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 Alarms & Shutdowns**
  - Latching or Non-Latching Fault Indication
  - Up to 11 Fault Selections as Used or Not Used
  - Up to 11 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 (%)

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 trend data points to a *.csv file

Detailed descriptions of software installation are available in Chapter 5.

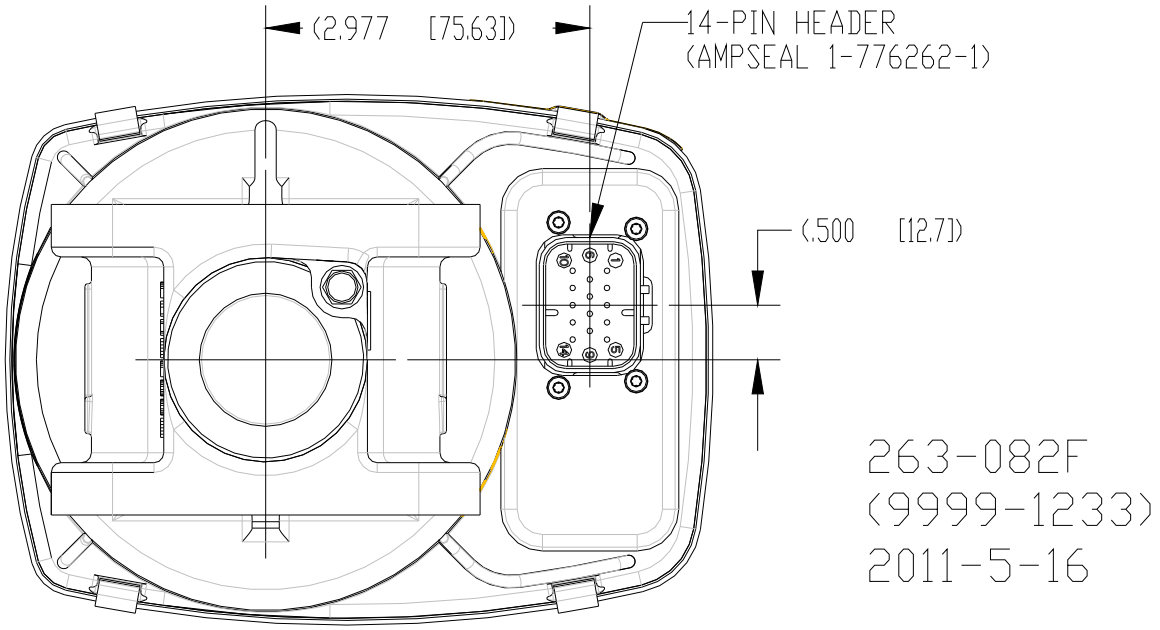

Figure 1-2. 14-Pin Electrical Connector

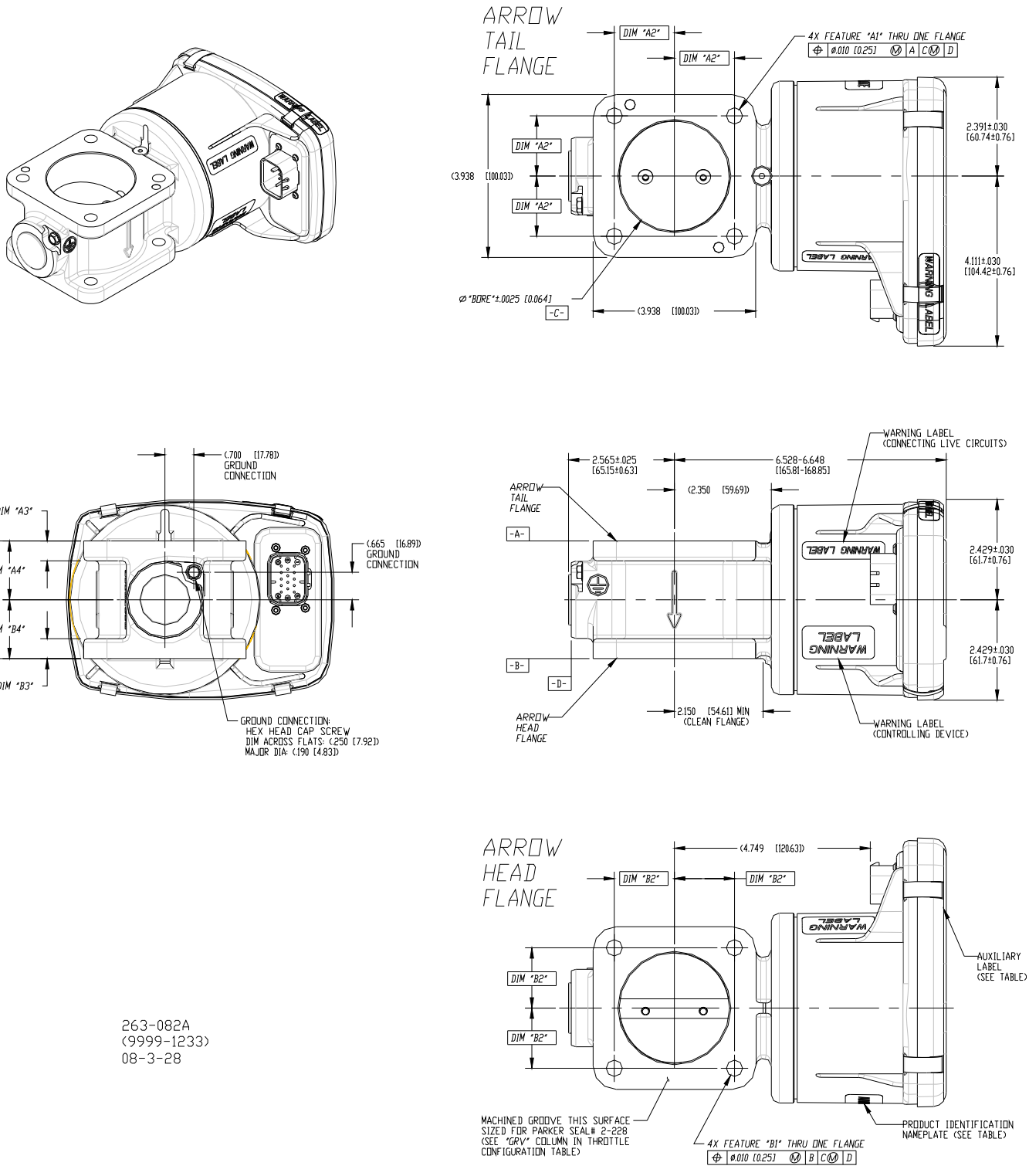

Figure 1-3a. F-Series ITB Outline Drawing

F-SERIES PRODUCT CONFIGURATION (HCS12 CPU)

F-SERIES PRODUCT	THROTTLE OPTION	HEADER		ACTUATOR FUNCTION	S/W PARAMETERS	FAIL CONDITION	NAMEPLATE	AUXILIARY LABEL
		PINS	PLAN					
8235-618	68/M10	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-623	48/STD	14	A	POSITION CONTROL	FACTORY DEFAULT	CLOSED	DEFAULT	DEFAULT
8235-624	48/M08	14	B	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	DEFAULT
8235-625	60/STD	14	A	POSITION CONTROL	FACTORY DEFAULT	CLOSED	DEFAULT	DEFAULT
8235-626	60/JADE	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	DEFAULT
8235-627	68/STD	14	A	POSITION CONTROL	FACTORY DEFAULT	CLOSED	DEFAULT	DEFAULT
8235-628	68/M10	14	A	POSITION CONTROL	FACTORY DEFAULT	CLOSED	DEFAULT	DEFAULT
8235-629	48/STD	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	DEFAULT
8235-630	60/STD	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	DEFAULT
8235-631	68/STD	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	DEFAULT
8235-632	60/M10	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-634	60/STD	14	B	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-639	68/STD	14	B	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	DEFAULT
8235-644	48/STD	14	B	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	DEFAULT
8235-647	60/STD	14	D	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-651	68/STD	14	D	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-652	60/SLOT	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-653	68/SLOT	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-654	48/□-RING	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-655	60/SLOT	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-656	33/STD	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-657	75/STD	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	CLOSED	DEFAULT	NONE
8235-664	33/STD	14	A	POSITION CONTROL	FLOTECH FLOW CURVE	OPEN	DEFAULT	NONE
8235-671	48/STD	14	D	POSITION CONTROL	CUSTOMER SPECIFIC	CLOSED	DEFAULT	DEFAULT
8235-672	33/STD	14	B	POSITION CONTROL	CUSTOMER SPECIFIC	OPEN	DEFAULT	DEFAULT

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THROTTLE OPTION DETAILS

THROTTLE OPTION	BORE	DETAILS -- ARROW TAIL FLANGE				DETAILS -- ARROW HEAD FLANGE					THROTTLE DESCRIPTION (REFERENCE)
		A1	A2	A3	A4	B1	B2	B3	B4	GRV	
48/STD	1.8900 [48.006]	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	48 MM BORE, THRU ØS FOR .375 SCREWS
48/M08	1.8900 [48.006]	Ø.354±.010 [8.99±0.25]	1.339 [34.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.354±.010 [8.99±0.25]	1.339 [34.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	YES	48 MM BORE, THRU ØS FOR M8 SCREWS, GROOVE USES PARKER 2-228
60/STD	2.3625 [60.008]	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	60 MM BORE, THRU ØS FOR .375 SCREWS
60/JADE	2.3625 [60.008]	Ø.354±.010 [8.99±0.25]	1.535 [38.99]	.425±.060 [10.8±1.52]	(1.3665 [34.709])	M8X1.25 THD [METRIC]	1.457 [37.01]	.535±.060 [13.59±1.52]	(1.4765 [37.503])	NO	60 MM BORE, THRU/THD'D ØS FOR M8 SCREWS
60/M10	2.3625 [60.008]	Ø.453±.010 [11.51±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.453±.010 [11.51±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	60 MM BORE, THRU ØS FOR M10 SCREWS
68/STD	2.6800 [68.072]	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	68 MM BORE, THRU ØS FOR .375 SCREWS
68/M10	2.6800 [68.072]	Ø.453±.010 [11.51±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.453±.010 [11.51±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	68 MM BORE, THRU ØS FOR M10 SCREWS
33/STD	1.299 [32.995]	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	33 MM BORE, THRU ØS FOR .375 SCREWS
75/STD	2.952 [74.981]	Ø.413±.010 [10.49±0.25]	1.875 [47.62]	.480±.060 [12.19±1.52]	(1.813 [46.050])	Ø.413±.010 [10.49±0.25]	1.875 [47.62]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	75 MM BORE, THRU ØS FOR .375 SCREWS
60/SLOT	2.3625 [60.008]	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.515 X .375 SLOT	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	60 MM BORE, SLOT ON ARROW HEAD FLANGE
68/SLOT	2.6800 [68.072]	Ø.515 X .375 SLOT	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	68 MM BORE, SLOT ON ARROW TAIL FLANGE
60/SLOT	2.3625 [60.008]	Ø.515 X .375 SLOT	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	Ø.394±.010 [10.01±0.25]	1.457 [37.01]	.480±.060 [12.19±1.52]	(1.4215 [36.106])	NO	60 MM BORE, SLOT ON ARROW TAIL FLANGE

Figure 1-3b. F-Series ITB Product Configuration and Throttle Option Details

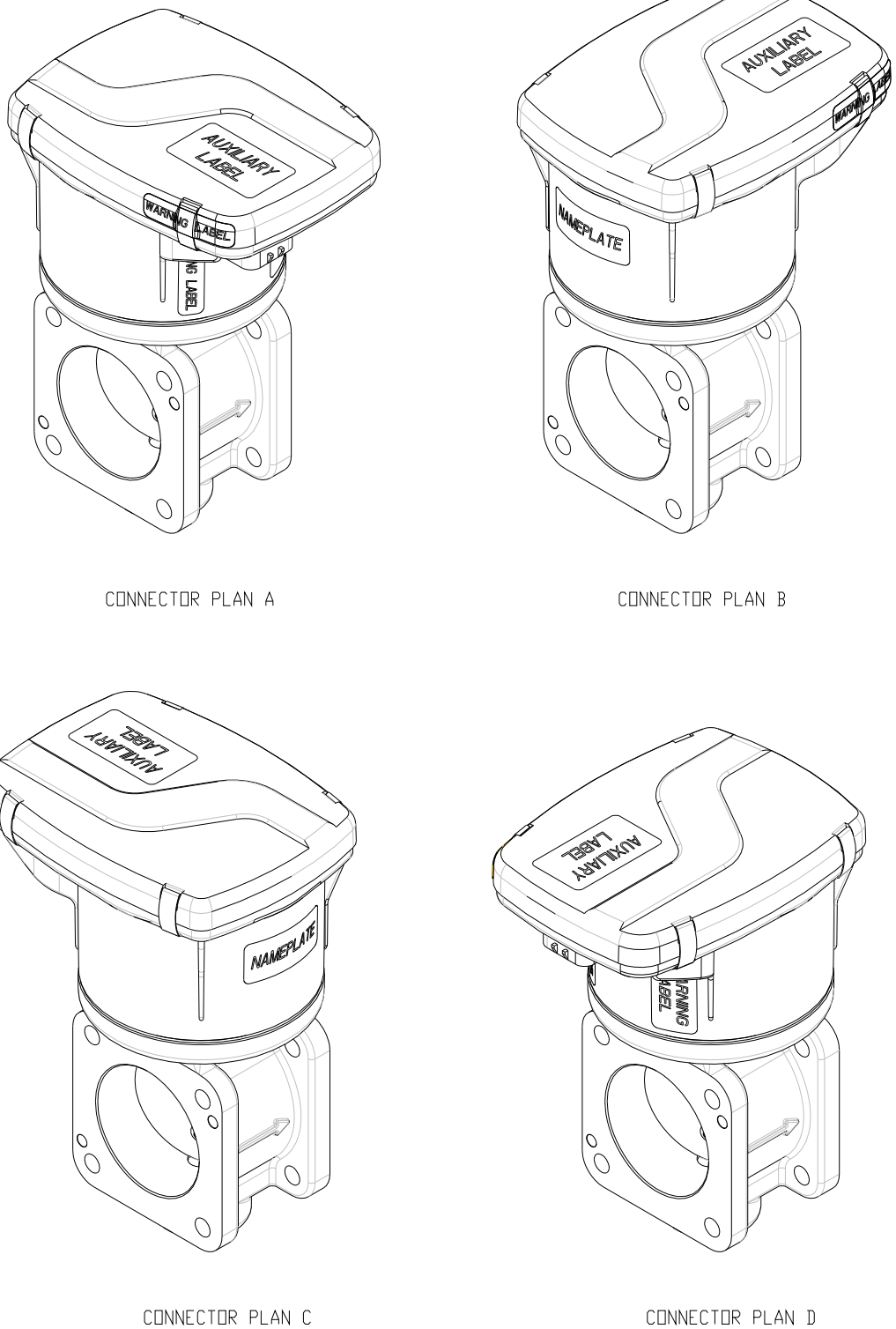


Figure 1-4. Electrical Connector Orientation Options

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 °C to +105 °C (–40 °F to +221 °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 cm (12 inches) in length, 3 mm² (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 on 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 3-1 shows typical control connections to external devices. Wiring pinouts, as viewed by looking into the F-Series control connector feature, are shown in Figure 3-2.

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 kΩ 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 mm² (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.

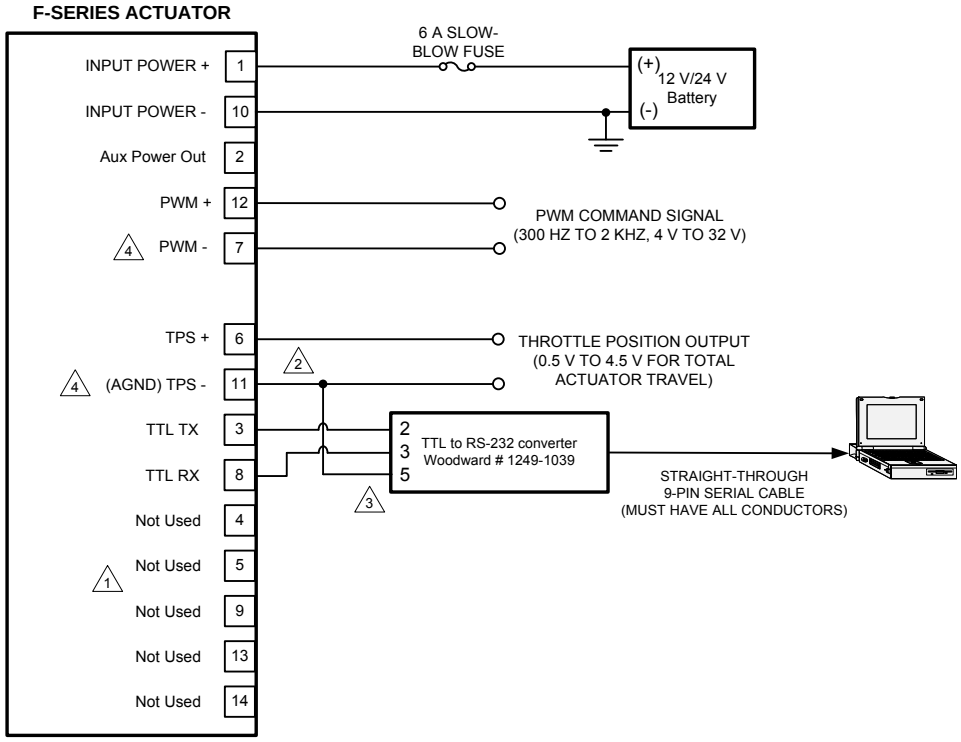
In spark-ignition engine applications, route the F-Series actuator harness wires away from the spark plug wires.

Connector

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

Description	AMP P/N	Woodward P/N
Mating Connector, 14-Pin	776273-1	1635-1517
Gold Sockets for all Connectors	770854-3	1608-1044

Table 3-1. F-Series Mating Connector



NOTES:

1. POPULATING ALL CONNECTOR PINS, INCLUDING THOSE "NOT USED", IS RECOMMENDED FOR IMPROVED VIBRATION ROBUSTNESS.
2. TPS -, PIN 11, IS ONLY USED WHEN THE USERS CONTROLLER CONTAINS A DIFFERENTIAL INPUT OR ISOLATED INPUT. 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 THE F-SERIES INPUT POWER - AND TPS -, PIN 11, IS NOT CONNECTED.
3. LOCATE THE TTL TO RS-232 CONVERTER A MAXIMUM OF 1 M (3.3 FT) FROM THE F-SERIES ACTUATOR
4. WHEN THE USERS PWM LOW SIDE SOURCE IS ISOLATED FROM POWER - , THEN PWM -, PIN 7, MUST BE TIED TO AGND, PIN 11. DO NOT TIE PWM -, PIN 7, TO AGND, PIN 11, IF THE USERS PWM LOW SIDE SOURCE IS NOT ISOLATED FROM POWER -, OR IF THE PWM SOURCE IS A PUSH-PULL TYPE.

Figure 3-1. Typical Control Wiring

Pin #	Function
1	Input Power +
2	Aux Power Out
3	TTL TX
4	Not Used
5	Not Used
6	TPS +
7	PWM -
8	TTL RX
9	Not Used
10	Input Power -
11	TPS -
12	PWM +
13	Not Used
14	Not Used

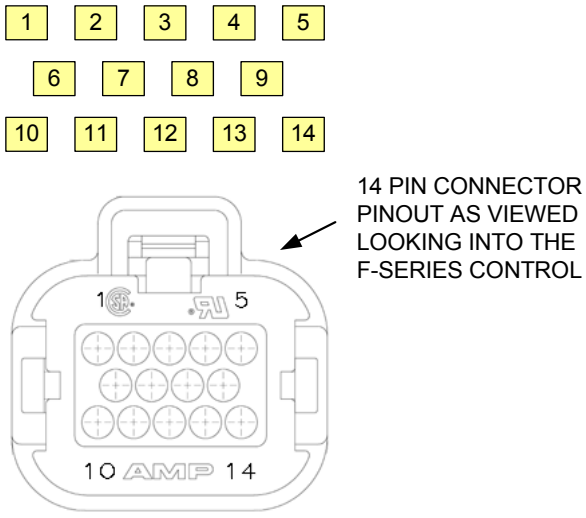


Figure 3-2. 14-Pin Connector Pin Assignments

Description of Electrical I/O

Representative circuitry is shown for the F-Series actuator inputs/outputs in Figure 3-1.

Power Supply Input

Pin 1 = Input Power (+)
Pin 10 = 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 3-3a and 3-3b). 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.

IMPORTANT

When wiring pin 11, 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 6 A slow-blow fuse for all F-Series controls.

IMPORTANT

All connector pins are short-circuit protected to ground and power except pin 11 which is not protected against shorts to battery positive.

Installation of a fuse on the battery negative (B–) wire to pin 10 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.

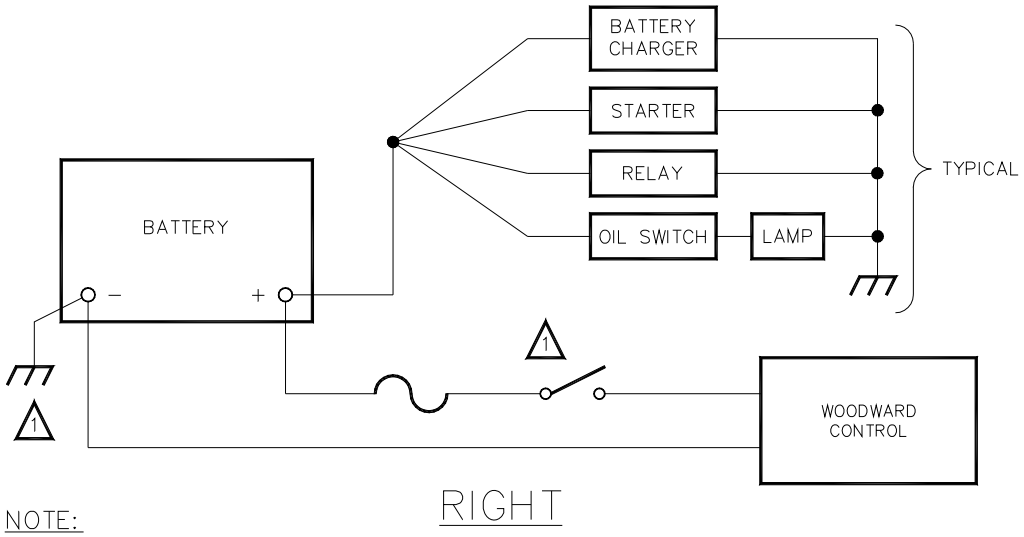


Figure 3-3a. Correct Wiring to Power Supply

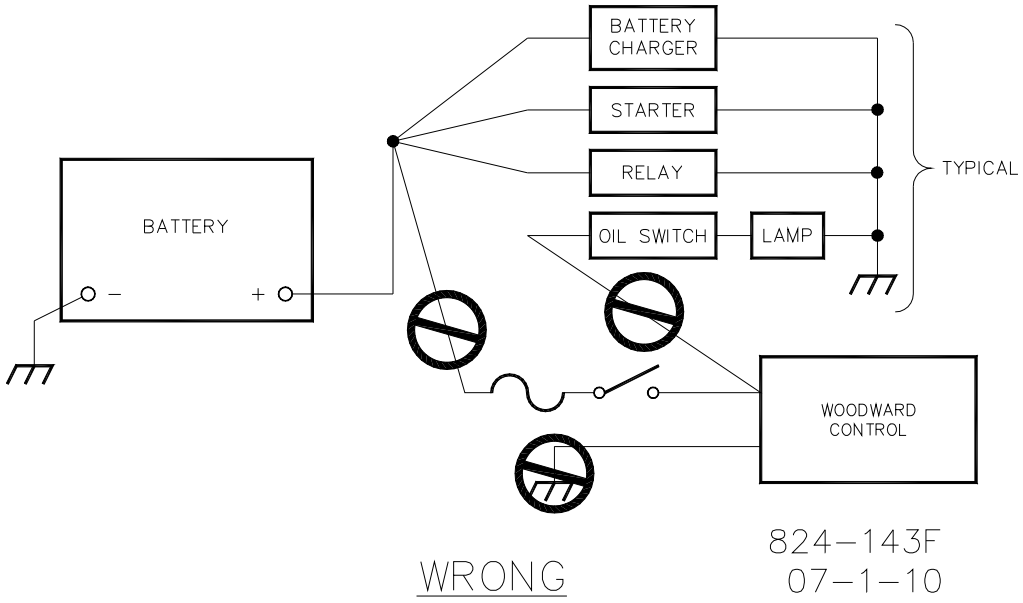
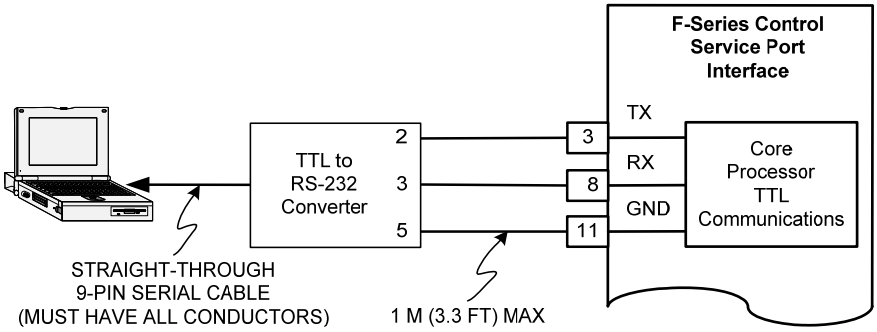


Figure 3-3b. Incorrect Power Supply Wiring

Service Port

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



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**. The RS-232 wiring must meet the requirements in the EIA RS-232 Standard document.

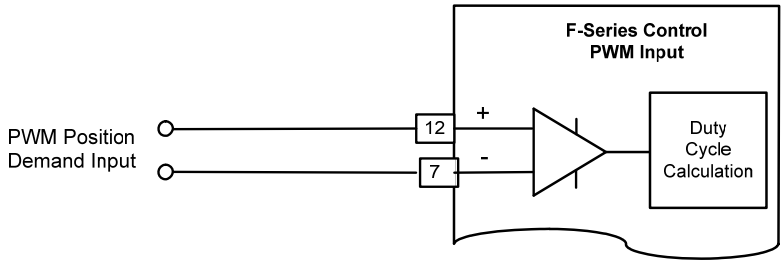
An external TTL to RS-232 converter is necessary to make communications possible with the Woodward F-Series Service Tool. The converter must be located a maximum of 1 meter from the F-Series actuator. A connectivity kit can be purchased from Woodward to accomplish this. Further instructions for using 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 12 = PWM (+)
Pin 7 = –PWM (–)

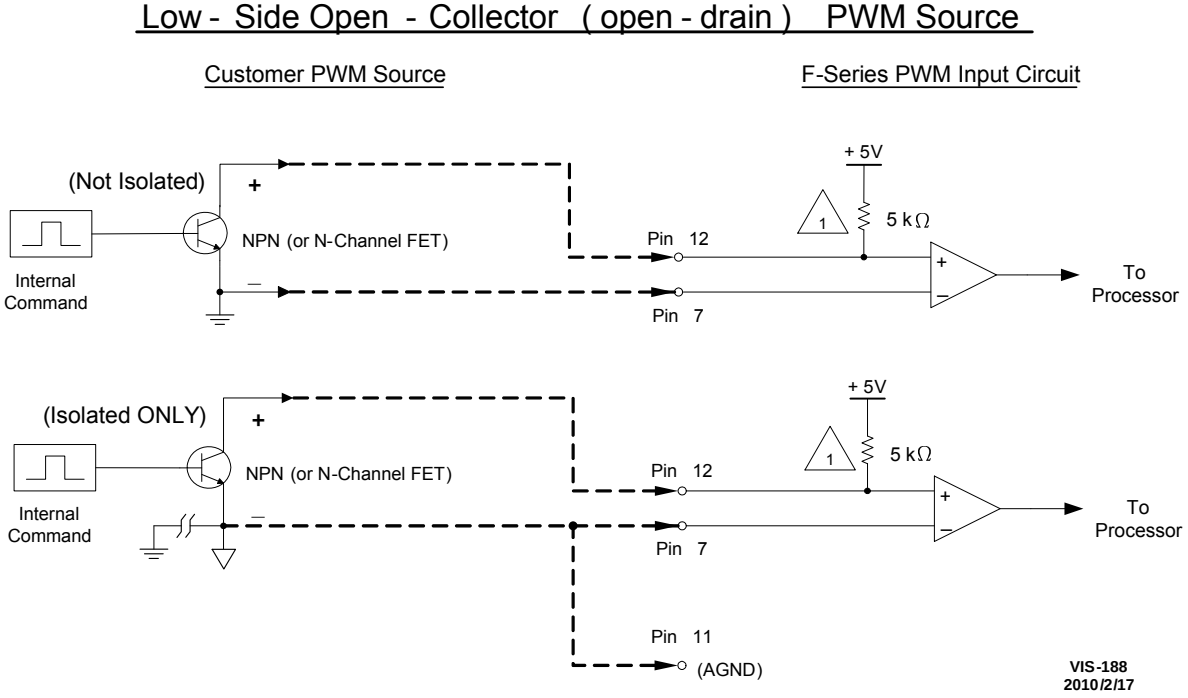


The PWM demand input is a differential type capable of handling low-side and push-pull style PWM sources. Pull-up level is 5 V through 4.99 kΩ. See Figure 3-6 for acceptable PWM input types.

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.

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.

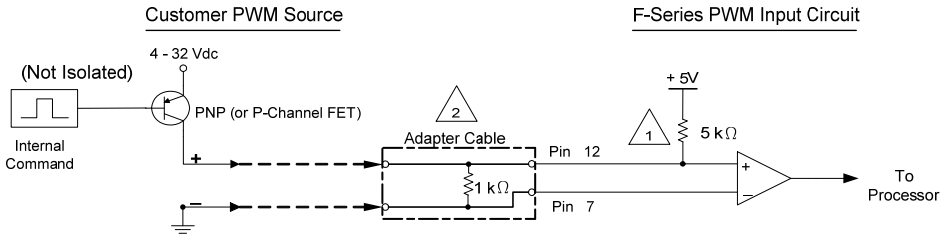


NOTES:

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.

Figure 3-4a. Acceptable PWM Input Types

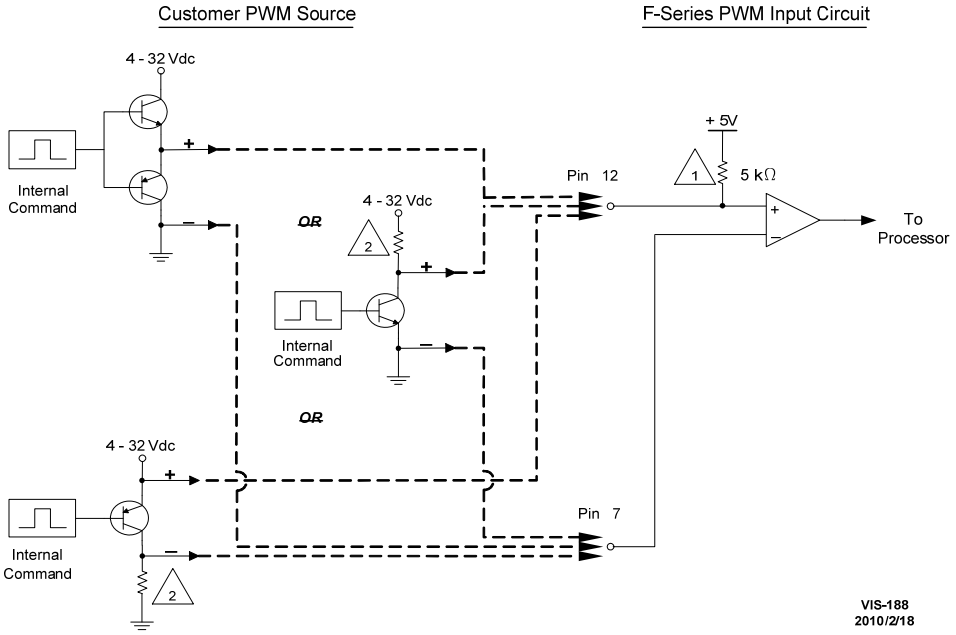
High-Side PWM Source



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. High side input capability is only available when Flotech to F-Series adapter cable (as called out in APP NOTE 51305) is used.

Push-Pull PWM Source (three variations)



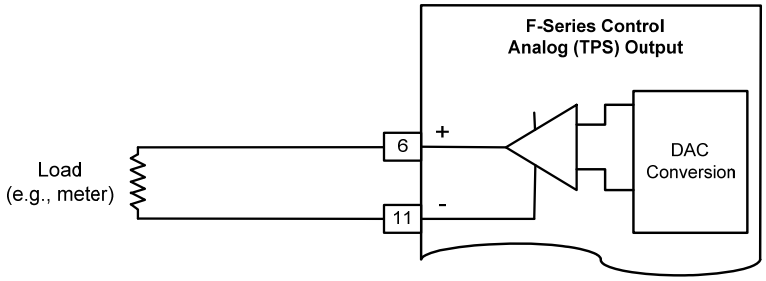
NOTES:

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 3-4b. Acceptable PWM Input Types

TPS Output

Pin 6 = TPS (+)
Pin 11 = TPS (–)



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.

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.

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.

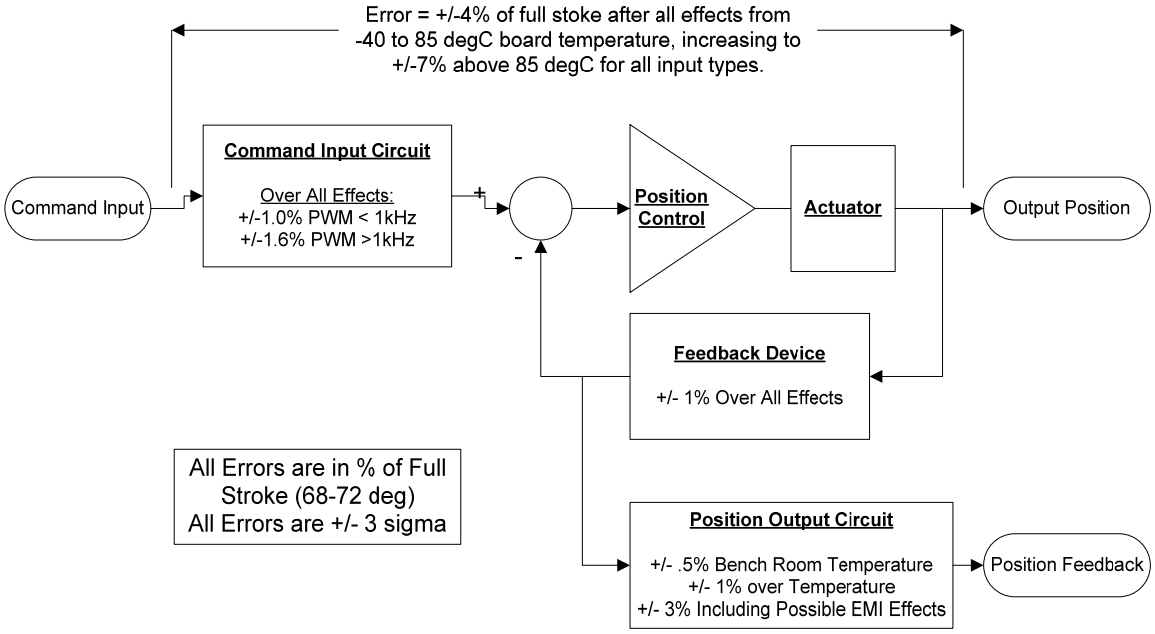
The supply voltage fault low and high thresholds are configurable. Default values are below 9 V (dc) and above 33 V (dc) respectively. The unit can be configured to either alarm or shutdown upon detection of a supply voltage fault.

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.



Position Demand Signal

The F-Series actuator accepts a PWM position demand input signal. The PWM input will function with low-side open collector and push-pull source types. A high-side can be used but only with external circuitry provided by the customer (see Figure 3-4b). The F-Series will handle a PWM frequency range from 300 to 2000 Hz at amplitudes ranging from 4 to 32 V. Default range is from 10 % to 90 % duty cycle, representing the hard stops in the actuator. This range is configurable (Figure 4-1).

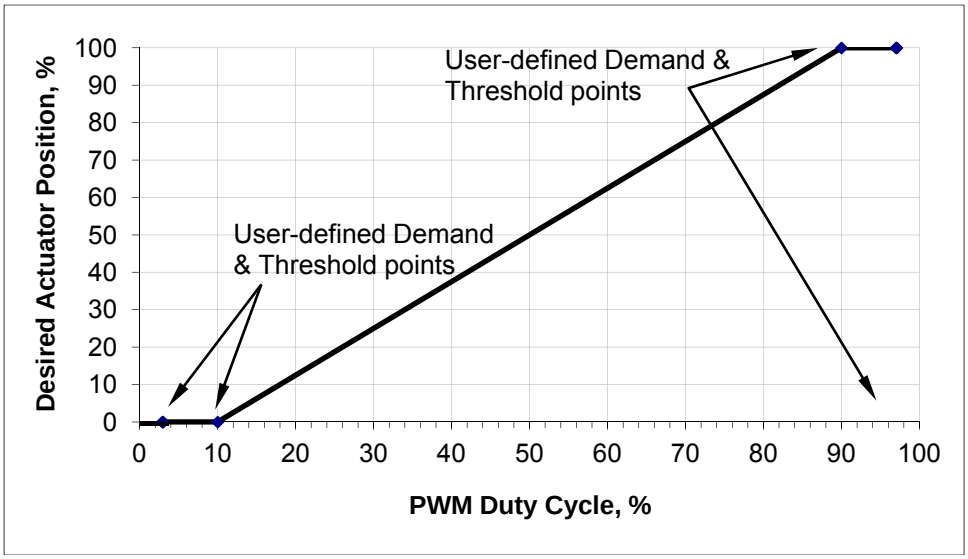


Figure 4-1. PWM Linear Demand to Position

The PWM position demand input signal failure level thresholds are configurable. Default settings are below 2 % and above 98 % duty cycle. The unit can be configured to either alarm or shut down upon detection of a position demand input failure.

The PWM input can optionally be configured to a non-linear mode that provides a 5-point curve relationship between the demand input (%) and the desired position demand (%) (Figure 4-2).

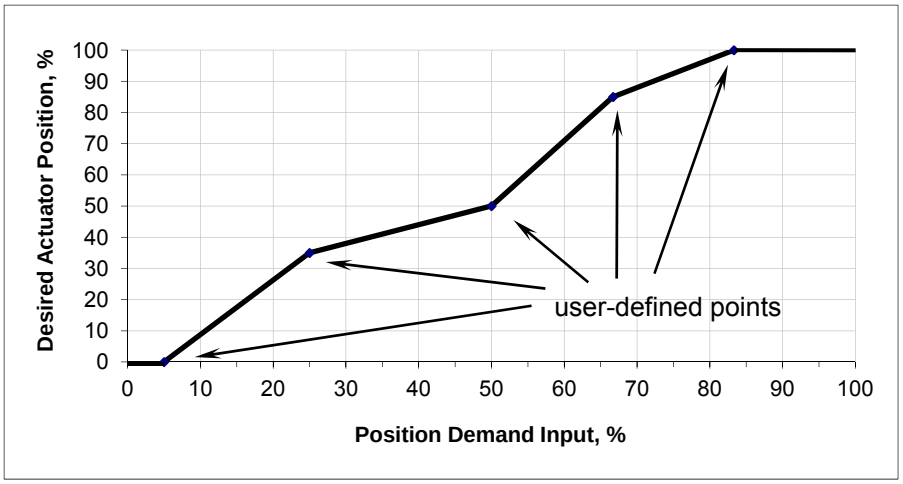


Figure 4-2. Non-Linear Position Demand to Actual Position Curve

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.

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.

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 8923-1254. 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. These threshold settings are fixed and not configurable.

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.

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'.

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 can be issued by using the Reset Active Faults button on the service tool.

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:

PWM Frequency Out Of Range—Indicates that there was a connected PWM signal with frequency out of the 250 Hz to 20 kHz range.
[not provided in 5418-2723]

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.

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.

- **EEPROM Read Fail**—Indicates a read problem with the EEPROM values.
- **EEPROM Write Fail**—Indicates a problem with writes to the EEPROM.
- **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.
- **SPI A/D Error**—Indicates the A/D is not communicating or did not complete all its conversions for more than 5 ms.
- **SPI D/A Error**—Indicates the D/A is not updating TPS output correctly. *[not provided in 5418-2723]*
- **5 V Supply on Internal A/D Error**—Indicates the internal 5 V power circuit is out of range, measured on internal A/D converter. *[not provided in 5418-2723]*
- **5 V Supply on External A/D Error**—Indicates the internal 5 V power circuit is out of range, measured on SPI A/D converter. *[not provided in 5418-2723]*
- **+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 50 ms.

Configurable Alarm and Shutdown List

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

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

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 configure Supply Voltage High Threshold.

Input Voltage Low—Indicates the input supply voltage went below the configure 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.

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.

Power-up Reset—This indication goes true when power is first applied to the F-Series actuator.

Low Power Reset—This indication goes true when reset was caused by low voltage on microcontroller. *[not provided in 5418-2723]*

Watchdog Reset Occurred—Indicates an internal fault caused a watchdog timer timeout that resulted in a reset of the microprocessor.

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

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.

Each F-Series actuator type has a unique Service Tool. The Service Tool selected for use must be appropriate for the actuator type (FST, FSTP, etc.) being serviced. The service tool for the 14-pin F-Series is available for download on **www.woodward.com/software**, part number 9927-1524 for firmware 5418-2745.

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 (P/N 8923-1254) can be purchased from Woodward. 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. See Figure 5-2a for communication harness connections.

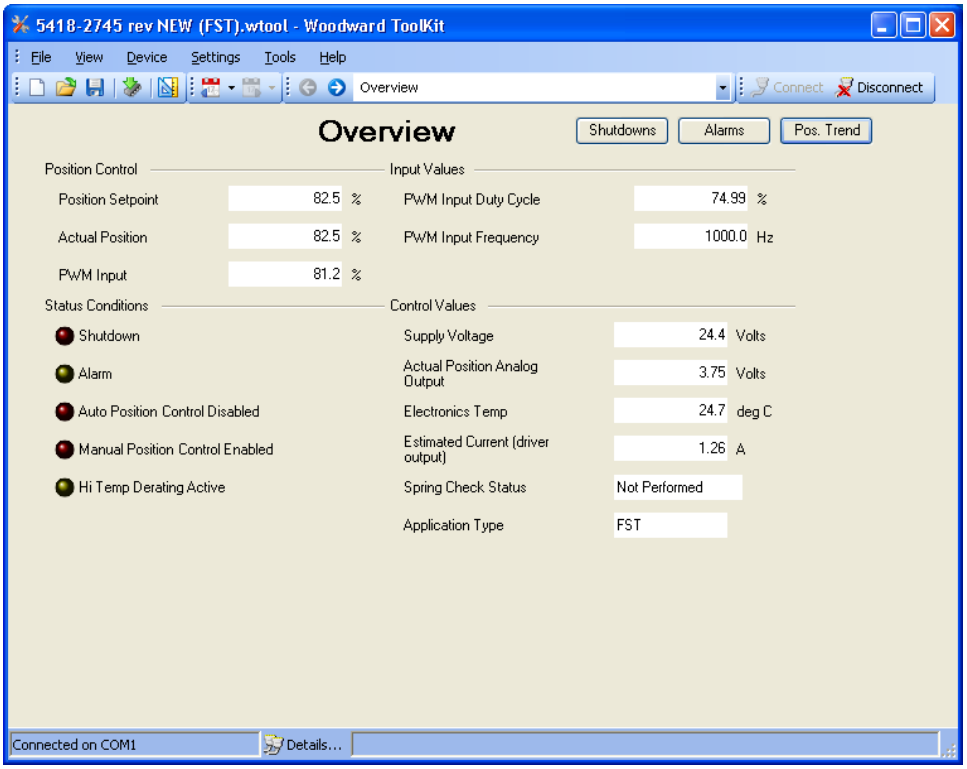


Figure 5-1. Example Service Tool Screen

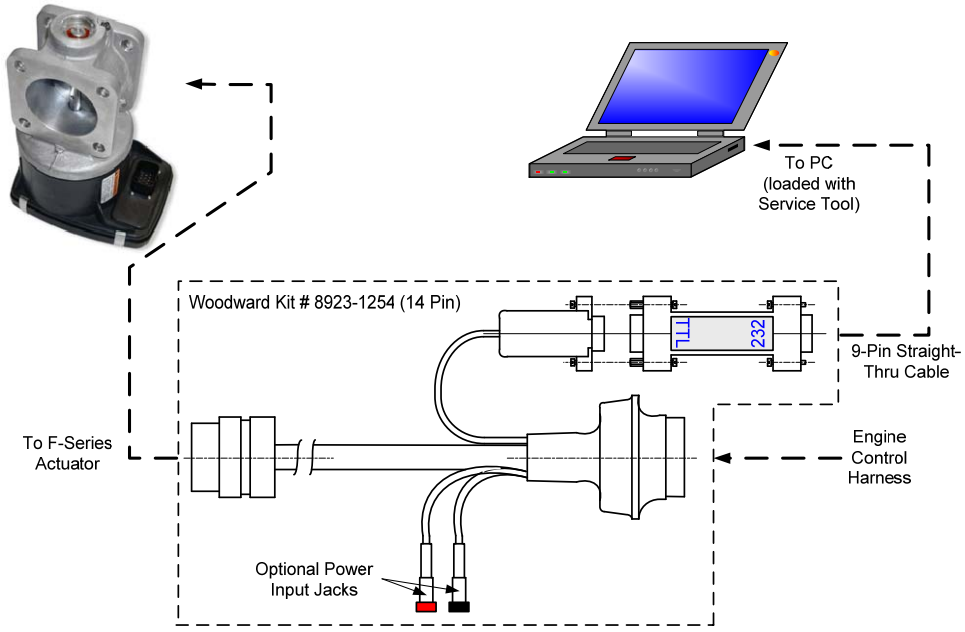


Figure 5-2a. Communication Harness Connections

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).

For end users wishing to make their own communication harness the transceiver used is a B & B Electronics model 232LPTTL (or equal) and wiring on the "TTL" end can be standard 16 to 18 AWG stranded wire. See Figure 5-2b for harness wiring and connector pinouts.

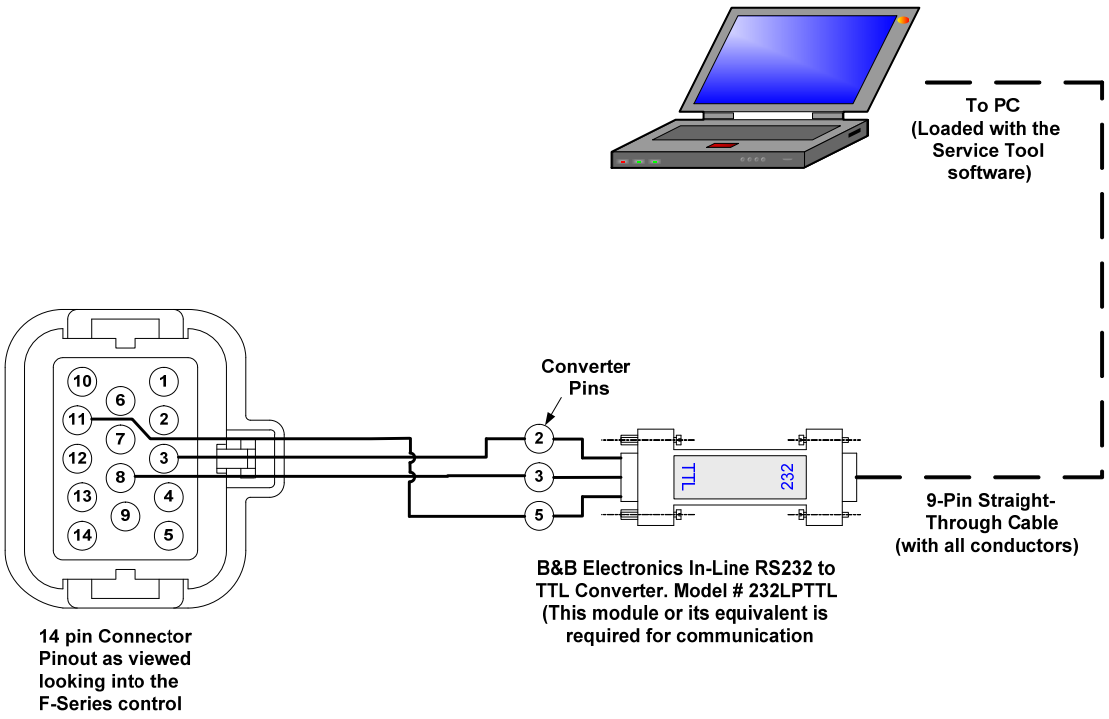


Figure 5-2b. Programming Harness Wiring

System Requirements

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

- PC-compatible laptop or desktop computer
- Microsoft Windows® XP, Vista, 7, (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**). 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 (V3.5 or newer) already installed should skip installing the standard version.

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 or by selecting ‘Device, Connect’ on the main menu.

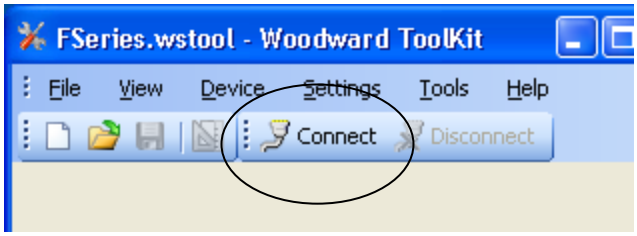


Figure 5-3. Connect to Device

Once connected to the control, the screen view will populate with current values and the status bar will display ‘Connected on COM x’.

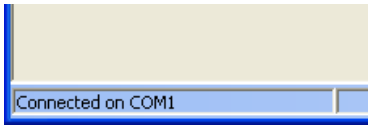


Figure 5-4. Connected Status Indication

The application type of the control (e.g. FST) is displayed on the Overview screen.

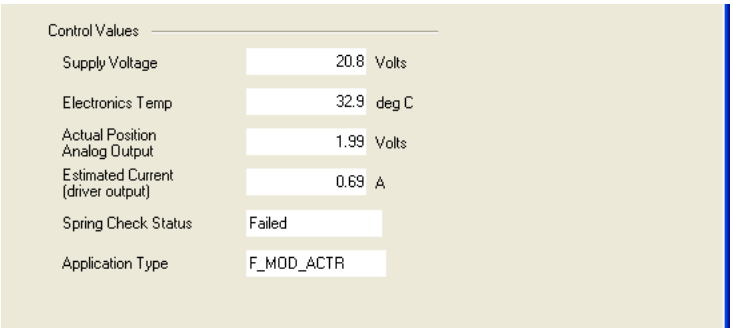


Figure 5-5. Application Type Indication

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.

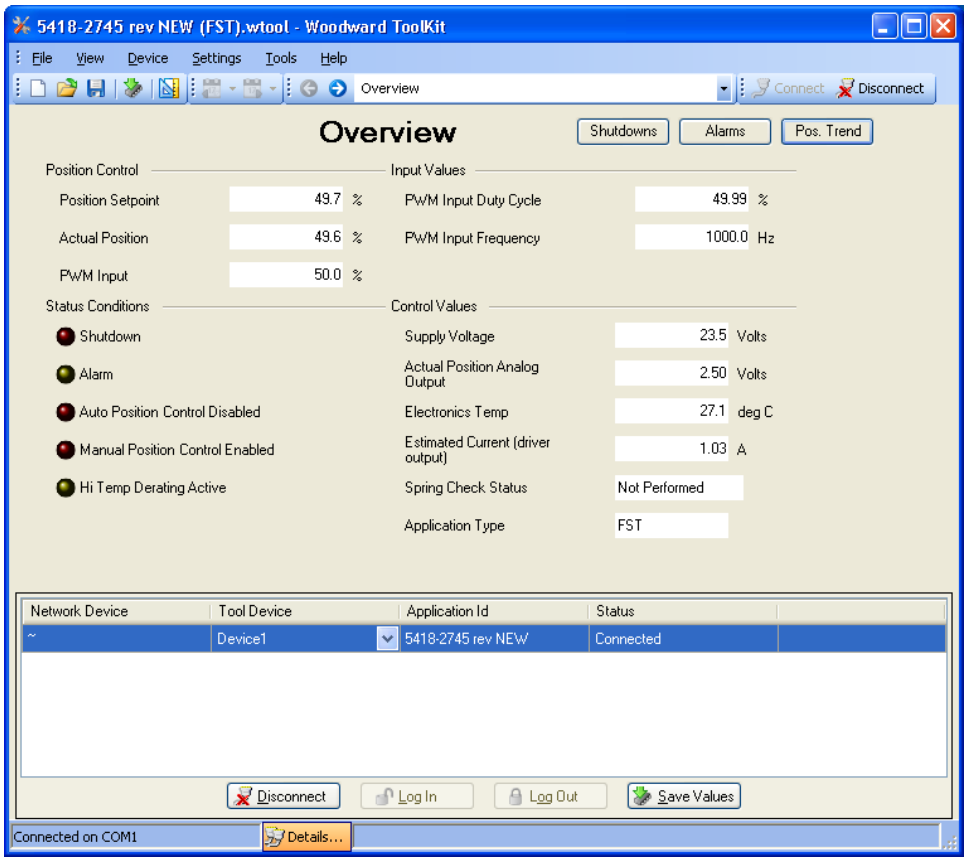


Figure 5-6. Communications Window

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, select the Browse button and choose the C:\Program Files\Woodward\Toolkit Definitions folder (default) or the folder chosen during the Service Tool install.

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/software**.

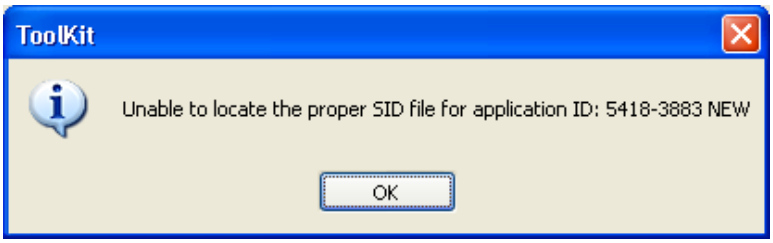


Figure 5-7. Improper SID Window

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

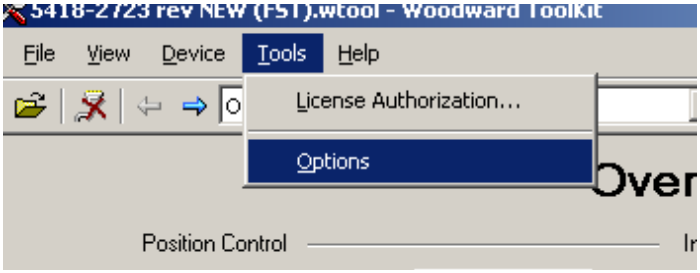


Figure 5-8. Options Menu

Highlight the SID files option, and then select Modify. Using the browser, choose the folder where the sid files have been installed - this is 'C:\Program Files\Woodward\Toolkit Definitions' by default. When finished select OK.

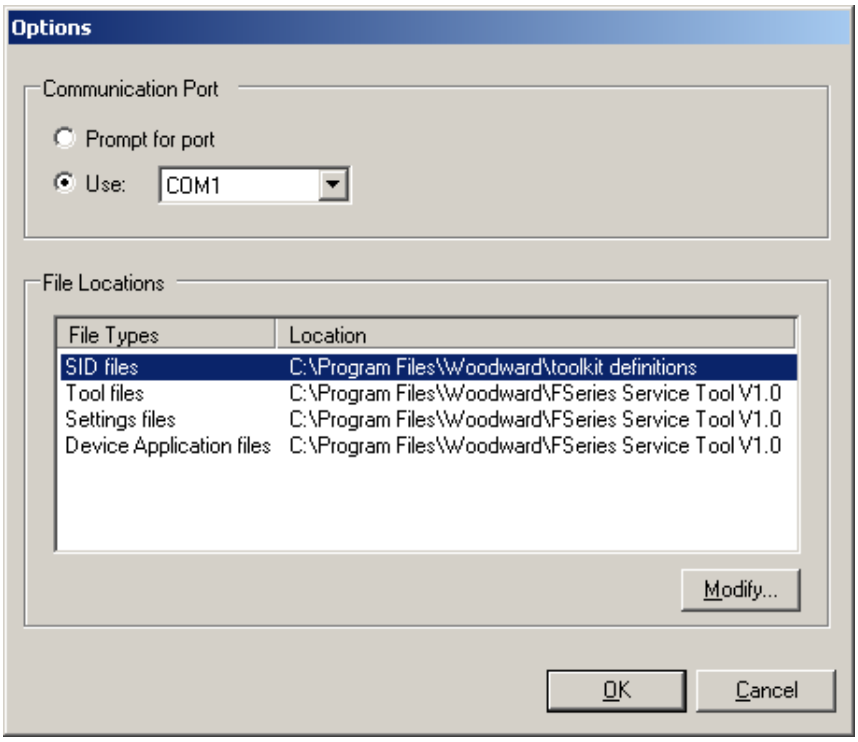


Figure 5-9. Options Window

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 5-3)
- Shutdowns (Figure 5-4)
- Alarms (Figure 5-5)
- Position Trend (Figure 5-6)

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

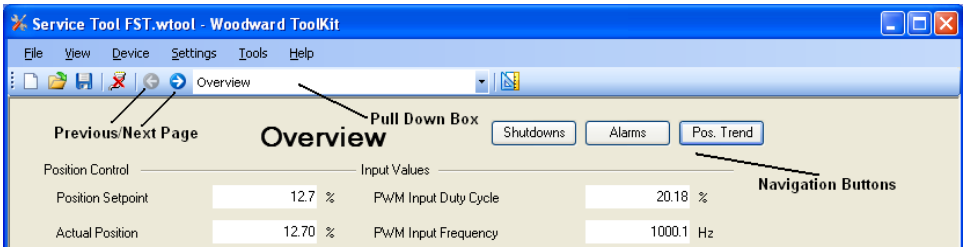


Figure 5-10. Screen Navigation

Overview Screen

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

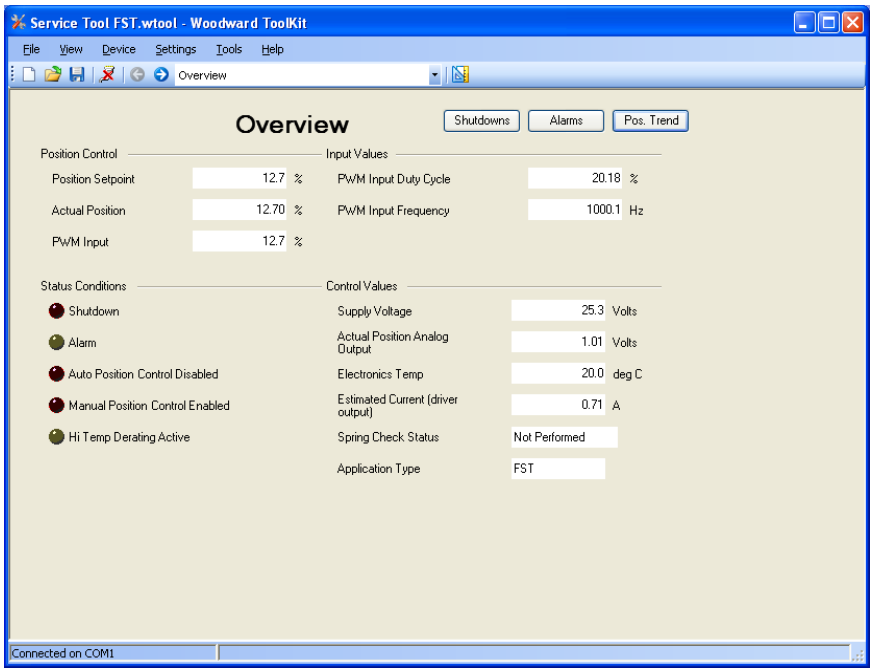


Figure 5-11. Overview Screen

Position Setpoint
Displayed value of the Position Setpoint – in percent.

Actual Position
Displayed value of the Actual Position – in percent.

PWM Input
Displayed value of the PWM Input Position – in percent.

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.

Hi Temp Derating Active LED
Indicates reduced actuator power output operation (due to detection of high actuator temperature) when illuminated (Yellow).

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.

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).

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 5-12. 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.

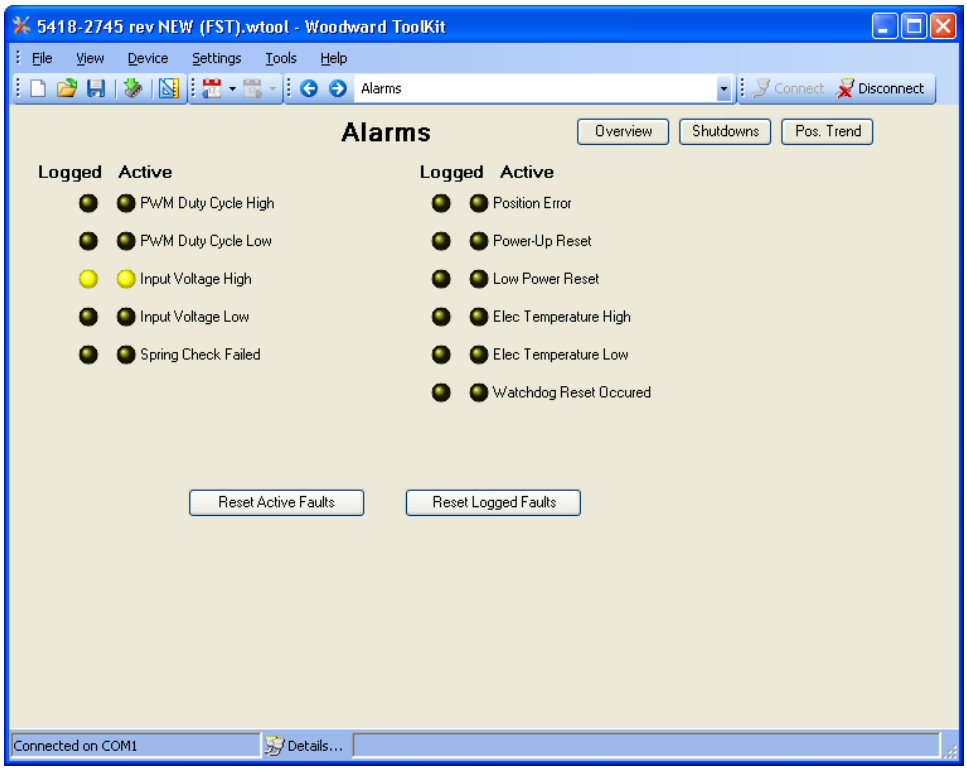


Figure 5-13. Alarms Screen

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)

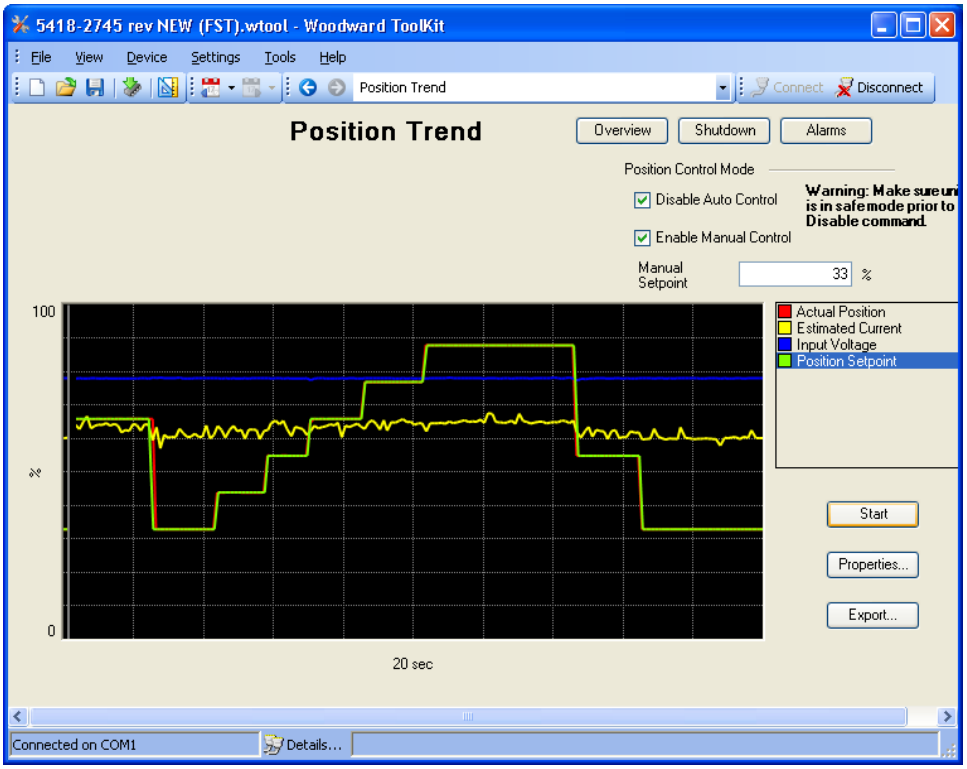


Figure 5-14. Position Trend Screen

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.

Properties
Trend properties can be changed. Click the Properties button to open the Trending Properties window (Figure 5-7). From this window the trend time span, sample rate, pen colors and high and low range scaling can be changed.

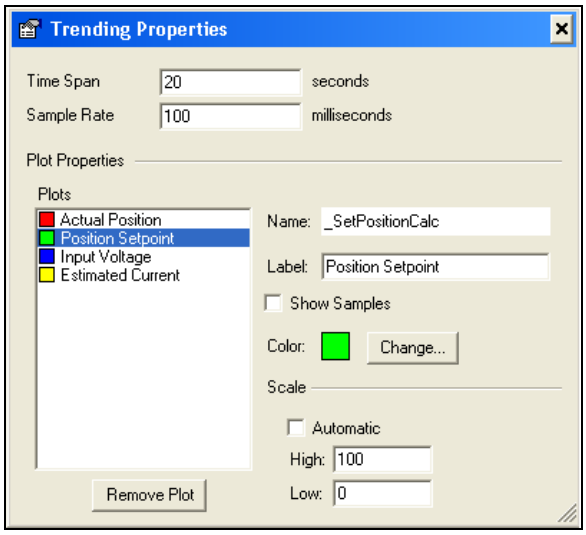


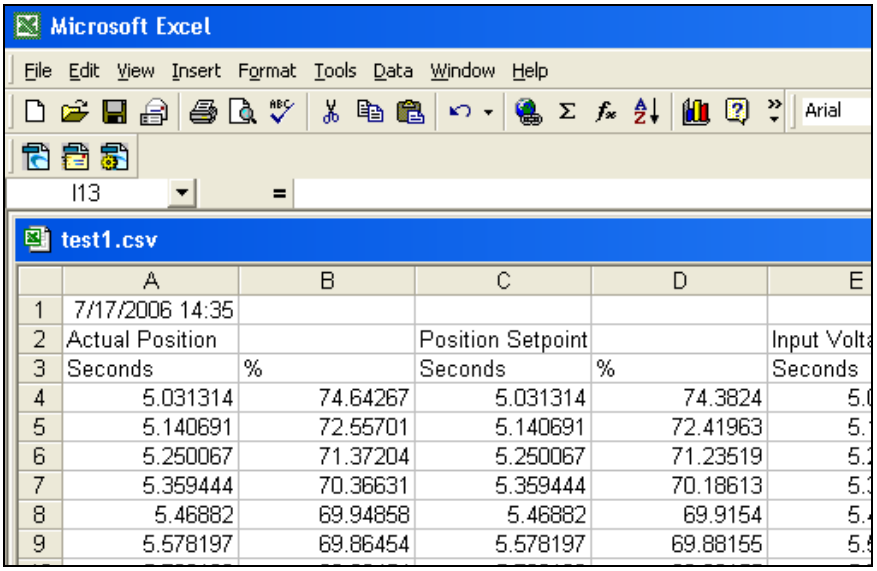
Figure 5-15. Trending Properties window

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 a *.csv file of the trend data points taken during the time period just prior to clicking the stop button (Figure 5-8).



	A	B	C	D	E
1	7/17/2006 14:35				
2	Actual Position		Position Setpoint		Input Volt
3	Seconds	%	Seconds	%	Seconds
4	5.031314	74.64267	5.031314	74.3824	5.0
5	5.140691	72.55701	5.140691	72.41963	5.
6	5.250067	71.37204	5.250067	71.23519	5.
7	5.359444	70.36631	5.359444	70.18613	5.
8	5.46882	69.94858	5.46882	69.9154	5.
9	5.578197	69.86454	5.578197	69.88155	5.

Figure 5-16. Trend Data Points *.csv File Example

Creating a Custom Trend

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

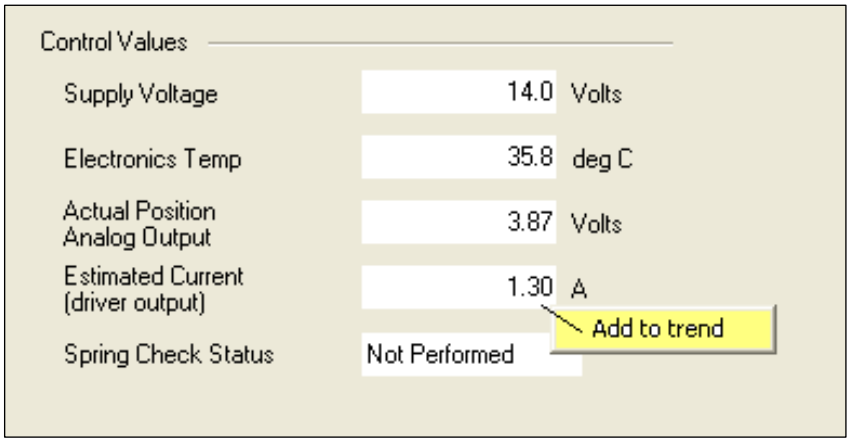


Figure 5-17. Custom Trend

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

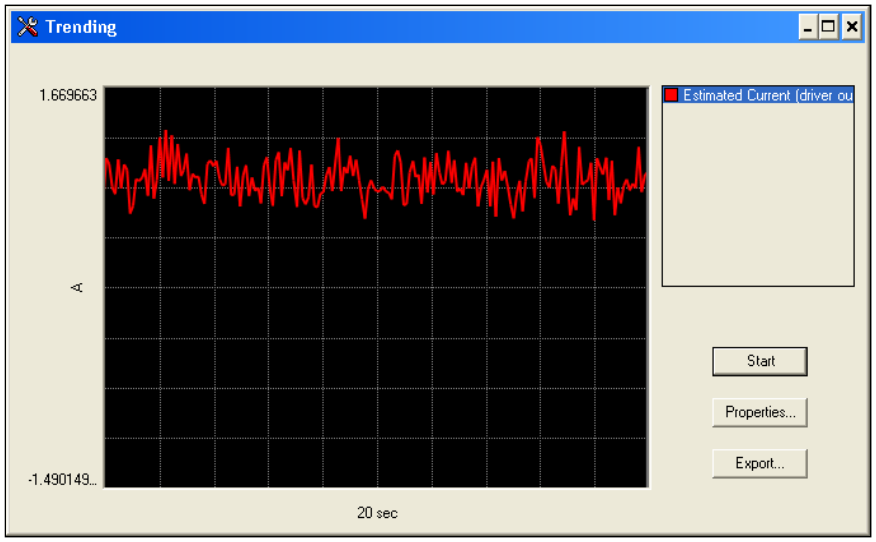


Figure 5-18. Custom Trend Example

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 *.csv file.

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. Create a Settings File by saving the current control settings to a file.
2. Open this newly saved Settings File.
3. Edit and save the revised configuration settings.
4. Load the configuration to the F-Series control.

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.

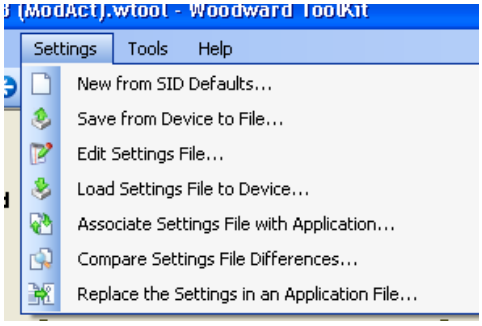
IMPORTANT

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.

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 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.

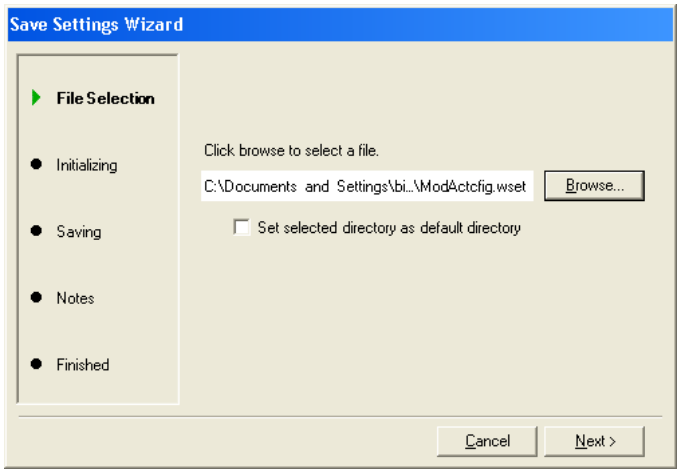


Figure 6-1. Save Settings Wizard

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.

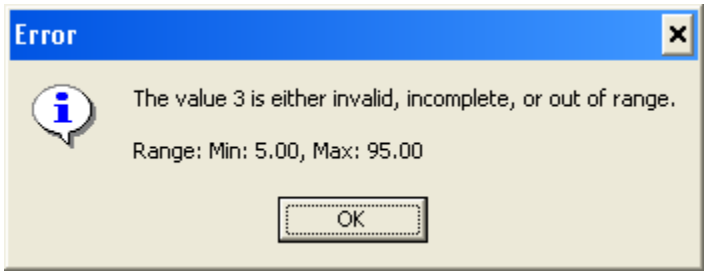
To open the Settings Files, click ‘Settings’ on the F-Series Service Tool menu bar then select ‘Edit Settings File’. From the list of names, simply double click the desired file name. This opens a Settings Editor screen for viewing or editing the configuration settings (for example, Figure 6-2, Configure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

Configuration Parameters

The Settings Editor screens are used to set the configuration parameters.

The following screens are provided:
- Configure PWM Input
- Configure Position Demand Curve
- Configure Analog Output
- Configure Alarms & Shutdowns
- Configure Input Voltage
- Configure Return Spring Check.

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 PWM Input

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

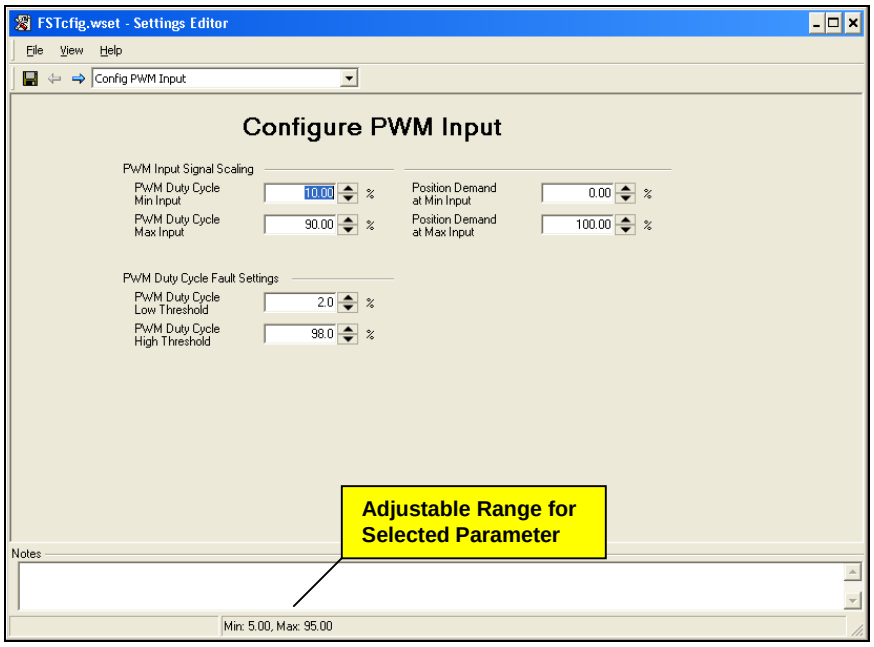


Figure 6-2. Configure PWM Input

PWM Duty Cycle Min Input
Sets the PWM Duty Cycle, in percent, that corresponds to the Position Demand at Min Input setting.
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.

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 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 Position Demand Curve

This screen provides position demand curve configuration settings.

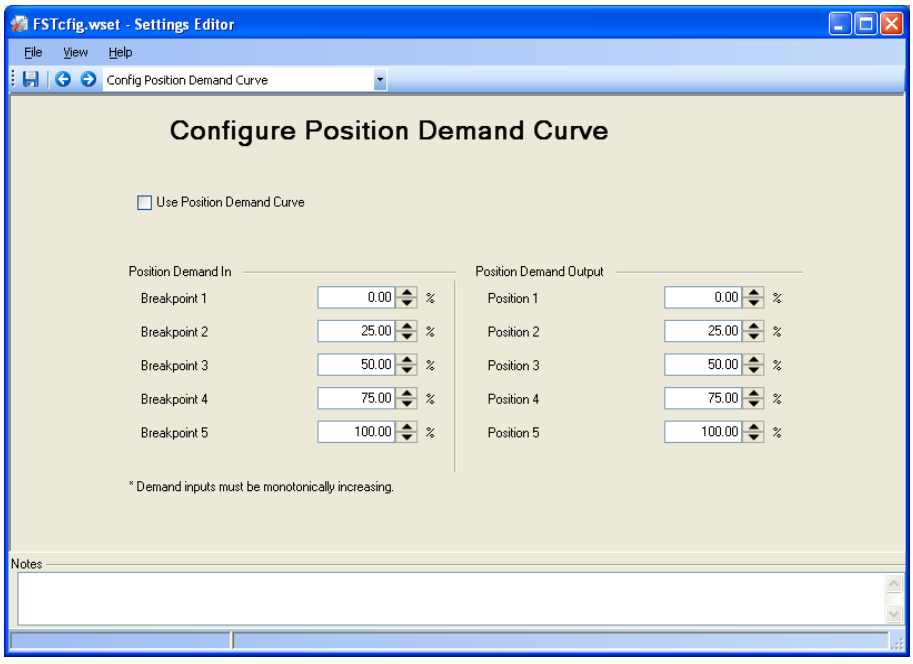


Figure 6-3. Configure Position Demand Curve

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 Output
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.

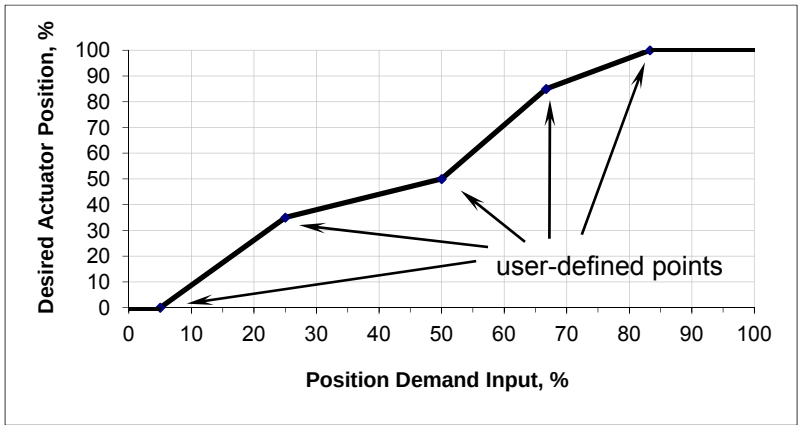


Figure 6-4. Position Demand Curve Example

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.

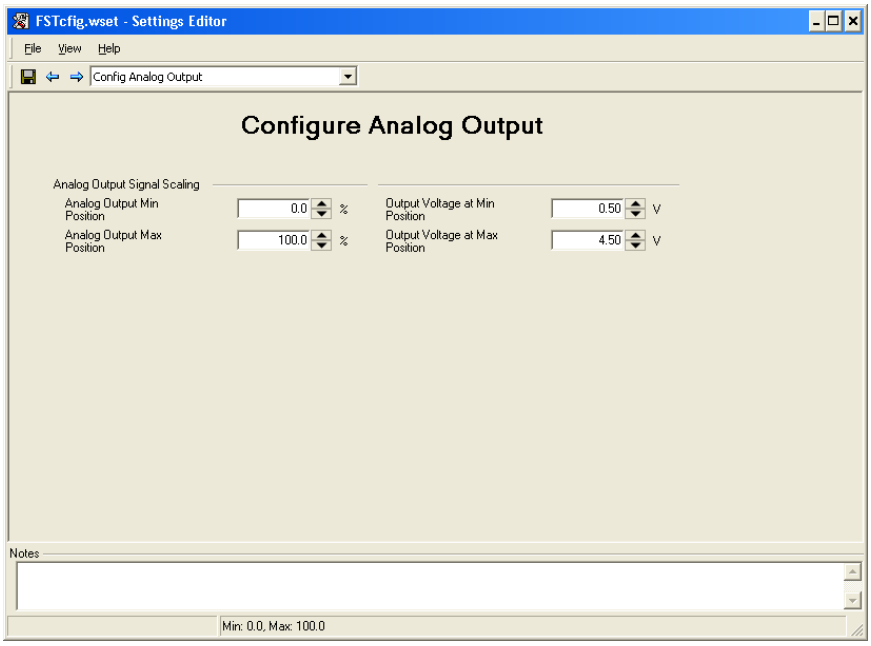


Figure 6-5. Configure Analog Output

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 Alarms & Shutdowns

This screen provides alarm & shutdown configuration settings.

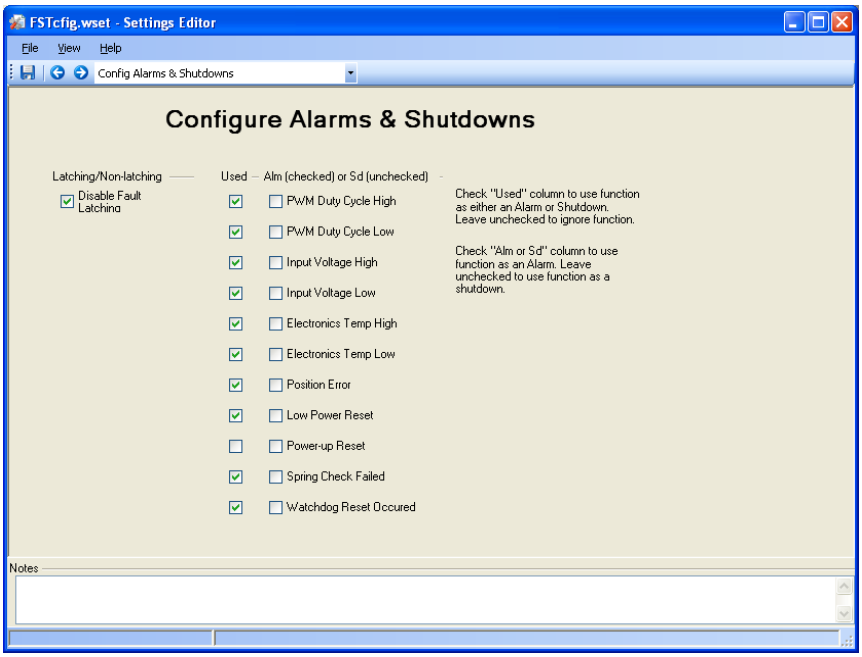


Figure 6-6. Configure Alarms & Shutdowns

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.

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.

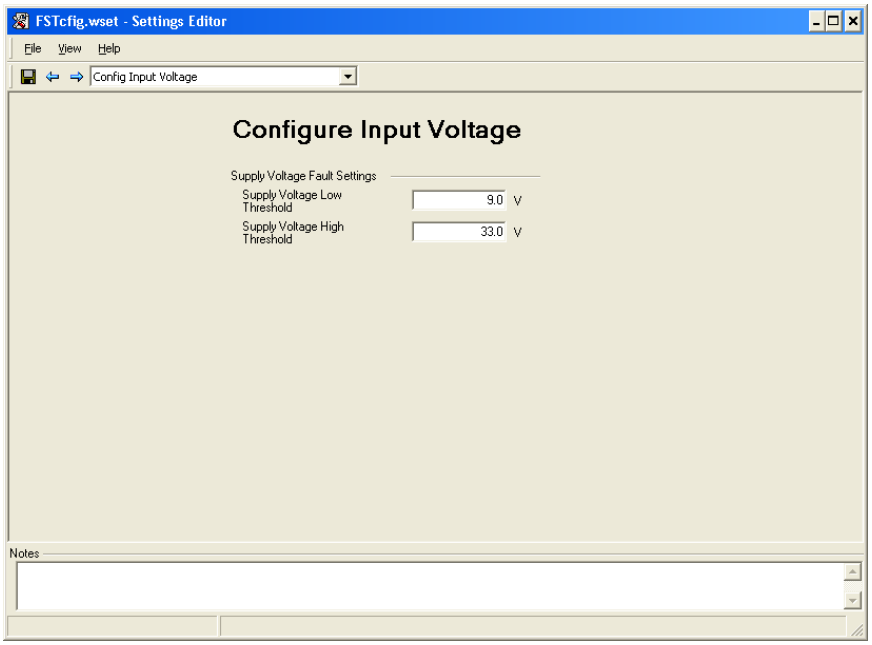


Figure 6-7. Configure Input Voltage

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.

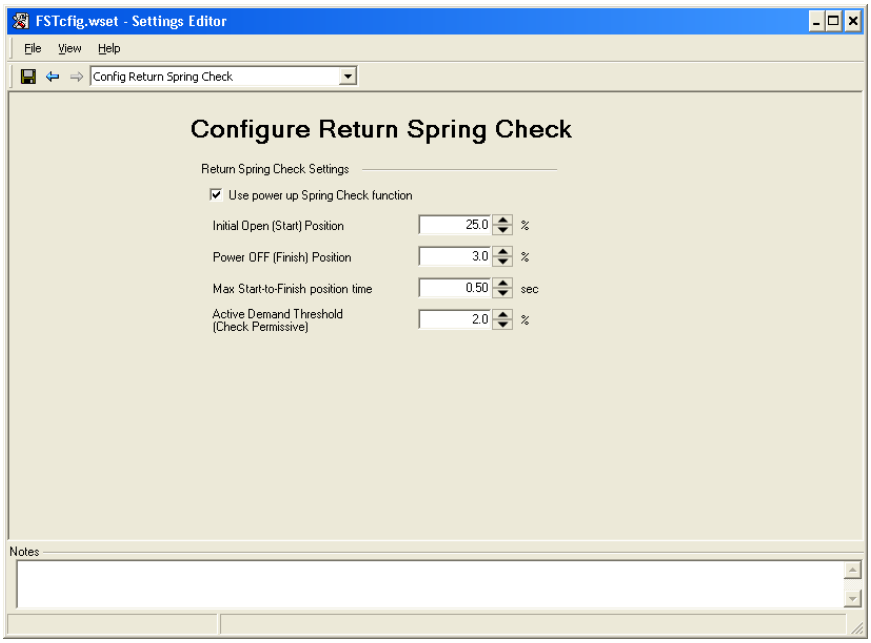


Figure 6-8. Configure Return Spring Check

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’.

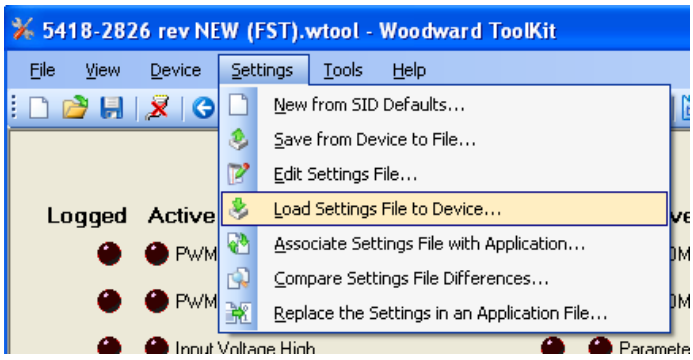
If the application is spring 'open', it is assumed the demand will normally be at 100 % position command. In this case the Active Demand Threshold/Permissive must be set to a value greater than the Initial Open (Start) Position (98 %) and the position demand must be greater than this setting at power 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 Wizard opens. Follow the wizard instructions to complete loading a Settings File configuration to the F-Series control.

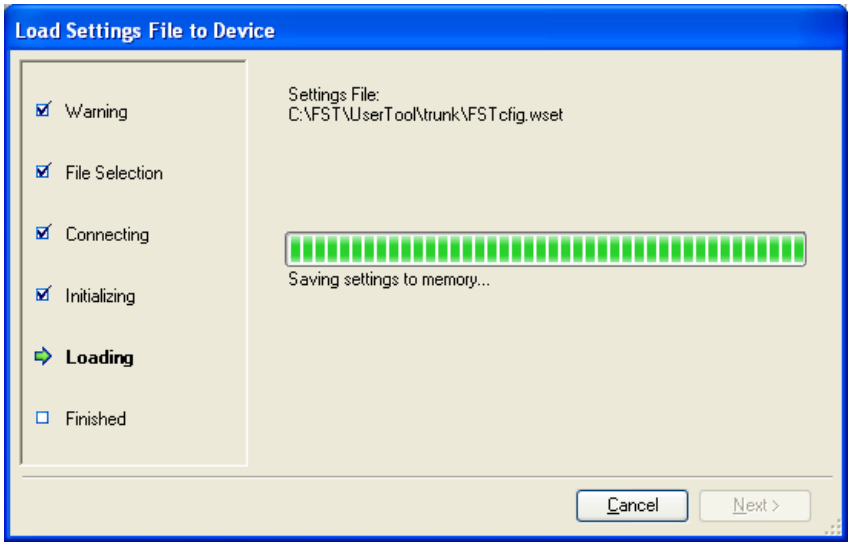
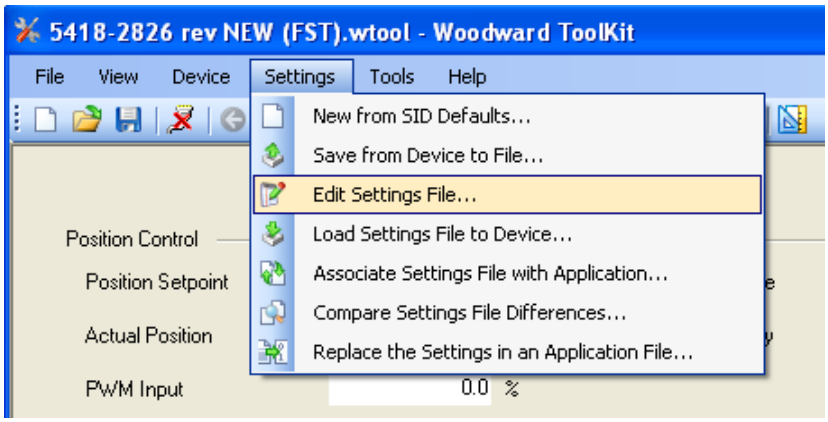


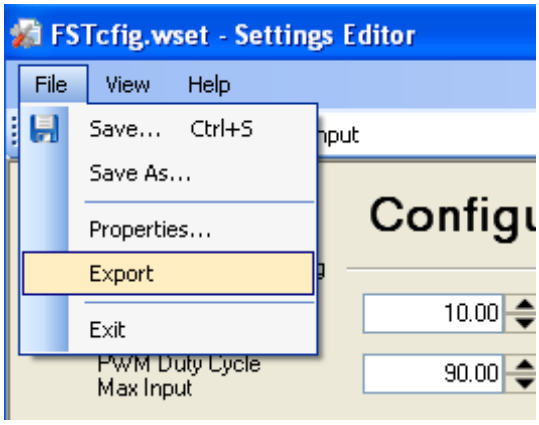
Figure 6-9. Load Settings Wizard

Exporting the Settings File Configuration

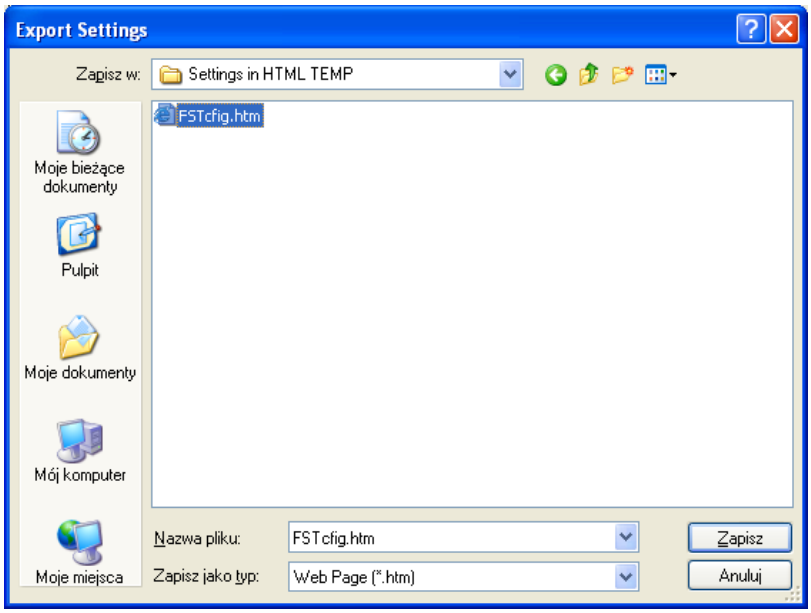
A Settings File configuration can be exported to an *.htm document file (e.g., FSTcfig.htm). This provides for listing the configuration settings, printing a hard copy of the settings or e-mailing the control settings.



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.

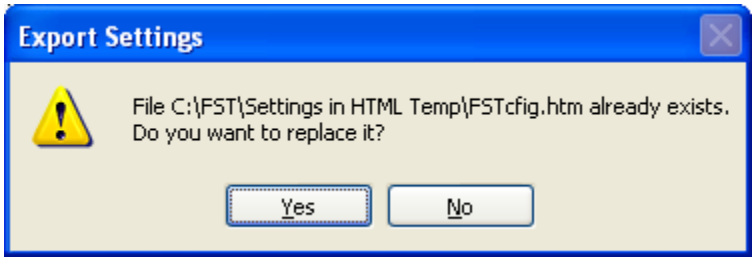


Once the Settings Editor screen opens, select ‘’File, Export’ on the menu bar



An Export Settings screen opens. Select a folder and File Name to save the exported file to. The file name may be existing (to replace) or a new name.

The following confirmation message appears if an existing file is selected.



Click ‘Yes’ to replace the existing exported document file or ‘No’ to create a different document file name or path for the exported settings file.

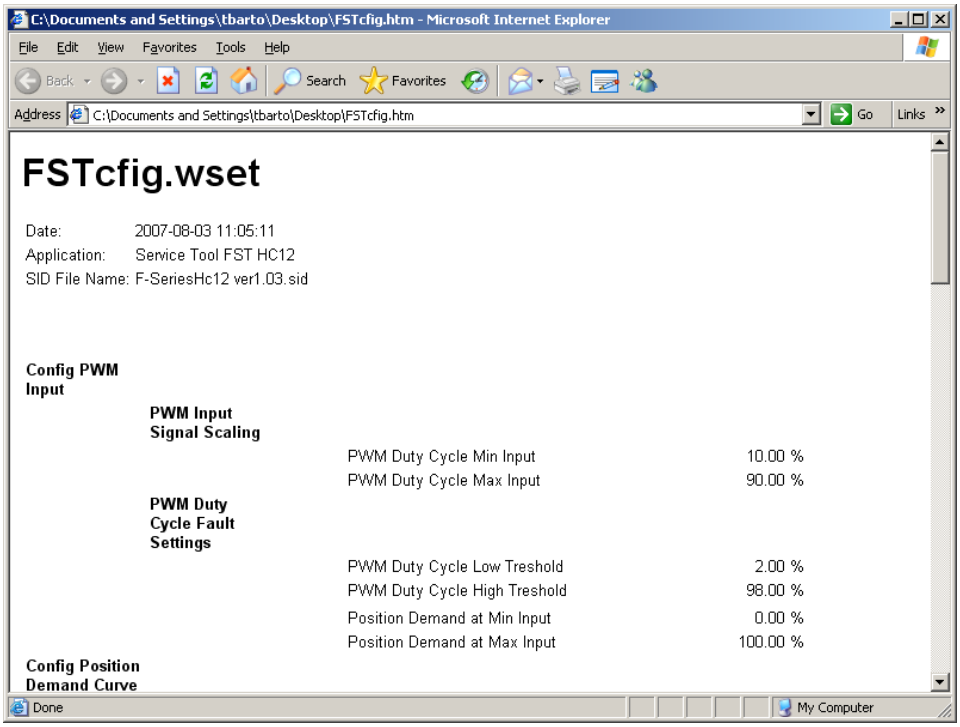


Figure 6-10. FSTcfig.htm Configuration Document Example

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

⚠WARNING

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

⚠WARNING

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

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

⚠CAUTION

Due to typical noise levels in 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 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.	Stuck throttle/frozen shaft	Move throttle by hand. Assess smoothness, friction, and return spring force.
	Power not applied to control	Disconnect starter motor solenoid. Disconnect harness from actuator. Test for +12/24 V between +12/24 V pin and ground pin.
	Run Enable not closed	Verify status of input. Measure input. Verify input and configuration using Service Tool.
	Incorrect configuration in control	Using Service Tool, read configuration from control and evaluate parameters for correction.
	Fault detected in control.	Using Service Tool, read faults from control. Verify/correct any shutdown conditions.
The actuator is not opening the control valve during engine cranking.	The control is configured for the wrong opening direction.	Check linkage setup.
	The Run Enable input is not enabled.	Make sure the run enable input, if configured for use, is made active. Check wiring.
	The control has detected a shutdown situation and has not been reset.	Reset the control by cycling power to the control, hitting reset on the Service Tool, or toggling the run enable switch.
	There is no power supplied to the control.	Check fuse, wiring, and battery voltage.
The engine over speeds on start-up.	The control is setup for the wrong opening direction.	Check linkage setup.
	Speed setting too high.	Verify speed control setpoint
	An overshoot in speed is caused by speed control.	Speed control dynamic settings or acceleration ramp rate are overly responsive. Tune the speed control
	The overspeed trip level is set incorrectly.	Verify the overspeed trip setting.
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.	Manually verify full travel of throttle plate.
	Fault detected in control.	Using Service Tool, view status of fault codes. Take appropriate action for active faults.

Problem	Possible Cause	Suggested Test/Correction
Not controlling at desired position setpoint.	PWM input signal inaccuracy.	Measure input duty cycle and convert to percentage. Verify controller signal using Service Tool. If different, adjust the PWM input scaling in the Settings Editor.
	Wiring fault or ground loop.	Check the wiring. Look for loose connections and disconnected or misconnected cables and connections. Remove all wiring except the position demand and power input and verify operation/functionality.
	Analog input signal inaccuracy.	As applicable, measure the analog demand voltage or current to verify that it is at the expected value in the range of 0 V to 5 V or 4 mA to 20 mA. Use the service tool to verify that analog input is being read correctly.
	Output shaft is bound or sticking.	Move output shaft by hand. Assess smoothness, friction, and return spring force.
Discrete output not working.	Wiring fault.	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.
	Configuration.	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”).
Service Tool not communicating–‘Establishing Connection on Com x’ status indicated.	Power not applied to control	Disconnect starter motor solenoid. Disconnect harness from actuator. Test for +12/24 V between +12/24 V pin and ground pin.
	Wiring fault.	Check pins TTL TX, TTL RX and Ground for loose or misconnected wiring connections.
	Incorrect cable used or converter missing.	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.
	The Service tool is disconnected.	Verify harness setup and connections (see Chapter 4). Check that Service Tool is running. Check fuse, wiring, and battery voltage. Connect the service tool by using the connect icon or ‘Device Connect’ menu selection.
	The wrong communication port has been selected.	Verify the port setting is correct.
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 (**www.woodward.com/software**).
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
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.
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.
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.
Low Power Reset	Indicates that unit reset was caused by low voltage on microcontroller.	Power Supply voltage drops. Internal voltage regulator error. Shorts on internal power circuits.	Check drops on power supply pins (check wiring and/or power supply system) Return unit to Woodward for repair.
Power-up Reset	Indicates power to the F-Series actuator was lost and is restored	Normal power up of the F-Series actuator. Loss or intermittent power supply wiring. Power supply wiring too long or too thin. F-Series actuator will reset during transient power uses.	No action needed. Possibly reset control. Check wiring for broken or loose connection. Make sure wiring is of the correct thickness and length according to manual.
PWM Frequency Out Of Range	The PWM Frequency is out of the 250 Hz to 20 kHz range	PWM signal has frequency out of range. Incorrect or intermittent wiring problem.	Check signal and fix incorrect signal frequency.

Error Flag	Description	Possible Source	Possible Action
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.
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 on External A/D Error	The 5 V power circuit is defective, measured on SPI A/D converter.	The F-Series actuator is defective.	Return unit to Woodward for repair.
5 V Supply on Internal A/D Error	The 5 V power circuit is defective, measured on internal A/D converter.	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 D/A Error	The D/A 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.	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:

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

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

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

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

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

Product Service Options

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

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

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

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

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

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

Returning Equipment for Repair

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

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

Packing a Control

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

NOTICE

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

Replacement Parts

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

Contacting Woodward's Support Organization

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

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

Products Used In Electrical Power Systems

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

Products Used In Engine Systems

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

Products Used In Industrial Turbomachinery Systems

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

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

Technical Assistance

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

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

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

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

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

Appendix A. Acronyms/Abbreviations

AUX	Auxiliary
CAN	Control area network
CCW	Counterclockwise
CRC	Cyclic redundancy check
CW	Clockwise
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
PWM	Pulse-width modulated
RS-232	A communications standard
SID	Service interface definition
SPI A/D	Serial peripheral interface analog/digital
SPI D/A	Serial peripheral interface digital/analog
TPS	Throttle position sensor

Appendix B.
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)
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)
Integrated Throttle Body (ITB) Sizes	33 mm, 48 mm, 60 mm, 68 mm, and 75 mm
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-m²

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, ±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 **NOTE**: 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 ºC, 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^2/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	**NOTE**: 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 kΩ all modes
Resolution	12 bits up to 1953 Hz The duty cycle and frequency are read with reduced resolution at higher frequencies
Accuracy	±1 % all modes at 32 V and frequencies < 1000 Hz ±2 % all modes at 32 V and frequencies > 1000 Hz **NOTE**: Low-Side detection accuracy could depend on integrity of signal source.
Pull-Up Level	5 V through 4.99 kΩ
I/O Execution Rate	600 µs
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 kΩ
Accuracy of Position Output	±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 Ω to ensure ±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)

Internal Electronics Temperature Sensor

Parameter	Value
Accuracy	±2 °C at 25 °C
	±3 °C over full 165 °C range
Scaling	Fixed at factory
Temperature Fault Levels	Configurable in software. See Chapter 6.
I/O Execution Rate	9.6 ms

Diagnostics Faults

Parameter	Value
Watchdog Reset Occurred	A watchdog timer is set at 13.1 ms. If the timer times out, the unit will reset and this fault is set.
EEPROM Read Fail	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	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 Version Error	This fault is set if the CRC checksum stored with the parameters does not match checksum currently residing in non-volatile memory.
AD Converter Error	This fault is set if the A/D is not getting interrupts and providing updates for more the 96 ms.
SPI DAC Error	This fault is set if voltage on TPS output is lower or higher with 0.5 V than it should be
SPI ADC Error	This fault is set if the A/D is not communicating or failed to complete all its conversions in 6 ms.
+15 V Supply Error	This fault is set if an out of range of the internal +15 V power circuit is detected.
–15 V Supply Error	This fault is set if an out of range of the internal –15 V power circuit is detected.
–5 V Reference Supply Error	This fault is set if an out of range of the internal –5 V reference is detected.
5 V Supply Error	This fault is set if an out of range of the internal 5 V power circuit is detected.
PWM Duty Cycle High	This fault is set if the PWM input went above the PWM Duty Cycle High threshold.
PWM Duty Cycle Low	This fault is set if the PWM input is below the PWM Duty Cycle Low threshold.
PWM Frequency Out Of Range	This fault is set if the PWM input frequency is out of 250 Hz to 20 kHz range.
Input Voltage High	This fault is set if the Input Supply Voltage went above the Supply Voltage High Threshold.
Input Voltage Low	This fault is set if the Input Supply Voltage went below above the Supply Voltage Low Threshold.
Electronics Temperature High	This fault is set if the internal electronics temperature went above 140 °C.
Electronics Temperature Low	This fault is set if the internal electronics temperature went below –45 °C.
Position Error	This fault is set if the position feedback is not following the position demand. Detection logic is designed to prevent against false indication during normal actuator response times.
Low Power Reset	This fault is set when unit was reset because power on microcontroller.
Power-up Reset	This fault is set when power is first applied to the unit and remains set until reset.

Parameter	Value
Spring Check Failed	This fault is set if the return spring fails to move the output shaft to the configured Finish position within the configured timeout period during power-up.
Diagnostics Execution Rate	9.6 ms

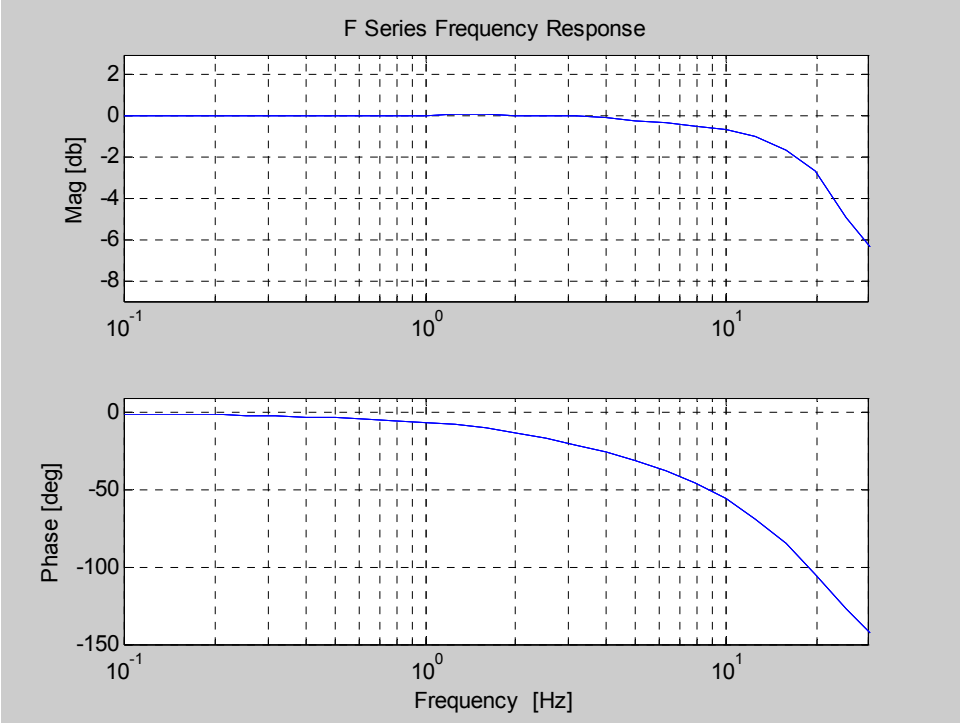


Figure B-1. Typical Bode Plot of F-Series Actuator Response

Revision History

Changes in Revision K—

- Corrected Pin 2 readout on Figure 3-1

Changes in Revision J—

- Updated information for 14-pin version
- Removed 23-pin version information (now in manual 26600)

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

Sam Coleman
Full Name

Compliance Engineering Supervisor
Position

WGC, Fort Collins, CO, USA
Place

21 August 2009
Date

00336-04-EU-02-03

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26355K.

B26355:K

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