



SPC Servo Position Controller

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

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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.



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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 Out-of-date translations are marked with .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— A bold, black line alongside the text identifies changes in this publication since the last revision.

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DeviceNet (Open DeviceNet Vendor Association, Inc. [ODVA])
Windows (Microsoft Corporation)

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Warnings and Notices

Important Definitions



This is the safety alert symbol 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.
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

WARNING

Lockout/Tagout

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

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.

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.

IMPORTANT

External wiring connections for reverse-acting controls are identical to those for direct-acting controls.

Regulatory Compliance

European Compliance for CE Marking:

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

ATEX Explosive Atmospheres Directive: Directive 2014/34/EU on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
Zone 2, Category 3, Group IIC Ex nA IIC T4 Gc X IP20

North American Compliance:

CSA: CSA Certified for Class I, Division 2, Groups A, B, C, & D, T4 at 70 °C Ambient for use in Canada and the United States.
Certificate 1250622

This product is certified as a component to be used within a suitable enclosure. The final assembly is subject to acceptance by CSA International or the authority having jurisdiction.

Marine: Models 8200-225 & 8200-226 American Bureau of Shipping, Steel Vessel Rules 4-9-7/13, 1-1-4/3.7, 2003

Det Norske Veritas, Rules for Classification of Ships, High Speed and Light Craft and Mobile Offshore Units

Lloyd's Register for ENV1, ENV2, and ENV3 as specified in Test Specification No.1, 1996

IMPORTANT

This equipment is considered indicator equipment and is not to be used as metrology equipment. All measurements need to be verified using calibrated equipment.

General Installation and Operation Notes and Requirements:

- The Servo Position Controller is suitable for use in Class I, Division 2, Groups A, B, C, and D per CSA for Canada and US or non-hazardous locations only.
- Wiring must be in accordance with North American Class I, Division 2 or European Zone 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.
- Per EN 60079-15:2010: Device meets ATEX Zone 2 requirements when installed in an ATEX compliant IP54 or better enclosure.
- The SPC chassis must be connected to PE Ground (Potential Earth) using the ground lug. The wire used for the PE Ground must be the same size used for the input wire.

Models 8200-225 and 8200-226 are suitable for marine applications per:

- American Bureau of Shipping, Steel Vessel Rules 4-9-7/13, 1-1-4/3.7, 2003
- Det Norske Veritas, Rules for Classification of Ships, High Speed and Light Craft and Mobile Offshore Units
- Lloyd's Register for ENV1, ENV2, and ENV3 as specified in Test Specification No.1, 1996.

 **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.

 **AVERTISSEMENT**

RISQUE D'EXPLOSION—Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurer 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 ou Zone 2.

Chapter 1.

General Information

The SPC (Servo Position Controller) is available in two model configurations:

8200-226: DeviceNet Control with Analog Backup (or Analog primary demand)
 8200-227: CANopen Control with Analog Backup (or Analog primary demand)

Models 8200-224 & 8200-225 are inactive and replaced by above item numbers.

The SPC positions a hydraulic or pneumatic actuator based on a position demand signal received from a control. The SPC positions a single-coil actuator using single or dual position feedback devices. The position demand signal can be sent to the SPC via DeviceNet or CANopen, (4 to 20) mA, or both. A software program running on a Personal Computer (PC) allows the user to easily configure and calibrate the SPC.

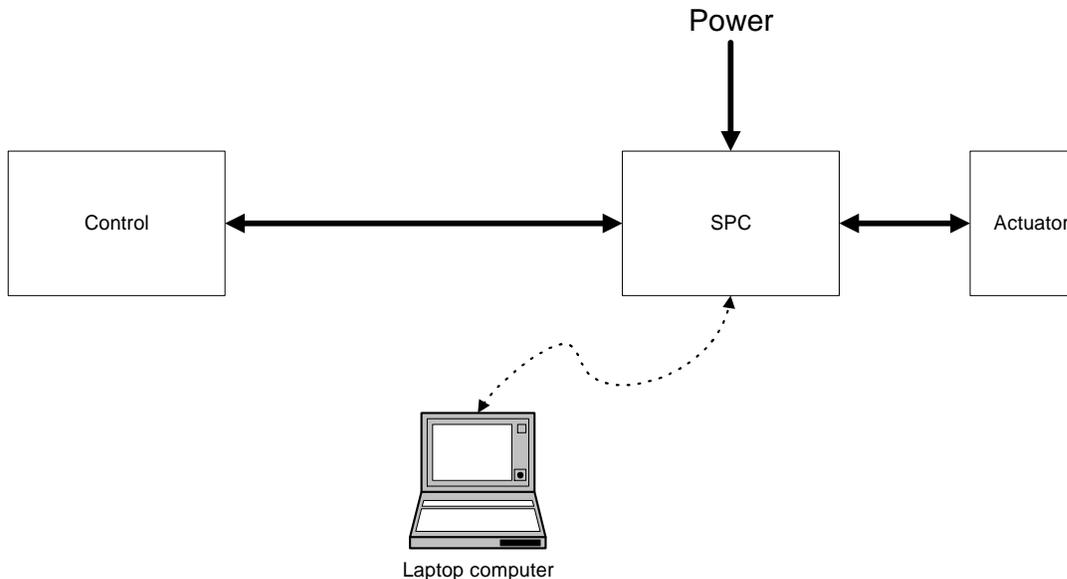


Figure 1-1. SPC Connections

The SPC Service Tool is used to configure, calibrate, adjust, monitor, and troubleshoot an SPC. The service tool runs on a PC and communicates with the SPC through a serial connection. The serial port connector is a 9-pin sub-D socket and uses a straight-through cable to connect to the PC. Woodward offers a USB to 9-pin Serial Adapter kit if needed for new computers that do not have a 9-pin serial connector (P/N 8928-463). This kit contains a USB adapter, software, and a 1.8 m (6 feet) serial cable. (See Chapter 4 for SPC Service Tool installation instructions.)

The SPC is configured by using the SPC Service Tool's configuration file editor to create a file that is then loaded into the SPC. The SPC Service Tool can also read an existing configuration from an SPC into the configuration file editor.

See Chapter 4, SPC User's Guide, for detailed instructions on using the SPC Service Tool.

The first time an SPC is connected to an actuator, it must be calibrated to the actuator's position feedback transducer. The user is guided through the calibration process by the service tool. Calibration can also be performed by the control via the Digital Control link (DeviceNet or CANopen). The calibration procedure can be found in the GAP help file.

Chapter 2. Installation

Power Requirements

The SPC requires a voltage source of (18 to 32) V (dc), with a current capacity of 1.1 A max. If a battery is used for operating power, a battery charger is necessary to maintain a stable supply voltage. The power line should be protected with a 5 A, 125 V fuse capable of withstanding a 20 A, 100 ms in-rush when power is applied.

IMPORTANT

The SPC is not equipped with input power switches. For this reason, some means of switching input power must be provided for installation and servicing.

NOTICE

To prevent damage to the control, make sure that the alternator or other battery-charging device is turned off or disconnected before disconnecting the battery from the control.

Location Considerations

Consider these requirements when selecting a mounting location for the SPC:

- Adequate ventilation for cooling
- Space for servicing and repair
- Protection from direct exposure to water
- Protection from high-voltage or high-current devices, or devices which produce electromagnetic interference
- Avoidance of vibration
- Selection of a location that will provide an operating temperature range of (–40 to +70) °C / (–40 to +158) °F

⚠ WARNING

This product is intended for installation in an enclosed industrial control cabinet. In order to meet the requirements for Zone 2 Hazardous Location, the SPC must be mounted in an enclosure with ingress protection of IP54 or greater.

Optional SPC Mounting Kit

Optionally, SPC mounting bracket kit #8928-7334 is available for use in reducing required panel mounting space within a cabinet. Ideal for applications where multiple SPCs are utilized, this bracket allows SPCs to be mounted such that they protrude vertically into the cabinet, reducing the required panel mounting area. This bracket's design allows users to first attach the SPC to the bracket, then install the entire assembly onto a cabinet side panel. Please refer to Figure 2-1.

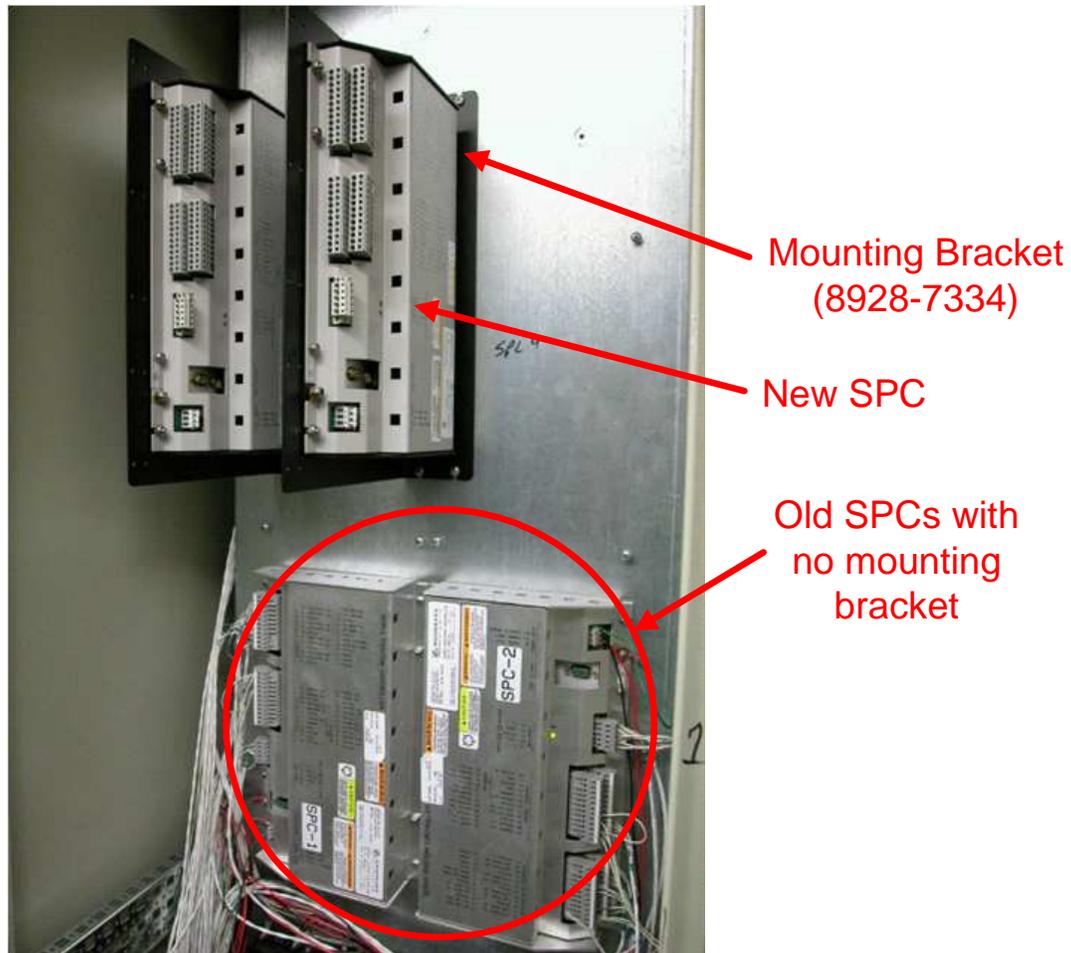
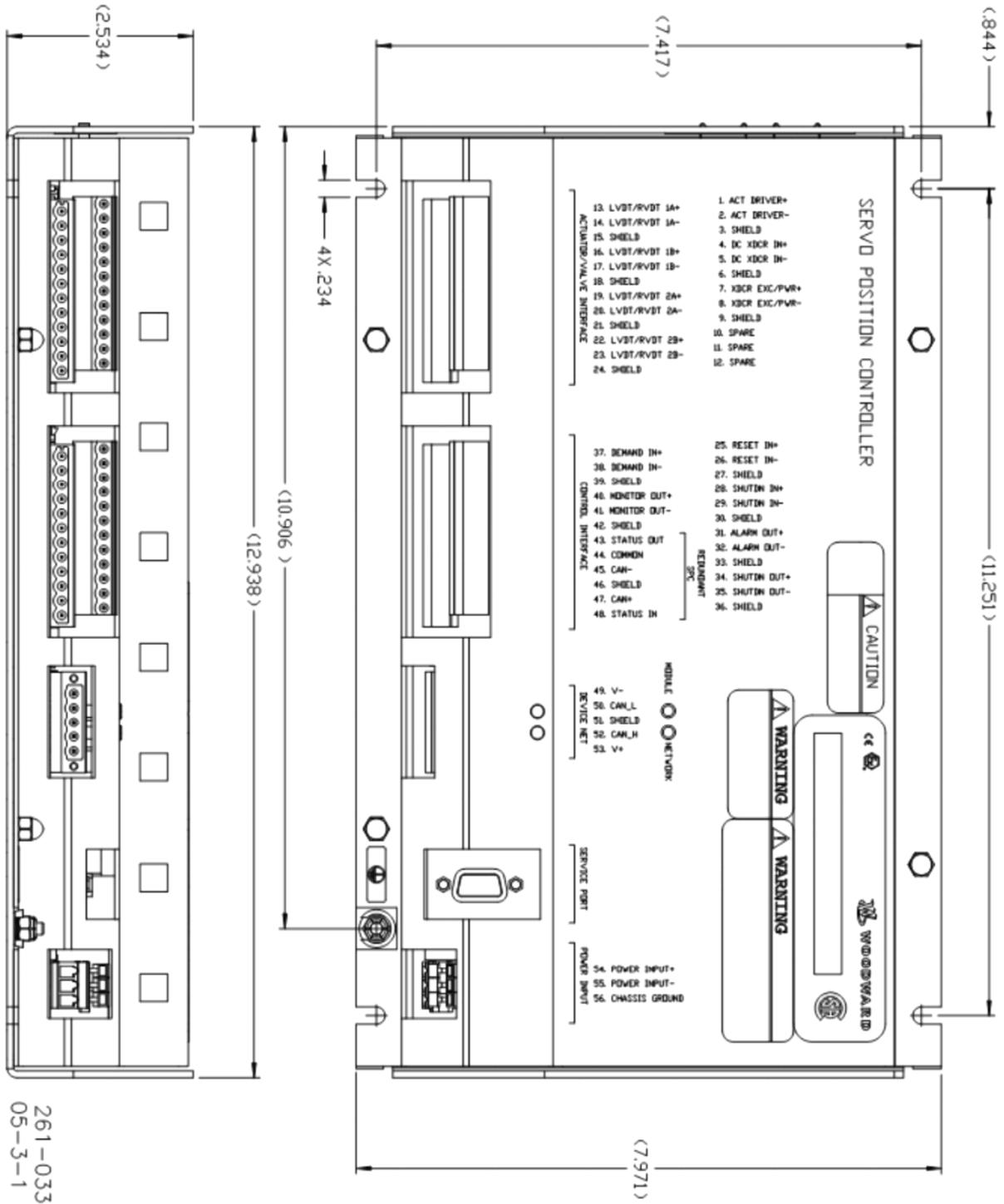


Figure 2-1. Optional SPC Mounting Bracket

Shields and Grounding

A shield termination is provided at the terminal block for each of the signals. All of these inputs should be wired using shielded, twisted-pair wiring. The exposed wire length beyond the shield should be limited to one 25 mm (1 inch). The shield should be terminated at only one end in order to avoid creating a ground loop.



261-033
05-3-1

Figure 2-2. SPC DeviceNet Outline Drawing

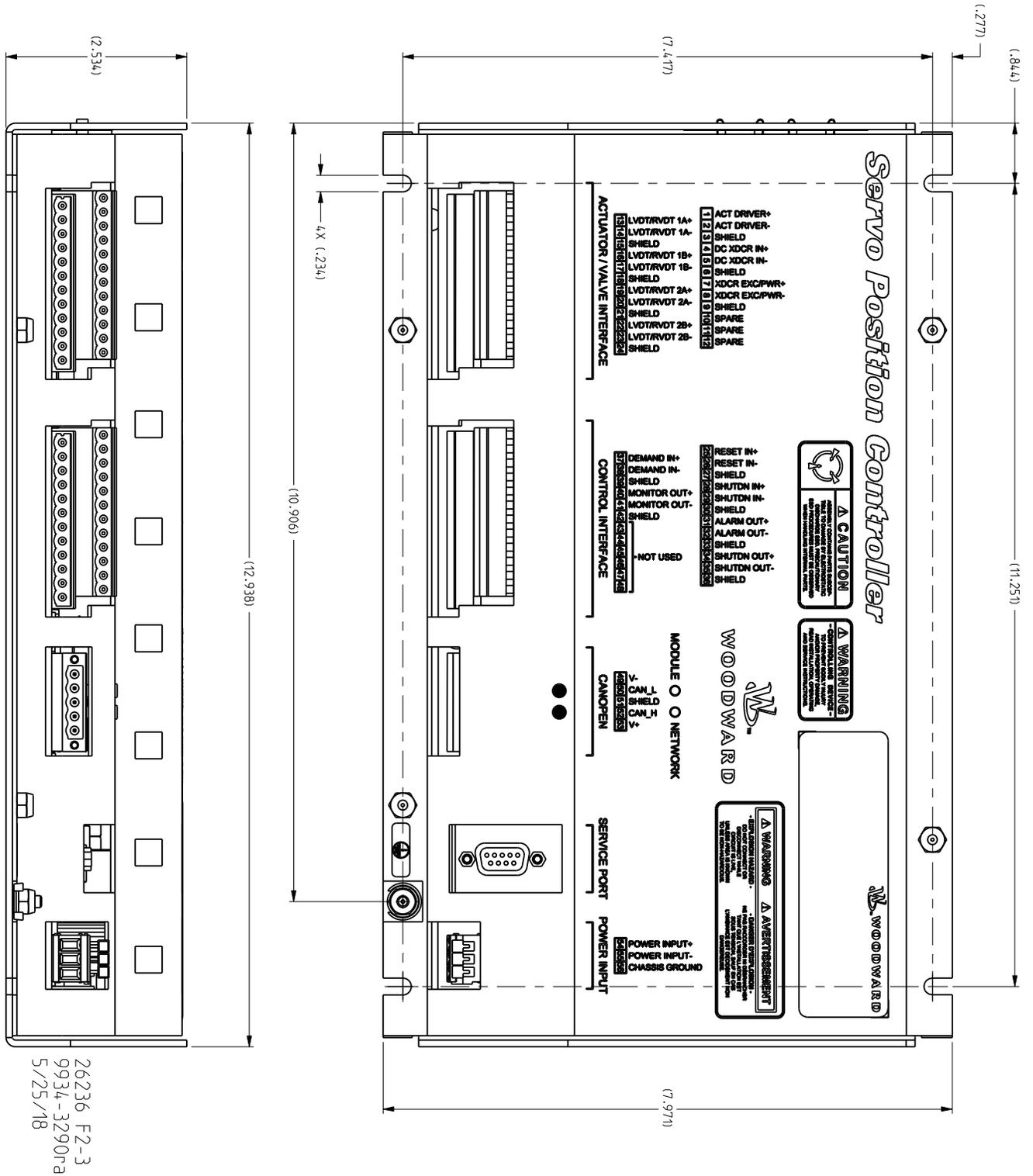


Figure 2-3. SPC CANopen Outline Drawing

IMPORTANT

The SPC chassis must be connected to PE Ground (Potential Earth) using the grounding lug. The wire used for PE ground must be the same size used for the input wires.

The SPC must be attached to protective earth by a ground strap or otherwise, and all cables shielded to ensure electromagnetic immunity integrity.

For best noise immunity, power cables should be run in separate cable trays or conduits from the low-level I/O cables.

Terminal Block Connections

All inputs and outputs are made through spring-actuated terminal blocks. The spring clamp can be actuated using the plastic lever included or by a standard 2.5 mm or 3/32 inch flat-bladed screwdriver. The terminal blocks accept wires from (0.08 to 4) mm² / (26 to 12) AWG. The recommended strip length is 8 mm (0.3 inch).

IMPORTANT

Do not tin (solder) the wires that terminate at the terminal blocks. The spring-loaded terminal blocks are designed to flatten stranded wire, and if those strands are tinned together, the connection loses surface area and is degraded.

See Figure 2-4 for the wiring diagram.

Actuator Driver Output

Connect shielded twisted-pair cable from actuator to ACT DRIVER+(1) and ACT DRIVER-(2). Connect the cable shield to SHIELD (3) but do not connect the shield at the actuator end. The Actuator Driver output is software configurable for ± 10 mA, ± 25 mA, ± 50 mA, ± 100 mA and ± 250 mA ranges.

DC Transducer Input

If a (4 to 20) mA position transducer is used for feedback, connect shielded twisted-pair cable from transducer to DC XDCR IN+(4) and DC XDCR IN-(5). Connect the cable shield to SHIELD(6) but do not connect the shield at the transducer end.

Transducer Exciter/Transducer Power Output

If an AC transducer is used for feedback, this output is used as an exciter for the LVDT or RVDT. Connect a shielded twisted-pair cable from the transducer excitation winding to XDCR EXC/PWR+(7) and XDCR EXC/PWR-(8). Connect the cable shield to SHIELD (9) but do not connect the shield at the transducer end.

If a DC transducer is used for feedback, this output is used to supply 18 V (dc) (120 mA max) for the transducer power. Connect a shielded twisted-pair cable from the transducer power input to XDCR EXC/PWR+(7) and XDCR EXC/PWR-(8). Connect the cable shield to SHIELD (9) but do not connect the shield at the transducer end.

LVDT/RVDT Inputs

If an AC transducer is used for feedback, connect a shielded twisted-pair cable from each LVDT or RVDT secondary to LVDT/RVDT 1A (13 & 14) and LVDT/RVDT 1B (16 & 17). Connect the shields to SHIELD (15 & 18).

If a redundant AC transducer is used, connect a shielded twisted-pair cable from each LVDT or RVDT secondary to LVDT/RVDT 2A (19 & 20) and LVDT/RVDT 2B (22 & 23). Connect the shields to SHIELD (21 & 24).

IMPORTANT

This input is also used for dc voltage position transducers.

Reset Contact Input

Connect a shielded twisted-pair cable from a control switch to RESET IN+(25) and RESET IN-(26). Connect the cable shield to SHIELD (27) but do not connect the shield at the switch end. During normal operation, the switch is open. Momentarily closing the switch will cause the SPC to reset any alarms or shutdowns.

Shutdown Contact Input

Connect a shielded twisted-pair cable from a control switch to SHUTDN IN+(28) and SHUTDN IN-(29). Connect the cable shield to SHIELD (30) but do not connect the shield at the switch end. During normal operation, the switch is closed. Opening the switch will cause the SPC to disable the Actuator Driver Output.

Alarm Status Relay Driver Output

Connect a shielded twisted-pair cable from a status relay to ALARM OUT +(31) and ALARM OUT-(32). Connect the cable shield to SHIELD (33) but do not connect the shield at the relay end. The relay driver is energized under normal operation and is de-energized during an alarm condition.

Shutdown Status Relay Driver Output

Connect a shielded twisted-pair cable from a status relay to SHUTDN OUT+(34) and SHUTDN OUT-(35). Connect the cable shield to SHIELD (36) but do not connect the shield at the relay end. The relay driver is energized under normal operation and is de-energized during a shutdown condition.

IMPORTANT

The Alarm and Shutdown Status Relay Driver Outputs are unpowered. External power must be connected in series with the output and the load. See Figure 2-3.

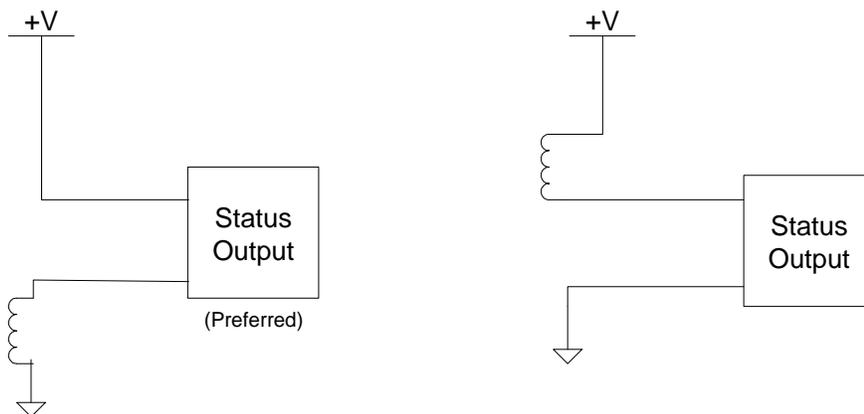


Figure 2-4. Status Relay Driver Output Wiring

Position Demand Input

Connect a shielded twisted-pair cable from the system controller (4 to 20) mA output to DEMAND IN+(37) and DEMAND IN-(38). Connect the cable shield to SHIELD (39) unless it is grounded at the system controller. The mA-to-position scaling is configurable using the SPC Service Tool.

Position Monitor Output

Connect a shielded twisted-pair cable from a (4 to 20) mA meter readout to MONITOR OUT+(40) and MONITOR OUT-(41). Connect the cable shield to SHIELD (42) unless it is grounded at the meter readout. A 4 mA signal occurs when the actuator is positioned at 0 %, and a 20 mA signal occurs when the actuator is positioned at 100 %.

Redundant SPC Interface

These terminals are reserved for a possible future feature and must be left unconnected.

DeviceNet Interface (8200-226 Model)

The SPC can be alternatively controlled via a network interface. The standard DeviceNet 5-pin plug-in connector allows connection to a DeviceNet network. Red/green indicators are provided to indicate the module and network status. The SPC conforms to DeviceNet Specification Release 2.0 as a Group II only slave. This product has been self-tested by Woodward and found to comply with ODVA Protocol Conformance Test Version 16.

The DeviceNet baud rate and MAC address can be configured using the “DeviceNet” tab under the Configuration File Editor in the Service Tool.

SPC DeviceNet Electronic Data Sheets (EDS) for selected Woodward products that conform to Group II on DeviceNet Specification Release 2.0 can be downloaded from the Woodward website. From www.woodward.com/software, select **DeviceNet Electronic Data Sheets (EDS)**.

The different values are either 4 or 2 bytes long. The entire value must be gathered before the application can be updated. After each index is received, the index sent must be increased by one with looping back to zero when the max is reached.

See Appendix B for specific signal addresses.

CANopen Interface (8200-227 Model)

The SPC can be alternatively controlled via a network interface. The standard CANopen 5-pin plug-in connector allows connection to a CANopen network. Red/green indicators are provided to indicate the module and network status.

The CANopen baud rate and Node Id can be configured using the “CANopen” tab under the Configuration File Editor in the Service Tool. The possible options are:

- 125kbps
- 250kbps
- 500kbps

Per CiA DS-102 Standard, the following are the recommended maximum cable lengths. Differences in the baud rate and the cable length affect the number of units that can be put onto a network.

Table 2-1. Recommended Maximum Cable Lengths and Number of Units

Baud Rate	Cable Length	Number of SPC on link
500kbps	100m	10
250kbps	250m	5
125kbps	500m	2

IMPORTANT

The use of controlled impedance (120 ohm) cable is recommended for proper CAN bus operation. See ISO 11898 series standards for further information.

See Appendix D for specific signal addresses.

Table 2-2. CANopen Terminal Wiring

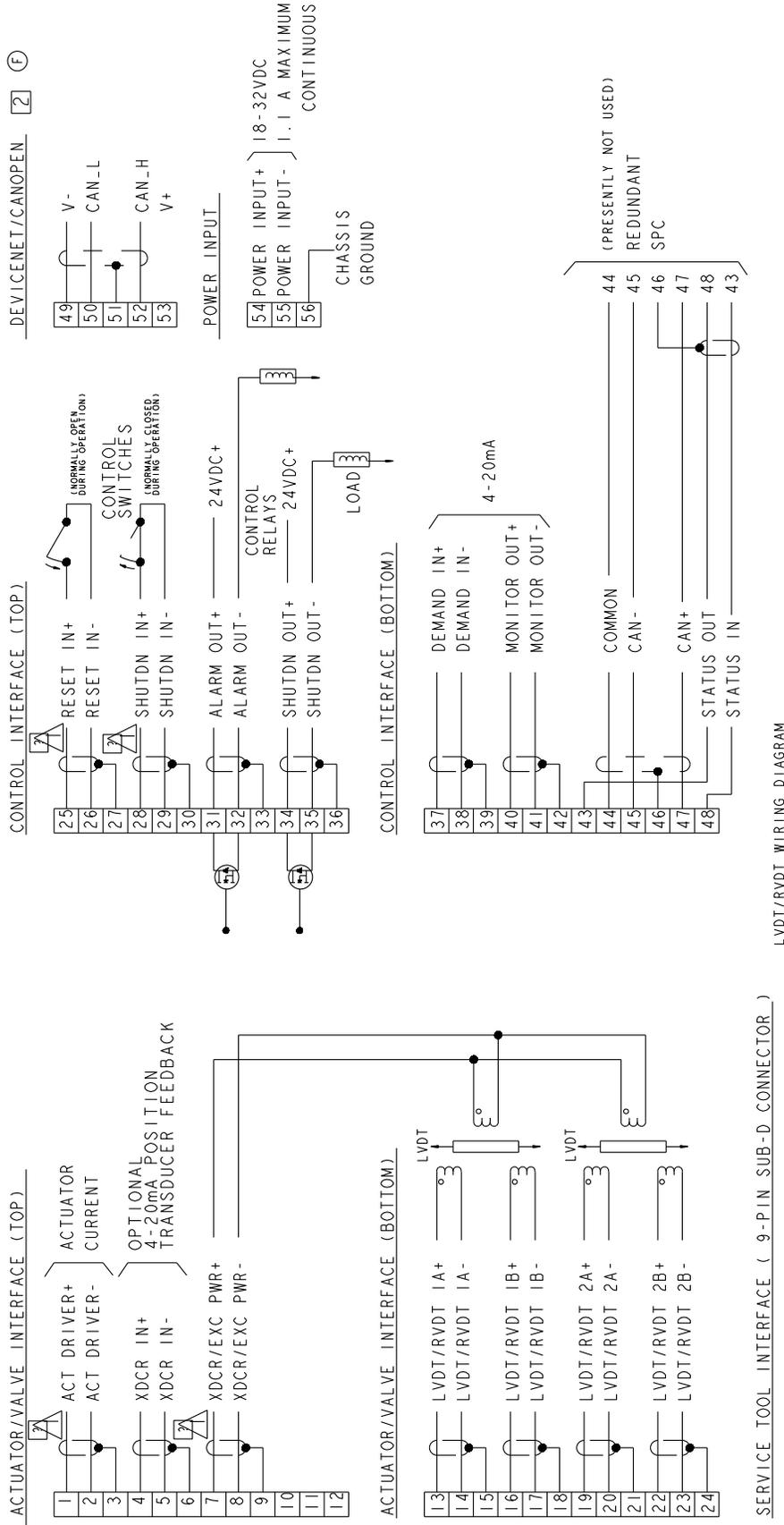
Signal	Terminal	Description
V- (COM)	49	Common
CAN_L	50	Signal Low
SHIELD	51	Shield
CAN_H	52	Signal High
V+ (PWR)	53	Power Supply (Not Used in SPC)

Power Input

Connect an (18 to 32) V (dc) power source to POWER INPUT+(54) and POWER INPUT-(55).

RS-232 Port

The serial port connector (9-pin Sub-D socket) is used for connecting to a PC via an extension cable (straight through). The wiring must meet the requirements of EIA RS-232. This standard requires a maximum cable length of 16 m (50 feet) with a total capacitance of less than 2500 pF.



26236 F2-5a
9936-465r00 (Sh1)
5/29/18

LVDT/RVDT WIRING DIAGRAM

Figure 2-5a. SPC Wiring Diagram

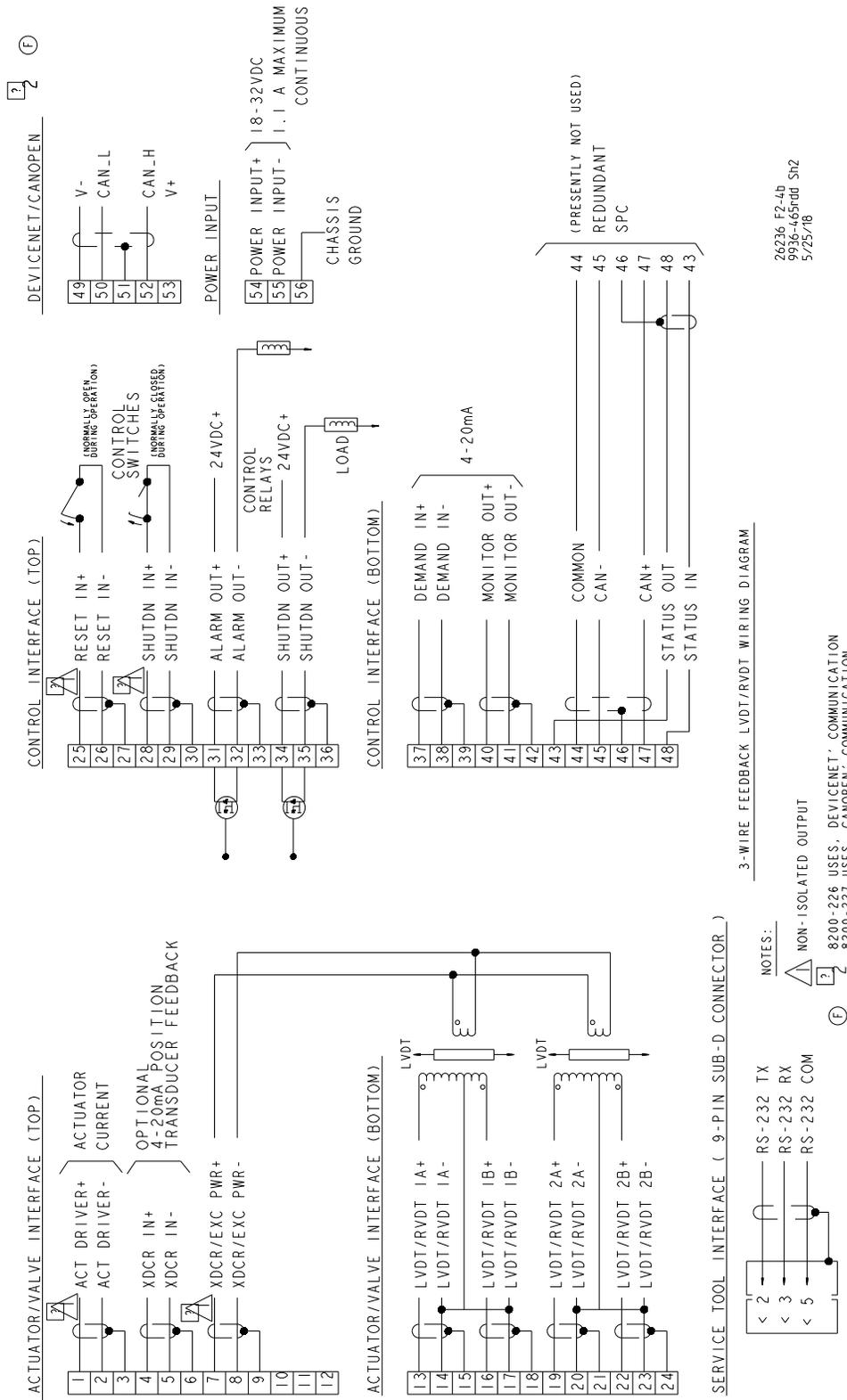


Figure 2-5b. SPC Wiring Diagram

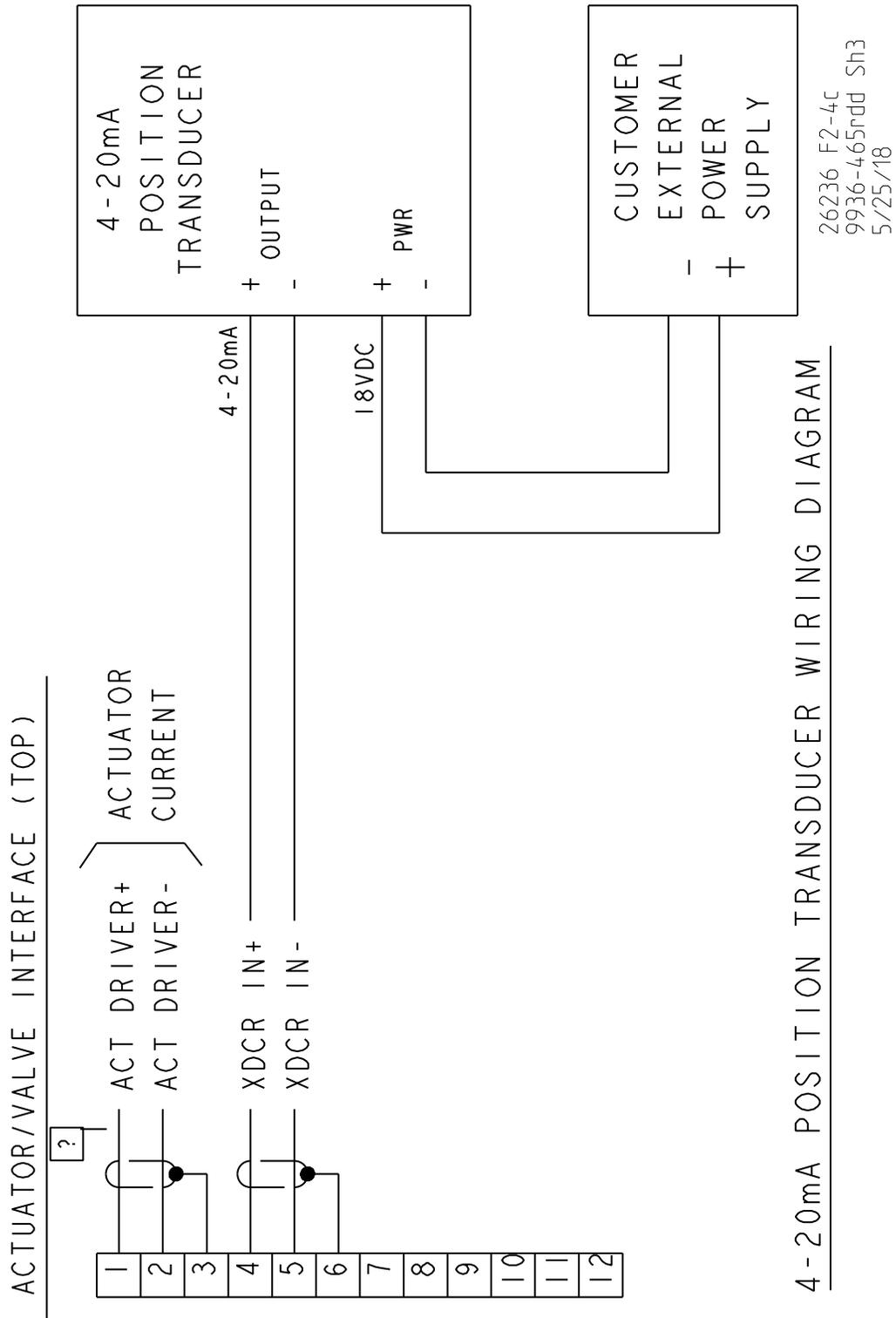
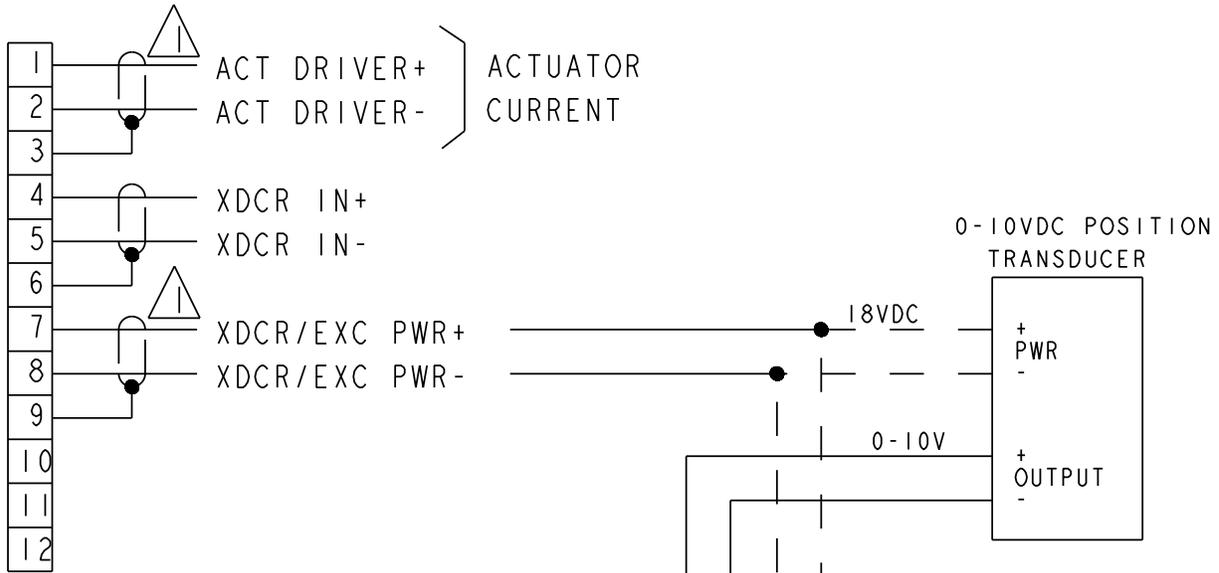
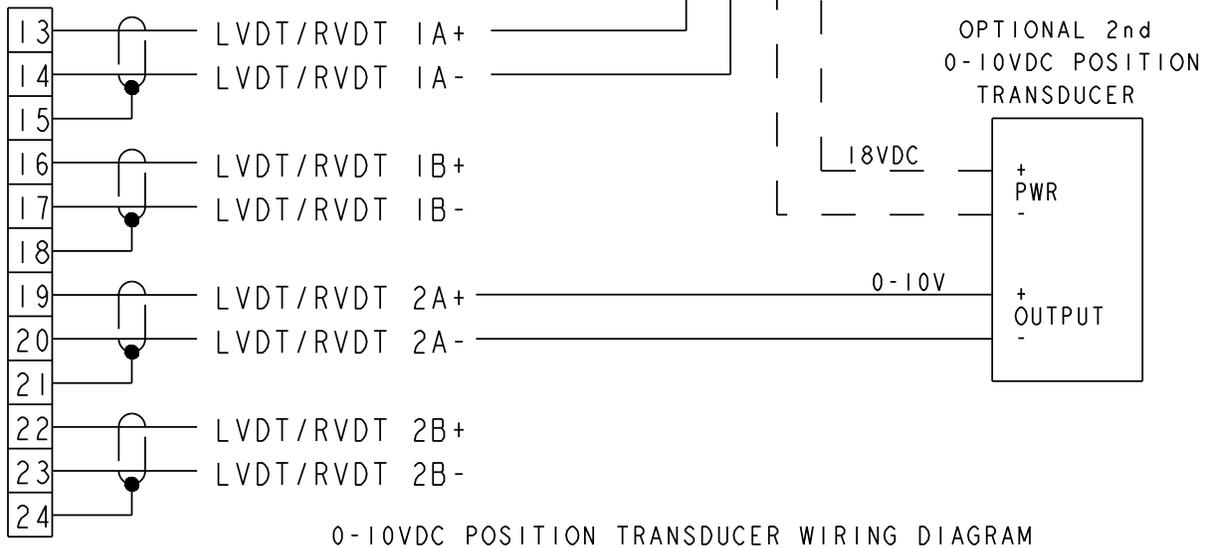


Figure 2-5c. SPC Wiring Diagram

ACTUATOR/VALVE INTERFACE (TOP)



ACTUATOR/VALVE INTERFACE (BOTTOM)



0-10VDC POSITION TRANSDUCER WIRING DIAGRAM

NOTES:

 NON-ISOLATED OUTPUT

26236 F2-4d
9936-465rdd Sh4
5/25/18

Figure 2-5d. SPC Wiring Diagram

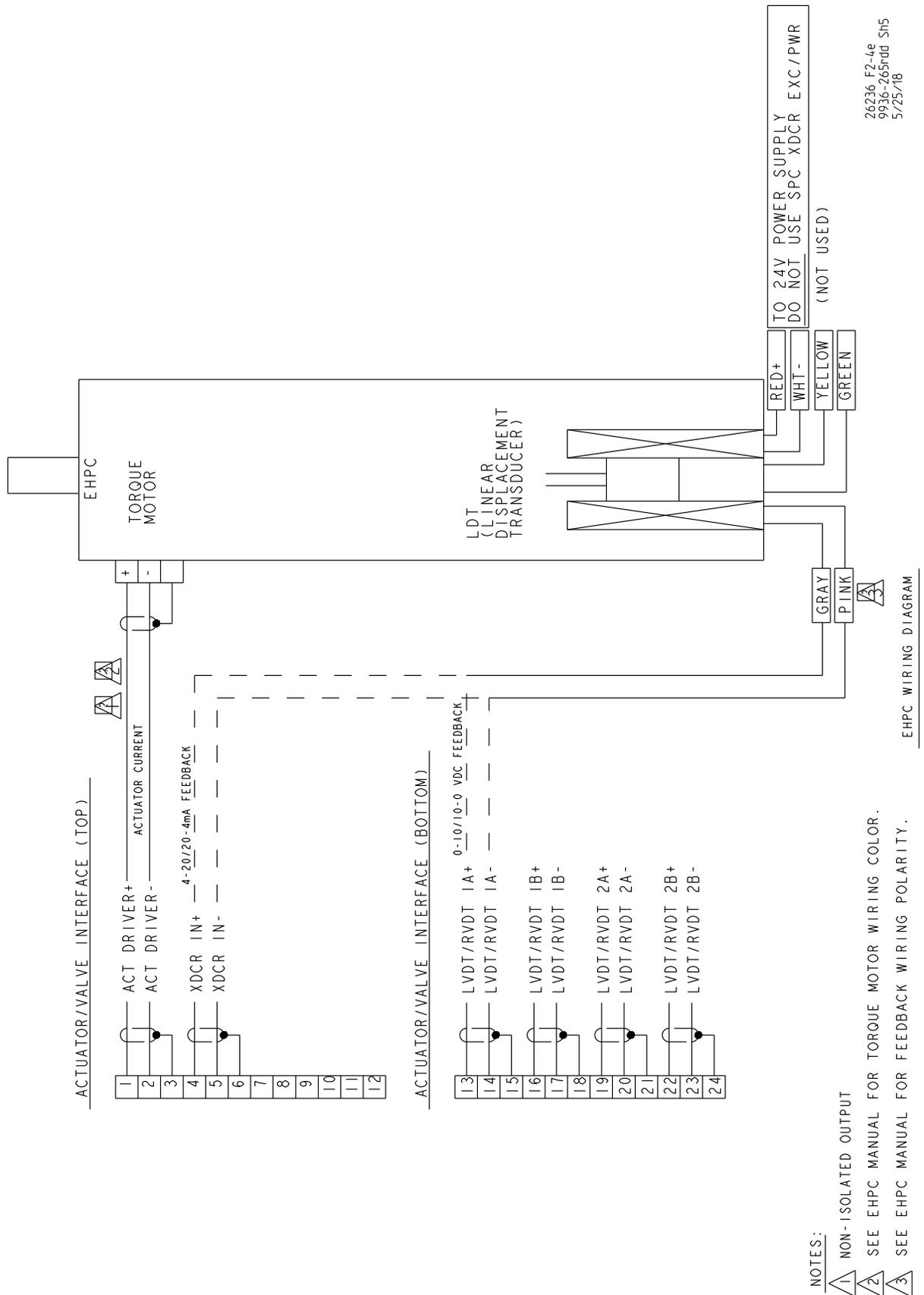


Figure 2-5e. SPC Wiring Diagram

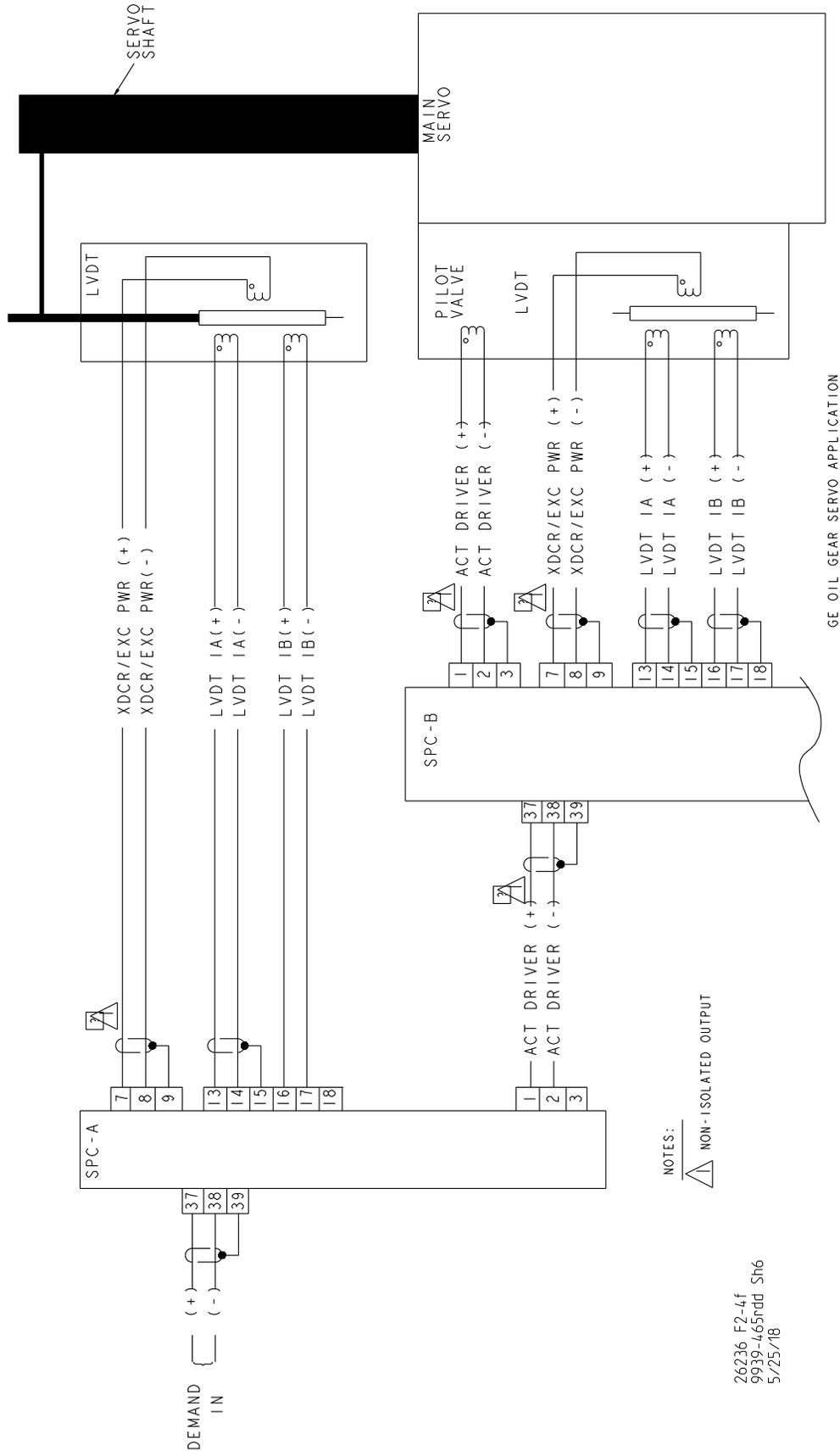
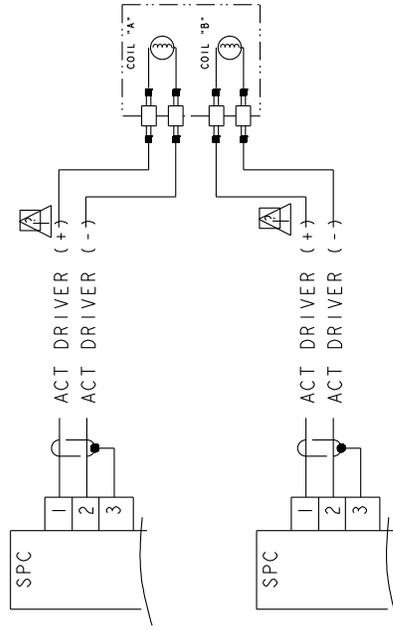


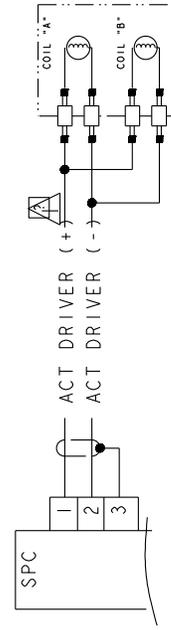
Figure 2-5f. SPC Wiring Diagram

OPTIONAL_DUAL_COIL_WIRING*

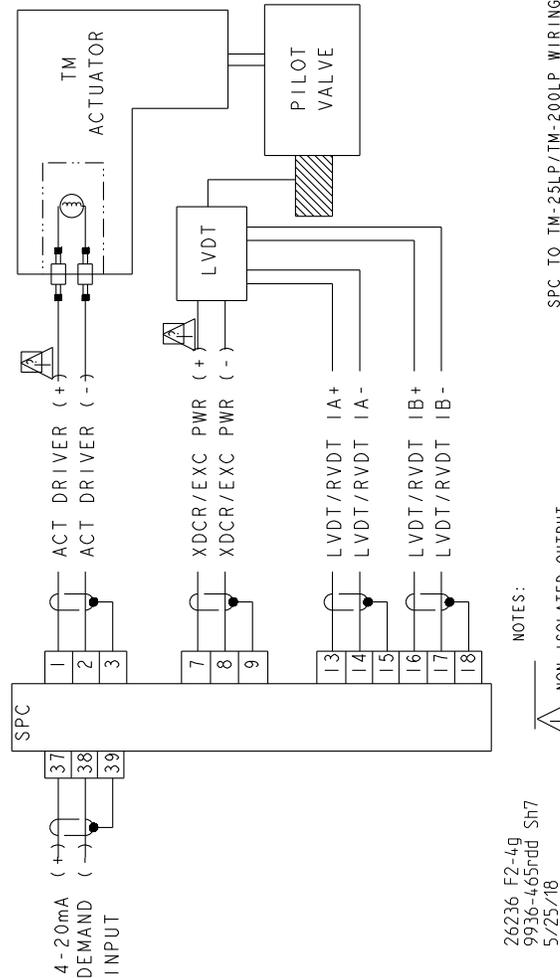


*ONLY ONE SPC CAN BE ACTIVE AT A TIME IN THIS CONFIGURATION.

OPTIONAL_DUAL_COIL_WIRING



SINGLE_COIL_WIRING - INTEGRATING SERVO APPLICATION



26236 F2-4g
9936-465rdd Sh7
5/25/18

NOTES:

NON-ISOLATED OUTPUT

SPC TO TM-25LP/TM-200LP WIRING

Figure 2-5g. SPC Wiring Diagram

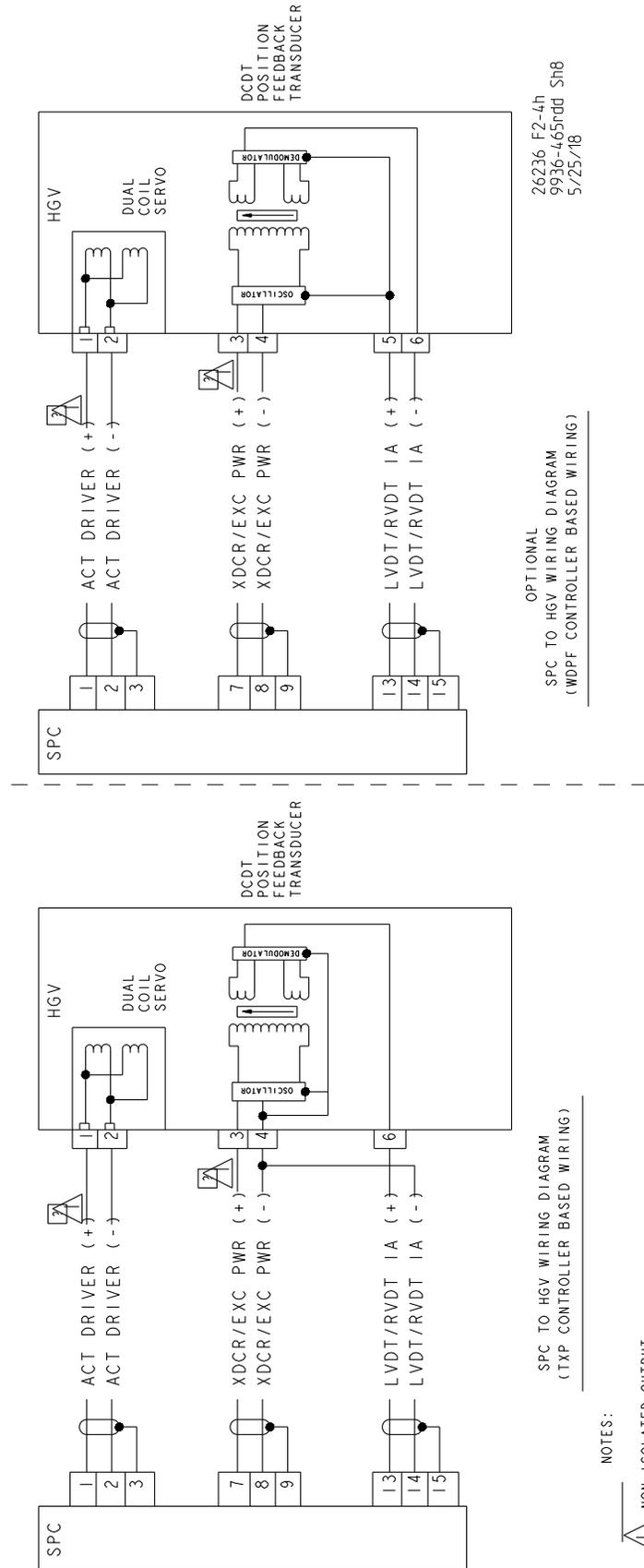


Figure 2-5h. SPC Wiring Diagram

Chapter 3. SPC Specifications

Table 3-1. System Accuracy

Using Digital Input	0.25 % of full scale @ 25 °C, TC < 150 ppm/°C
Using (4 to 20) mA Input	0.25 % of full scale @ 25 °C, TC < 300 ppm/°C

IMPORTANT

System accuracy excludes the position transducer. It assumes field calibration with a minimum feedback span of 4 V (rms) (LVDT/RVDT) or 8 mA (dc transducer).

Table 3-2. Electrical Specifications

Power Input

Nominal Voltage	24 V (dc)
Maximum Voltage Range	(18 to 32) V (dc)
Maximum Continuous Current	1.1 A

Power Dissipation 20 W typical heat load

Actuator Driver Output

Current Range	±10 mA ±25 mA ±50 mA ±100 mA ±250 mA
Output Filter	6 ms lag
Resolution	11 bits
Linearity	0.2 % of full scale
Temperature Sensitivity	300 ppm/°C
Dither	(0 to 10) %, 25 % duty cycle @ 25 Hz
Load Resistance Range	see Diagnostics section below

Analog Demand and DC Transducer Inputs

Nominal Range	(4 to 20) mA
Operating Range	(2 to 22) mA
Fault Detection	Current < 1 mA or > 23 mA
Common Mode Input Voltage	200 V (dc)
Common Mode Impedance	400 kΩ
Common Mode Rejection	-60 dB @ 60 Hz
Input Impedance	200 Ω
Input Filter	5 ms lag
Resolution	13 bits
Linearity	0.1 % of full scale
Temperature Sensitivity	150 ppm/°C

Monitor Output

Nominal Range	(4 to 20) mA
Operating Range	(0 to 25) mA
Isolation Voltage	500 V (rms)
Maximum Load	500 Ω
Output Filter	3 ms lag
Resolution	12 bits
Linearity	0.2 % of full scale
Temperature Sensitivity	300 ppm/°C

LVDT/RVDT/DC Voltage Input

Maximum AC Voltage	10 V (rms)
DC Voltage Range	(0 to 12) V (dc)
Common Mode Input Voltage	200 V (dc)
Common Mode Rejection	-60 dB @ 60 Hz
Input Impedance	100 k Ω min
Input Filter	10 ms lag
Resolution	14 bits
Linearity	0.1 % of full scale
Temperature Sensitivity	150 ppm/ $^{\circ}$ C

Transducer Exciter Output

Voltage Range	(4 to 10) V (rms)
Frequency Range	(1 to 5) kHz
Maximum Load	120 mA
Resolution	0.1 V (rms)
Accuracy	0.2 % of full scale @ 25 $^{\circ}$ C
Temperature Sensitivity	150 ppm/ $^{\circ}$ C

Transducer Power Output

Nominal Voltage	18 V (dc) \pm 10 %
Maximum Load	120 mA

Discrete Inputs

Operating Current	10 mA
Contact Open Threshold	> 11 V
Contact Closed Threshold	< 4 V

Relay Driver Outputs

Normal Operating State	Driver On
Maximum Voltage	32 V (dc)
Maximum Current	500 mA
Maximum Voltage Drop	1 V @ 500 mA
Maximum Leakage	10 μ A
Isolation Voltage	500 V (rms)
Maximum Delay	1 ms

Digital Input (DeviceNet/CANopen)

Node Isolation	500 V (rms)
Node Power	self-powered

Service Port

Protocol	RS-232
Connector	9-pin Sub-D socket
Interface Cable Type	Extension (not null modem)
Isolation	500 V (rms)

Diagnosics

The SPC performs multiple diagnostic functions as described in the User Guide of the SPC Service Tool. Following are some details on the hardware-specific aspects of these diagnostic functions:

Table 3-3. Diagnosics

Driver Current Error Threshold:	Demanded current does not match measured current to within $\pm 20\%$.
Driver Overcurrent Threshold:	Measured current exceeds demanded current by more than 25 %.
Approximate Actuator Open Threshold (minimum):	$13/(\text{maximum required current, in amps})$ The open threshold varies with current. The lowest open threshold occurs at the highest required output current. For example, if the maximum current required is 120 mA, the lowest value that will count as an open is $13/0.120 = 108 \Omega$.
Approximate Actuator Shorted Threshold:	$1/(\text{full scale current, in Amps}) \text{ ohms}$, where full scale current is the driver current range displayed on the service tool. For example, if the driver current range is ± 100 mA, the short threshold is $(1/0.100) = 10 \Omega$.
Exciter Voltage Tolerance:	± 0.2 V (rms)
System Diagnostics:	Memory test, continuous monitoring of internal supply voltages, A/D converter reference check, hardware CPU power monitor, software watchdog timer
DeviceNet Communication Faults:	Communications between the SPC and its assigned master have stopped or slowed to less than 200 ms.
CANopen Communication Faults:	The SPC does not receive SYNC and RXPDO1 messages for the configured timeout.

Table 3-4. Environmental Specifications

Temperature Range:	(-40 to +70) °C
Shock:	30 G, 11 ms half sine pulse
Vibration (random):	0.7 G, (5 to 2000) Hz
Humidity:	95 % condensing

Mechanical Specification

Dimension:	330 X 203 X 76 mm (13 X 8 X 3 Inches)
Weight :	1.565 Kg (3.45 lbs)

Pollution Resistance

Particulate Pollution Resistance:	IEC 664-1 Pollution Degree 2 (Normally only nonconductive pollution occurs. Temporary conductivity caused by condensation is to be expected.)
Gaseous Pollution Resistance:	The polyacrylate conformal coating withstands NO ₂ , CO ₂ , SO ₂ , and H ₂ S gases per IEC 60068-2-60: 1995 Part 2.60 Method 1 and 4 (Flowing Mixed Gas Corrosion Test). It will withstand levels typical of telecommunications and computer installations as defined by Battelle Labs Class III (between IEC 60721-3-3 classification 3C1 and 3C2, light industrial to urban industrial, heavy traffic).

Chapter 4.

SPC User's Guide

Introduction

Portions of the text information in this chapter can also be found with the SPC Service Tool software under the “Help” pull down; select “Contents”.

Operating Modes

The SPC has four operating modes—Configure, Calibrate, Manual Stroke, and Run. The operating mode changes by request of the SPC Service Tool user or by request of the control system when calibration via Digital Control Network has been enabled.

Operating Mode Summary

Configure mode characteristics

- The SPC configuration is being changed.
- The actuator position is not actively controlled.
- The actuator current is forced to 0 mA.

Calibrate mode characteristics

- The SPC is being calibrated to the position feedback of a particular actuator.
- Actuator position changes as a result of forcing different fixed currents to the actuator except during the verification portion of the calibration procedure, when the actuator position is actively controlled using the new position feedback information.
- The normal position demand inputs are ignored.

Manual Stroke mode characteristics

- The SPC uses a user-entered position demand value to control the actuator position.
- The normal position demand inputs are ignored.

Run

- The SPC uses the normal position demand inputs to control the actuator position.

Using the SPC Service Tool

The SPC Service Tool is used to configure, calibrate, adjust, monitor, and troubleshoot an SPC. The service tool runs on a personal computer and communicates with the SPC through a serial connection.

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

Detailed information on the SPC is contained in the SPC Service Tool. After loading the Service Tool onto a PC, go under the Help header in the Service Tool Select “Contents”.

The SPC Service Tool can be found on the Woodward website at: www.woodward.com/software. Select software product “SPC Tools”. Follow the installation instructions given on that page.

IMPORTANT

SPC model 8200-227 requires SPC Service Tool version 14.05 or later to function correctly. This tool version also supports the 8200-226.

Models 8200-224 and 8200-225 can use version 1.2 or later.

Loading an updated version of the Service Tool will automatically remove any previous versions of the Service Tool on the PC. You will receive a prompt that the software will remove the previous version when installing the later version of the Service Tool.

Existing configuration files that reside inside the SPC control created with an earlier version of the Service Tool can be downloaded/saved onto a PC. The downloaded configuration file will automatically be converted to the latest version of the Service Tool.

Finding Detailed Operating Instructions

From the Windows Start menu, select **Programs**, then **Woodward**, then **SPC Service Tool**, and finally select **SPC Service Tool**. Once the SPC Service Tool has started, select **Help** from the menu, and then select **User's Guide**.

The User Guide describes how to configure and calibrate the SPC, and how to monitor and control operation using the service tool, the Digital Control Network, and the analog and discrete I/O lines.

LED Status Indicators

The SPC has two LEDs for status indication. The Network Status LED provides information about the Digital Network port. The Module Status LED provides information about the general operating status of the SPC.

Table 4-1. Network Status LED

LED state	Indicates
Off	SPC is not on-line
Flashing Green	SPC is on-line but no connections have been established
Green	SPC is on-line and allocated to a master
Flashing Red	One or more connections have timed out
Red	SPC is unable to communicate

Table 4-2. Module Status LED

LED State	Indicates
Off	SPC is not powered
Flashing Green	SPC requires configuration and/or calibration
Green	SPC is running normally
Red	SPC internal fault—unit may need to be replaced

Minimum Computer Requirements

- Microsoft Windows 95 / 98 / Me / NT 4.01 2000 / XP
- 300 MHz Pentium CPU
- 64 MB RAM
- 800 by 600 pixel screen
- Serial Port
- Serial Extension Cable

SPC Service Tool Organization

The service tool includes the following windows:

SPC Service Tool

The SPC Service Tool window is the main window of the service tool, and it is always visible while the service tool is running. This window allows you to manage service tool–SPC communication and to monitor and adjust parameters within the SPC. The window also displays the status of the SPC. For more information, see the following topics:

- Managing Service Tool–SPC Communication
- Monitoring with the Service Tool
- Adjusting with the Service Tool
- Understanding the Status Bar
- Viewing and Resetting Alarms and Shutdowns
- Changing Alarm and Shutdown Settings

Configuration Editor

The Configuration Editor window is used to edit and load configurations. For more information, see the following topic:

- Configuring the SPC

Calibration Assistant

The Calibration Assistant window guides you through the calibration procedure step-by-step. For more information, see the following topics:

- Calibrating from the service tool
- Understanding the Status Bar

Manual Stroke

The Manual Stroke window is used to manually stroke the actuator, and it is opened from the SPC Service Tool window. For more information see:

- Manually Stroking the Actuator
- Understanding the Status Bar

Managing Service Tool–SPC Communication

The SPC Service Tool communicates with the SPC in order to display and modify values in the SPC.

To establish communication between the service tool and SPC, open the SPC Service Tool and select the appropriate serial port on the PC.



Figure 4-1. Selecting Communication Port

Once the serial port is selected, the service tool will attempt to connect to the SPC using the selected serial port, and the communication status message in the status bar will change to “Connecting”. When the connection is established, the communication status message in the status bar will change to “Connected” and the service tool will begin to display live information from the SPC.

If the communication connection is lost, the service tool attempts to re-establish the connection. While the service tool is re-establishing the connection, the communication status displays “Connecting” and the windows are grayed with parameters frozen at their last read value. A connection will be lost if the SPC loses power or the serial cable is disconnected.

You may start or stop communication between the service tool and SPC at any time by selecting **Communication** and then **Connect or Disconnect from SPC...** from the menu of the SPC Service Tool window.

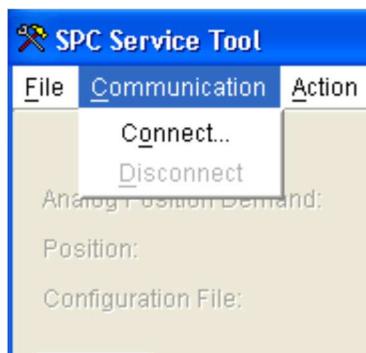


Figure 4-2. Connecting to the SPC

 WARNING	<p>Switching the serial cable from one SPC to another while the communication status is “Connected” may result in invalid data being read from and/or written to the SPC. Always select “Disconnect” before plugging the serial cable into a different SPC.</p>
--	---

Understanding the Status Bar

At the bottom of the SPC Service Tool, Calibration Assistant, and Manual Stroke windows is a status bar. The status bar has several sections. From left to right the sections show Communication Status, SPC Operating Mode, Data Entry Limits, and Alarm & Shutdown Status.

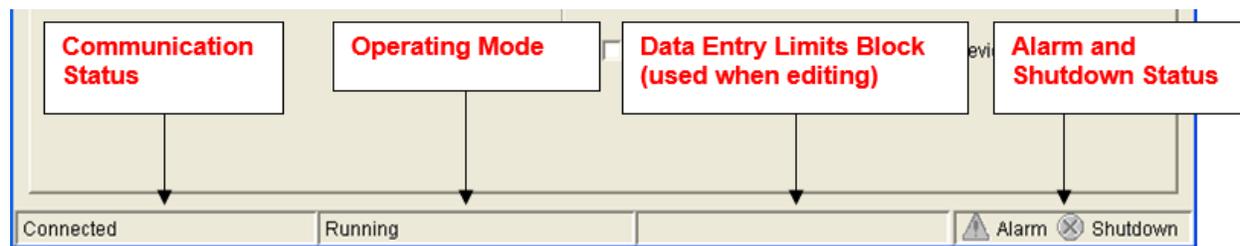


Figure 4-3. Service Tool Status Bar

Communication Status

This section of the status bar shows the status of communication between the service tool and the SPC. For more information, see Managing Service Tool–SPC Communication.

SPC Operating Mode

This section of the status bar shows the current operating mode of the SPC.

Needs to be configured

- The SPC has not been configured.
- The actuator position is not actively controlled.
- The actuator current is forced to 0 mA.

Configured; needs to be calibrated

- The SPC has been configured but not calibrated.
- The actuator position is not actively controlled.
- The actuator current is forced to 0 mA.

Configured

- The SPC has been configured and calibrated.
- The actuator position is not actively controlled.
- The actuator current is forced to 0 mA.

Calibrating

- The SPC is being calibrated to the position feedback of a particular actuator.
- Actuator position changes as a result of forcing different fixed currents to the actuator except during the verification portion of the calibration procedure, when the actuator position is actively controlled using the new position feedback information.
- The normal position demand inputs are ignored.

Calibrated

- The SPC has been calibrated.
- The normal position demand inputs are ignored.

Manual Stroking

- The SPC uses a user-entered position demand value to control the actuator position.
- The normal position demand inputs are ignored.

Running

- The SPC uses the normal position demand inputs to control the actuator position.

Data Entry Limits

This section of the status bar displays limits on data entry for the item that is currently being edited. When editing a numeric parameter, the range of valid values that can be entered will be displayed in the data entry limits section of the status bar. The service tool will not accept values outside of the range.

Alarm and Shutdown Status

This section of the status bar quickly shows if there are any alarms or shutdowns in the SPC. If there are any alarms, a warning indicator  will be displayed; otherwise the indicator is gray . If there are any shutdowns, an error indicator  will be displayed; otherwise the indicator is gray .

Using the SPC Digital Control Network Port

The SPC includes a Digital Network port that allows it to be monitored and controlled over a DeviceNet or CANopen bus. Before the SPC can communicate over the Digital Network bus, it must be configured as described in **Configuring Digital Control Network**.

All items available for monitoring from the SPC service tool are also available over the Digital Network bus.

The servo controller proportional and integral gains can be configured to be adjustable over the Digital Network bus by checking the **Gain Adjustments are made from the fieldbus** check box on the **Servo Controller** page of the Configuration File Editor.

The position feedback device calibration procedure can be performed over the Digital Network bus by checking the **Calibration will be performed through DeviceNet or CANopen** checkbox in the DeviceNet or CANopen page of the SPC Service Tool window.

Configuring the SPC

Before the SPC can position an actuator, it must be configured. The SPC must have information about the actuator, about where the position demand is coming from, and about how alarms and shutdowns are to operate. Configurations are created and edited and then loaded to the SPC. Changes to a configuration do not affect the SPC until the configuration is loaded to the SPC. An SPC is configured using the SPC Service Tool and following these steps:

Creating a New Configuration or Opening an Existing Configuration

Creating a new configuration

On the menu of the SPC Service Tool window, select **File** and then select **New Configuration....** Select the Service Interface Version.

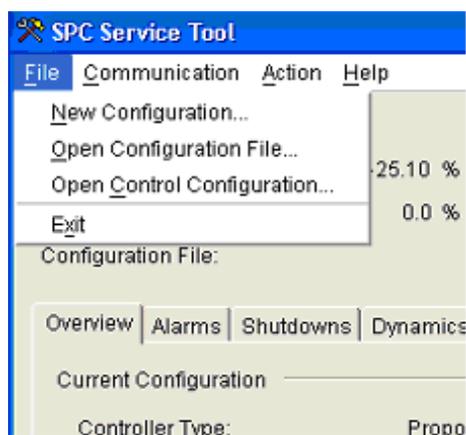


Figure 4-4. Selecting Configuration Options

The Service Interface Version can be determined by opening the Service Tool with the SPC connected. Select the *Identification* Tab and note the Software Part Number.

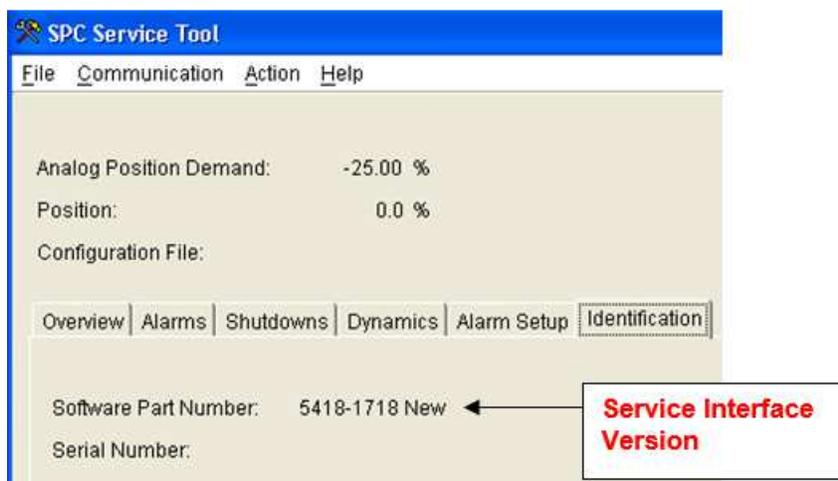


Figure 4-5. Determining Service Interface Version

The Software Part Number corresponds to the appropriate Service Interface Version. The Configuration Editor window will open with an incomplete configuration that is ready to be edited once the Service Interface Version is selected.

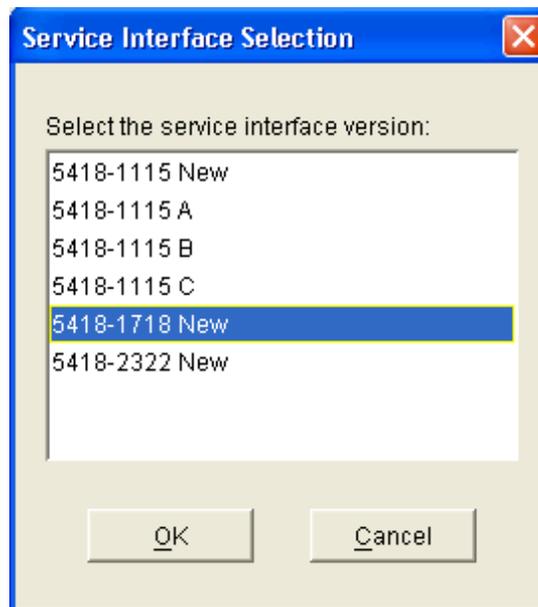


Figure 4-6. Selecting Service Interface Version

Opening a configuration file

On the menu of the SPC Service Tool window, select **File** and then select **Open Configuration File**. You will be asked to identify the configuration file you wish to open. Once you have selected the file, the Configuration Editor window will open with the configuration from the file ready to be edited.

Open a configuration read from an SPC

To read and open a configuration from an SPC, the service tool must be connected to the SPC. On the menu of the SPC Service Tool window, select **File** and then select **Open Control Configuration**. The service tool will read the configuration from the SPC and open a copy in the Configuration Editor window. Changes made to the configuration in the Configuration Editor will not affect the SPC until the configuration is loaded to the SPC.

Edit the Configuration

Editing a configuration does not require a connection to the SPC. A configuration is divided into six parts. The Configuration Editor has a tabbed page for each part. The tabbed pages are Servo Controller, Position Demand, Feedback, Position Error, Driver and DviceNet or CANopen. The following topics describe each part of the configuration:

- Configuring the Servo Controller
- Configuring the Position Demand Source
- Configuring the position Feedback
- Configuring the Position Error Settings
- Configuring the Driver
- Configuring DviceNet or CANopen

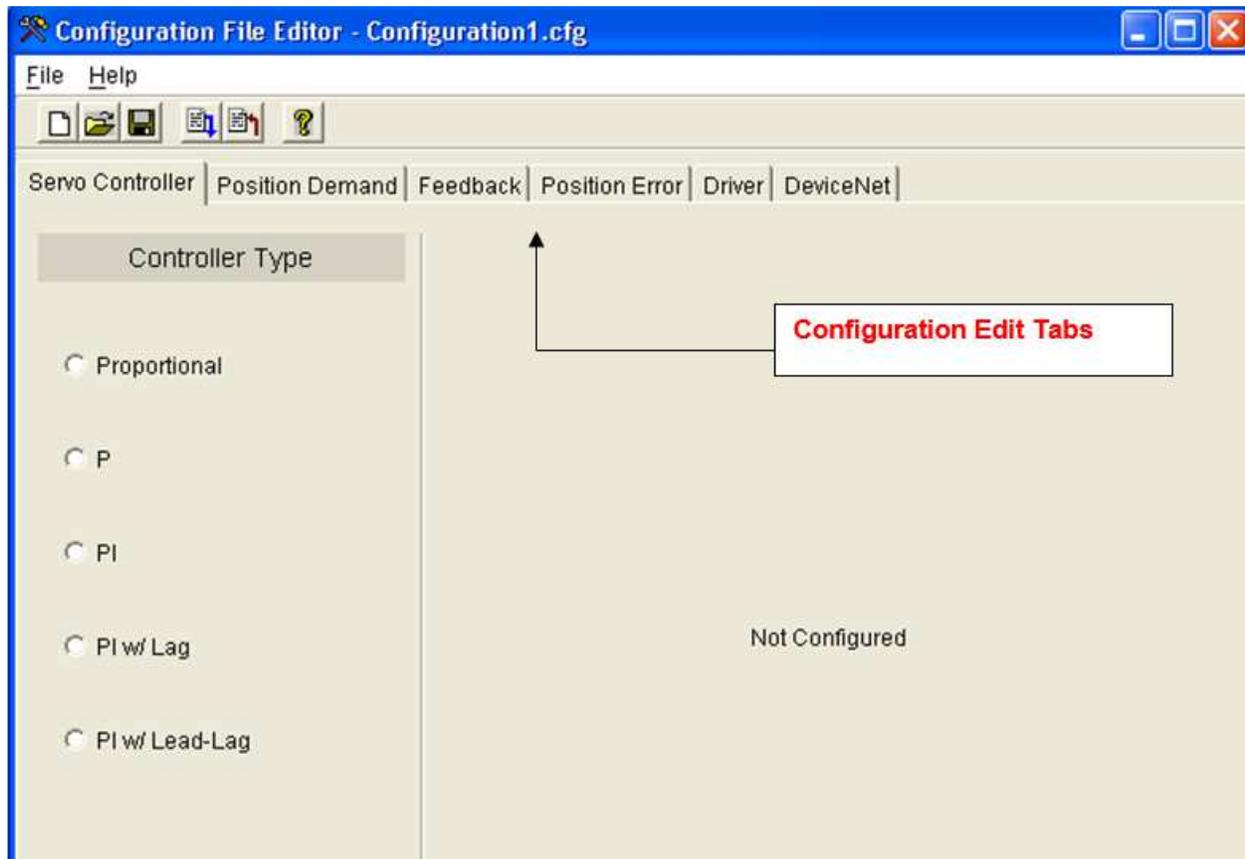


Figure 4-7. Configuration Editing Tabs

As values are entered in a configuration window, other portions of the window may change so that only the relevant information is displayed. Changes are saved by selecting **File** and then **Save** or **Save As** from the menu.

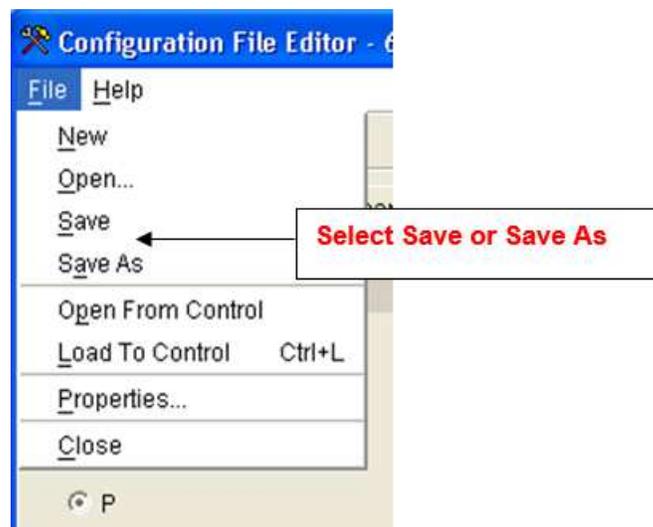


Figure 4-8. Saving the Configuration File

Loading the Configuration File to the SPC

NOTICE

Downloading a configuration to the SPC control will cause the SPC to shut down.

To begin loading a configuration, the service tool must be connected to the SPC and the configuration must be open in the Configuration Editor window. After a connection is established, from the menu of the Configuration Editor window select **File** and then select **Load to Control**. The service tool requires that a configuration be saved to a file before it can be loaded to an SPC. If the configuration is saved, then the service tool will attempt to place the SPC into the Configure mode. If the SPC is in Run mode, then a warning indicating that the SPC will be shut down will be displayed.

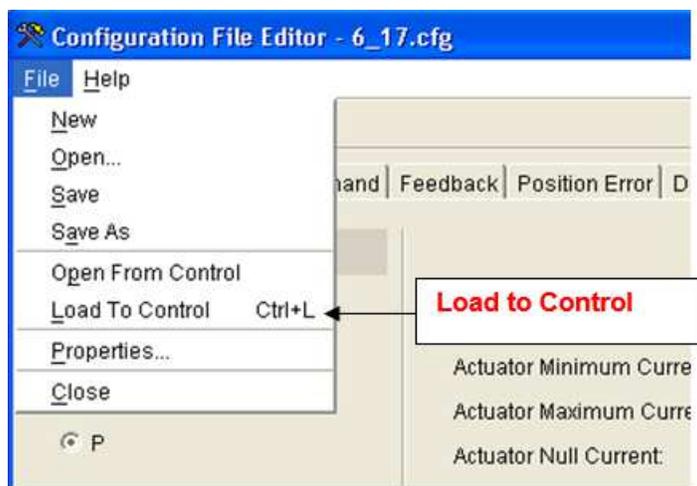


Figure 4-9. Loading Configuration File to the Control

After the configuration is loaded, the Configuration Identifier, which is displayed in the SPC Service Tool on the Overview Tab, will change to indicate the loaded configuration file name and time.

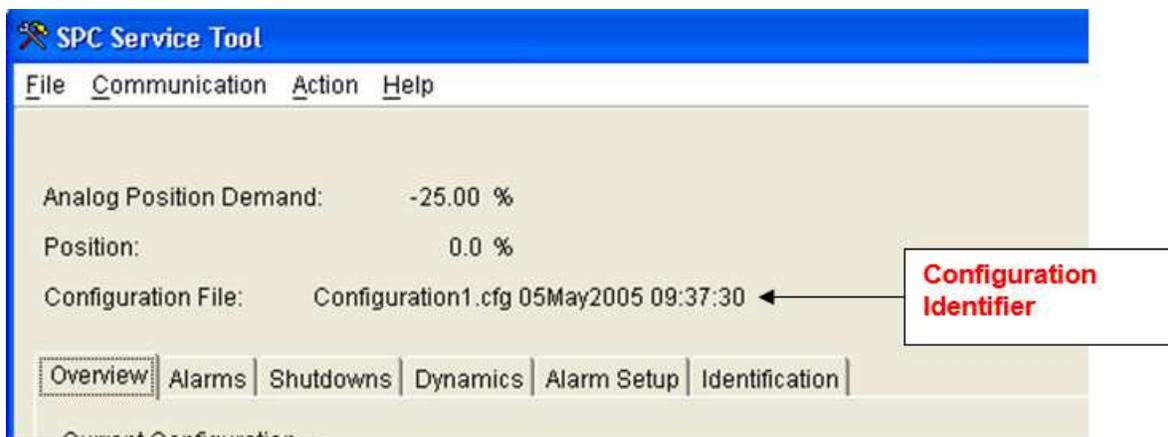


Figure 4-10. Identifying the Configuration File in the Control

Servo Controller Configuration

The controller type is selected according to the type of actuator and the type of servo controller desired. In general, the actuator's response to the input current will either be proportional or integrating. In a proportional actuator, position is proportional to the input current. In an integrating actuator, position rate-of-change is proportional to the input current. At a certain input current, called the null current, the integrating actuator position does not change.

Selecting a Controller

The controller type is selected on the **Servo Controller** page of the Configuration File Editor.

- Proportional actuators **must** use the Proportional controller.
- Integrating actuators use the P, PI, PI w/Lag, or PI w/Lead-Lag controllers.

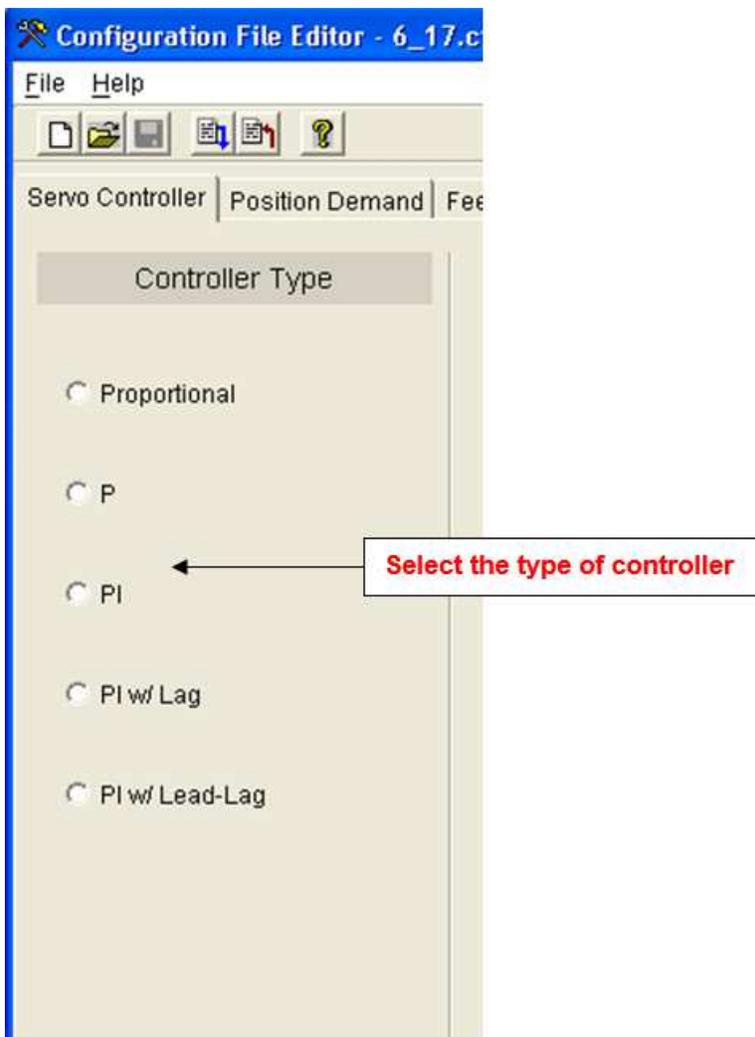


Figure 4-11. Selecting Type of Control

Five Different Controllers are Available:

- **Proportional Actuators**
Proportional
- **Integrating Actuators**
P
PI
PI w/Lag
PI w/Lead-Lag

Proportional—The proportional actuator controller uses a “command trim” scheme to reduce steady-state position errors in proportional actuators.

P—The P Controller provides the best stability. This control is the simplest controller, is very robust and works well for systems that aren’t very sensitive to position errors. Steady-state errors will exist if the Actuator Null Current value does not equal the actual null current of the actuator.

PI—The PI Controller will adapt best to small changes in the system. The PI controller is used in a majority of the applications (90 %+). Position feedback is forced to match position demand during steady-state operation.

PI w/Lag—The PI w/Lag controller is a PI controller with a lag block conditioning the demand signal. The lag term may be used to cancel, or partially cancel, a zero in the closed-loop transfer function. Tuning of this control is exactly the same as the PI control. **Use this control if you have a critical process which cannot tolerate overshoots.** *This control will limit actuator response, although the lag can be set to a low value to avoid excessive delay.*

PI w/Lead-Lag—The PI w/Lead/Lag controller is a PI controller with a lead/lag block conditioning the demand signal. Note that the lead-time constant is not entered directly, but is determined by the Lead Lag Ratio. Tuning this control is the same as the PI control. The lead/lag term may be used to set the actuator response to some ideal value. **The lead/lag may be used for increasing or decreasing the apparent bandwidth of the actuator thereby tailoring performance for the application.** *Of course, the control cannot force the actuator to exceed its physical limits, e.g., slew rate and dead time.*

Configuring and Adjusting a Proportional Control

(Figures 4-12 and 4-13)

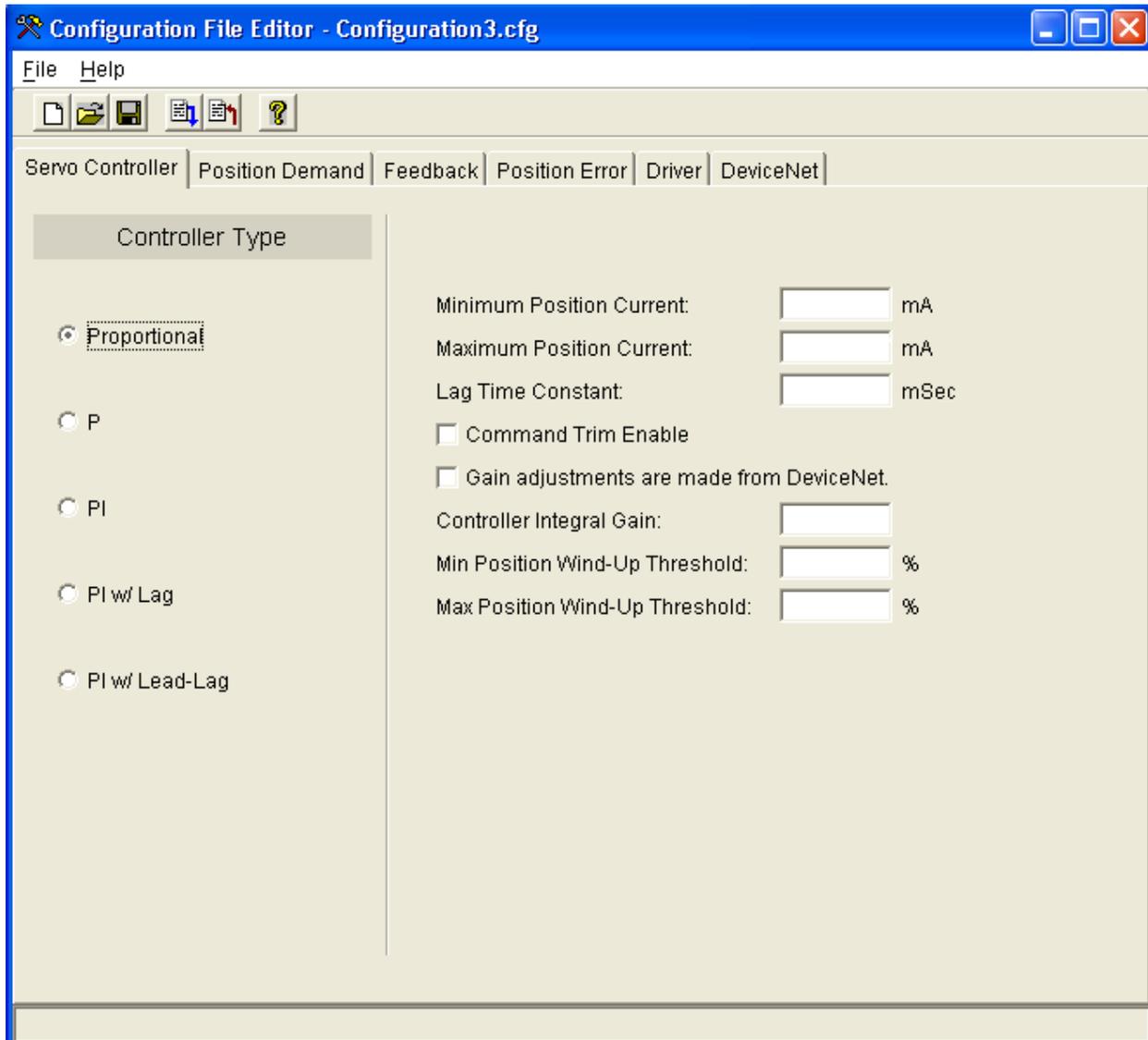


Figure 4-12. Proportional-Control Configuration Settings

Proportional—The proportional actuator controller uses a “command trim” scheme to reduce steady-state position errors in proportional actuators.

Minimum Position Current

The actuator current which corresponds to 0 % position demand.
Allowed Range: –250 mA to +250 mA

Maximum Position Current

The actuator current which corresponds to 100 % position demand.
Allowed Range: –250 mA to +250 mA

Lag Time Constant

The approximate actuator lag time.

Command Trim Enable check-box

When checked, an integrator trims the error between the position demand and the position feedback to zero, when not checked, position feedback is ignored and the current to the actuator is directly proportional to the demand input.

Gain Adjustments are made from DeviceNet or CANopen check-box

When checked, the Controller Integral Gain is updated over the DeviceNet or CANopen bus and cannot be modified by the service tool. When unchecked, the Controller Integral Gain may be modified by the service tool.

Controller Integral Gain

Integrator gain for the command trim function.

Min Position Wind-Up Threshold

Determines the region near the minimum stop where the integrator in the command trim function is turned off to avoid integrator wind-up. When the position demand moves below this value, the integrator is turned off. The integrator turns back on when the position demand exceeds 150 % of the threshold. When the Min Position Wind-Up Threshold is set to 0 % this function is disabled, and the integrator is always enabled regardless of the position demand value.

Allowed Range: 0 % to 10 %

Max Position Wind-Up Threshold

Determines the region near the maximum stop where the integrator in the command trim function is turned off to avoid integrator wind-up. When the position demand moves above this value, the integrator is turned off. The integrator turns back on when the position demand moves below (100 % demand—150 % of the threshold). When the Max Position Wind-Up Threshold is set to 100 % this function is disabled, and the integrator is always enabled regardless of the position demand value. Allowed Range: 90 % to 100 %

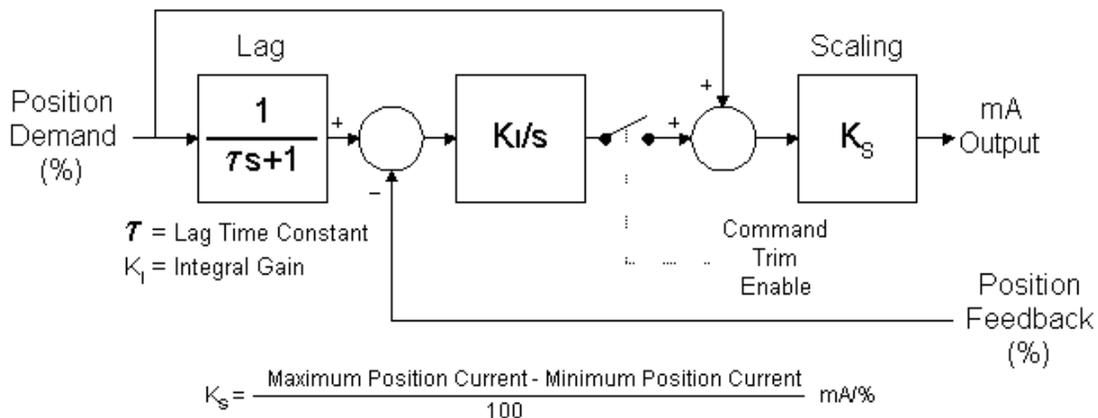


Figure 4-13. Proportional Control Structure

When command trim is not enabled, position feedback is ignored and the current to the actuator is directly proportional to the demand input. When command trim is enabled, an integrator trims the error between the position demand and the position feedback to zero. The output of the integrator is limited to $\pm 10\%$ of the range defined by Minimum Position Current and Maximum Position Current.

The command trim function is internally disabled if there is no valid feedback signal. When command trim is configured as disabled, position error faults are not generated.

The lag block reduces overshoot when the position demand changes faster than the actuator can respond. Ideally, the lag exactly matches the response of the actuator and therefore no change is required out of the K_i/s block.

An SPC adjusted to an under-damped condition will be more responsive with less gain margin. It is more susceptible to instability due to changes in the system.

An SPC adjusted to an over-damped condition will have slower response and better stability. It is less susceptible to instability due to changes in the system.

The ideal adjustment is a critically damped condition. This produces the best stability and response combination. Refer to Manual 83402 *PID Control* for additional information on tuning the control.

Configuring and Adjusting a P Control

(Figures 4-14 and 4-15)

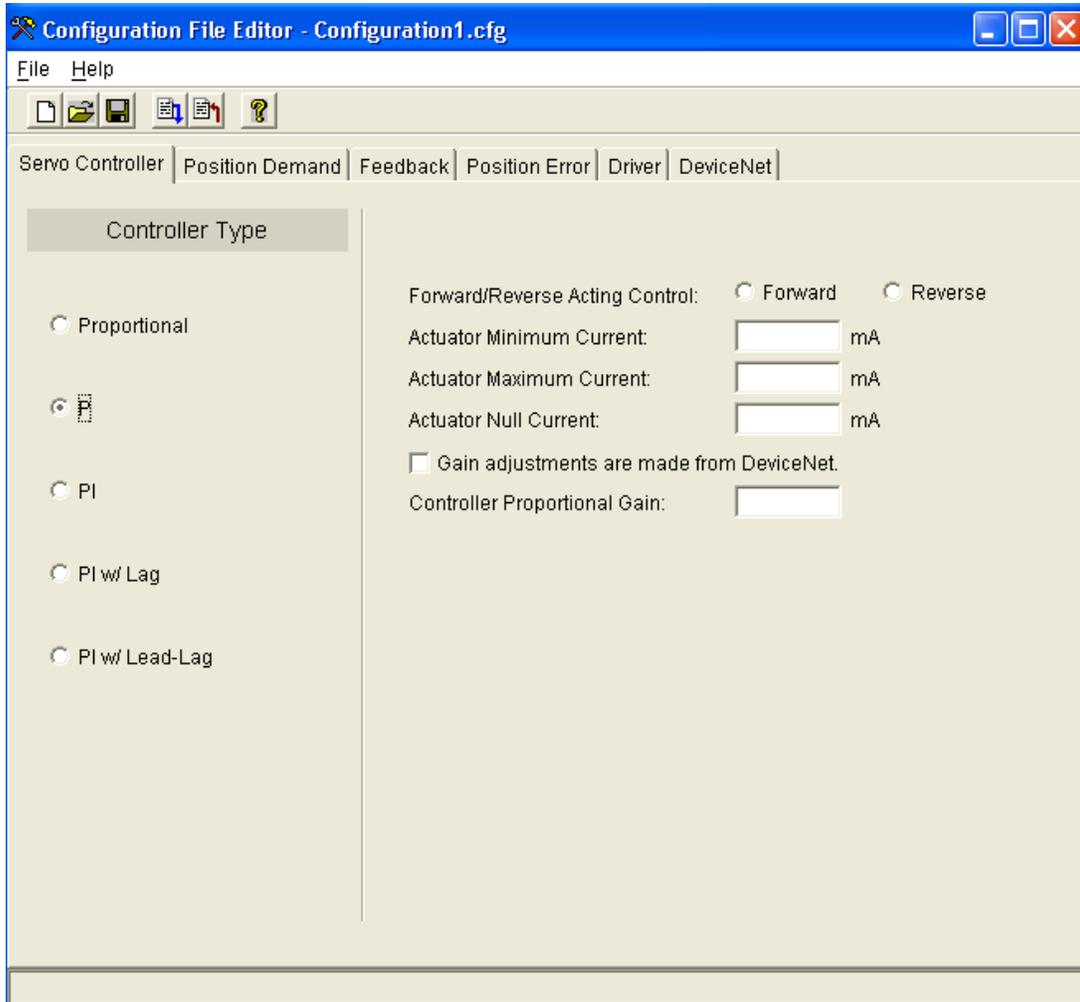


Figure 4-14. P-Control Configuration Settings

P—The P Controller provides the best stability. This control is the simplest controller, is very robust, and works well for systems that are not very sensitive to position errors. Steady-state errors will exist if the Actuator Null Current value does not equal the actual null current of the actuator.

Forward/Reverse Acting Control

This Control selects the sense of the error signal in the controller. For example, when the demanded position exceeds the actual position (positive error), a forward-acting controller drives the output more positive, while a reverse-acting controller drives the output more negative.

Actuator Minimum Current

Determines the most negative actuator current that can be output, and sets the scaling for the -100 % controller output point.

Allowed Range: -250 mA to +250 mA

Actuator Maximum Current

Determines the most positive actuator current that can be output, and sets the scaling for the 100 % controller output point.

Allowed Range: -250 mA to +250 mA

Actuator Null Current

Should be set equal to the actual null current of the actuator.

Allowed Range: Actuator Minimum Current to Actuator Maximum Current

Gain adjustments are made from DeviceNet or CANopen check-box

When checked, the Controller Proportional Gain is updated over the DeviceNet or CANopen bus and cannot be modified by the service tool. When unchecked, the Controller Proportional Gain may be modified by the service tool.

Controller Proportional Gain

Sets the proportional gain of the P control.

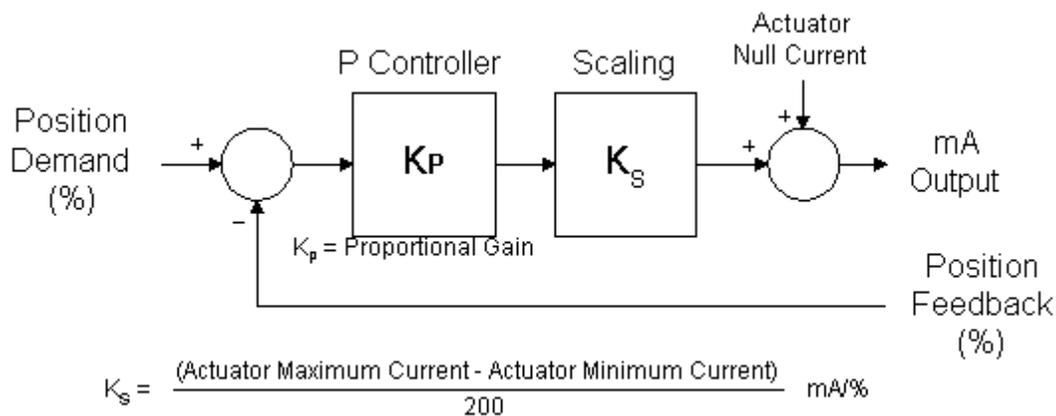


Figure 4-15. P Control Structure

Accomplish tuning by increasing the Proportional Gain until the actuator just starts to oscillate, then reducing the Proportional Gain by a factor of two.

An SPC adjusted to an under-damped condition will be more responsive with less gain margin. It is more susceptible to instability due to changes in the system.

An SPC adjusted to an over-damped condition will have slower response and better stability. It is less susceptible to instability due to changes in the system.

The ideal adjustment is a critically damped condition. This produces the best stability and response combination. Refer to Manual 83402 *PID Control* for additional information on tuning the control.

Configuring and Adjusting a PI Control

(Figures 4-16 and 4-17)

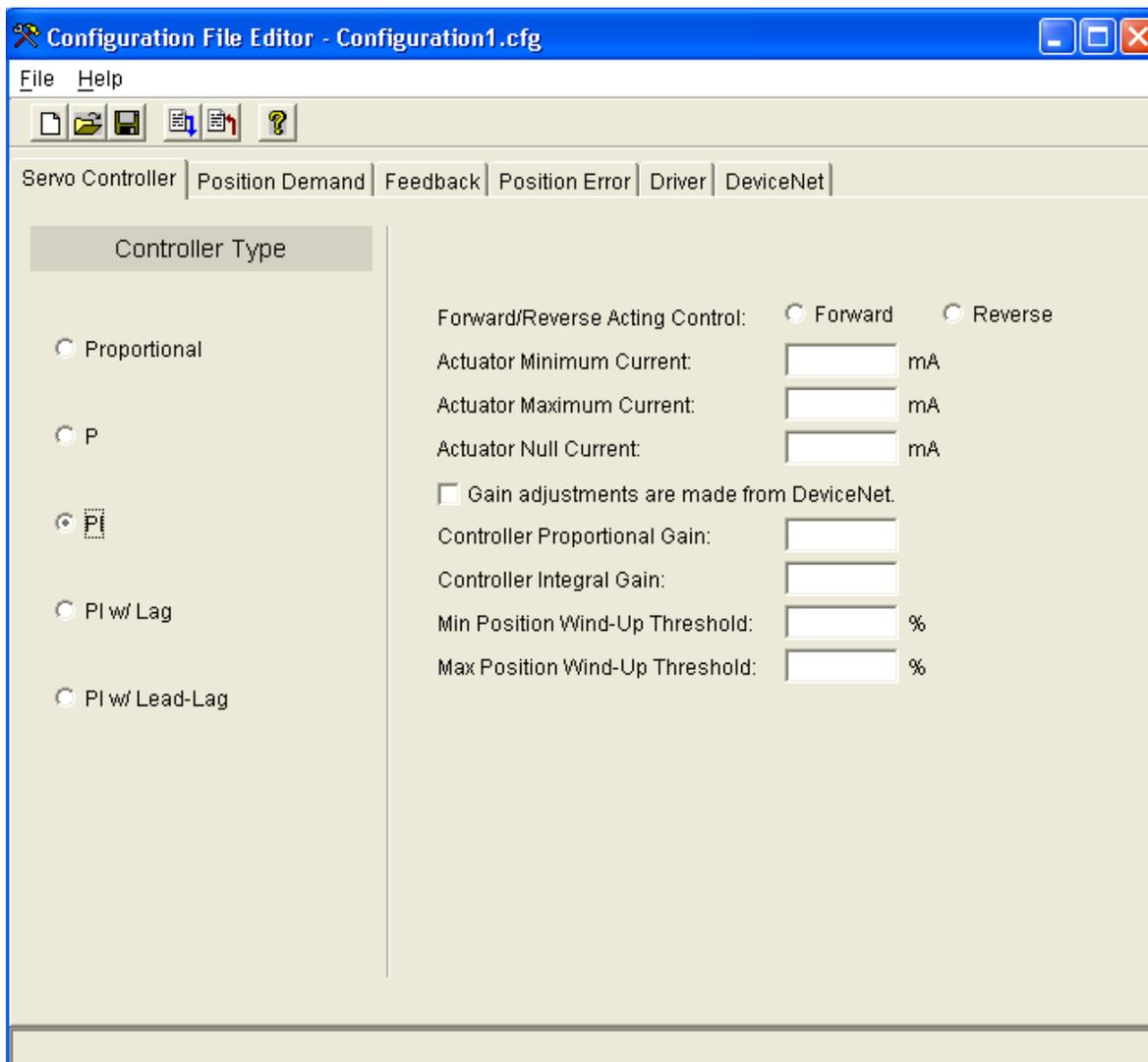


Figure 4-16. PI-Control Configuration Settings

PI—The PI Controller will adapt best to small changes in the system. The PI controller is used in a majority of the applications (90 %+). Position feedback is forced to match position demand during steady-state operation.

Forward/Reverse Acting Control

Selects the sense of the error signal in the controller. For example, when the demanded position exceeds the actual position (positive error), a forward-acting controller drives the output more positive, while a reverse-acting controller drives the output more negative.

Actuator Minimum Current

Determines the most negative actuator current that can be output, and sets the scaling for the -100 % controller output point.

Allowed Range: -250 mA to +250 mA

Actuator Maximum Current

Determines the most positive actuator current that can be output, and sets the scaling for the 100 % controller output point.

Allowed Range: -250 mA to +250 mA

Actuator Null Current

Should be set equal to the actual null current of the actuator.

Allowed Range: Actuator Minimum Current to Actuator Maximum Current.

Gain Adjustments are made from DeviceNet or CANopen check box

When checked, the Controller Integral Gain is updated over the DeviceNet or CANopen bus and cannot be modified by the service tool. When unchecked, the Controller Integral Gain may be modified by the service tool.

Controller Proportional Gain

Sets the proportional gain or 'P' term of the PI control.

Controller Integral Gain

Sets the integral gain or "I" term of the PI control.

Min Position Wind-Up Threshold

Determines the region near the minimum stop where the integrator is turned off to avoid integrator wind-up. When the position demand moves below this value, the integrator is turned off. The integrator turns back on when the position demand exceeds 150 % of the threshold. When the Min Position Wind-Up Threshold is set to 0 % this function is disabled, and the integrator is always enabled regardless of the position demand value. Set the Min Position Wind-Up Threshold as close as possible to the minimum operating point. (Typically set at 1 % above the Minimum Position)

Allowed Range: 0 % to 10 %

Max Position Wind-Up Threshold

Determines the region near the maximum stop where the integrator is turned off to avoid integrator wind-up. When the position demand moves above this value, the integrator is turned off. The integrator turns back on when the position demand moves below (100 % demand - 150 % of the threshold). When the Max Position Wind-Up Threshold is set to 100 % this function is disabled, and the integrator is always enabled regardless of the position demand value. Set the Max Position Wind-Up Threshold as close as possible to the maximum operating point. (Typically set at 1 % below the Maximum Position)

Allowed Range: 90 % to 100 %

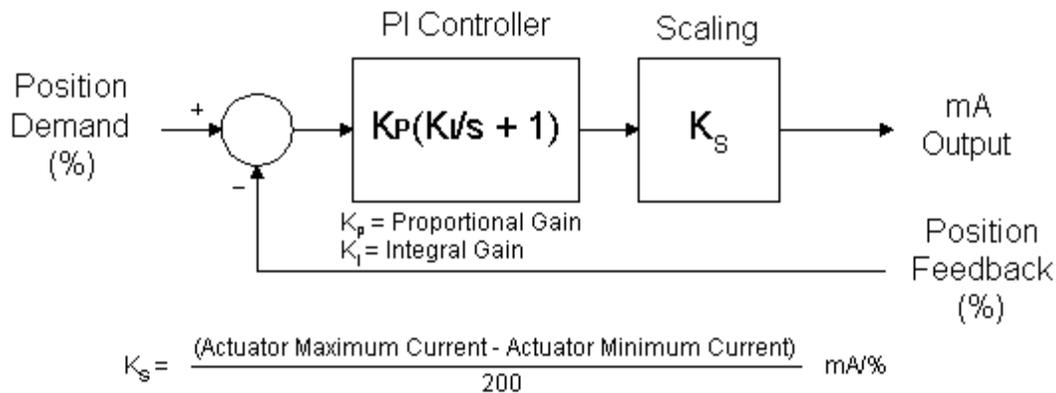


Figure 4-17. PI Control Structure

The following procedure may be used as a starting point to finding the optimal dynamic settings:

1. Adjust Controller Integral Gain to a minimum value.
2. Increase Controller Proportional Gain until the actuator just starts to oscillate. Record the Period of the oscillation (Posc) and Controller Proportional Gain (Kosc).
3. Set Controller Proportional Gain $0.45 * K_{osc}$ and Controller Integral Gain $1.2/Posc$.

This gives stable response. Test the actuator response and further refine the tuning until the desired performance is obtained.

An SPC adjusted to an under-damped condition will be more responsive with less gain margin. It is more susceptible to instability due to changes in the system.

An SPC adjusted to an over-damped condition will have slower response and better stability. It is less susceptible to instability due to changes in the system.

The ideal adjustment is a critically damped condition. This produces the best stability and response combination. Refer to Manual 83402 *PID Control* for additional information on tuning the control.

Configuring and Adjusting a PI w/Lag Control

(Figures 4-18 and 4-19)

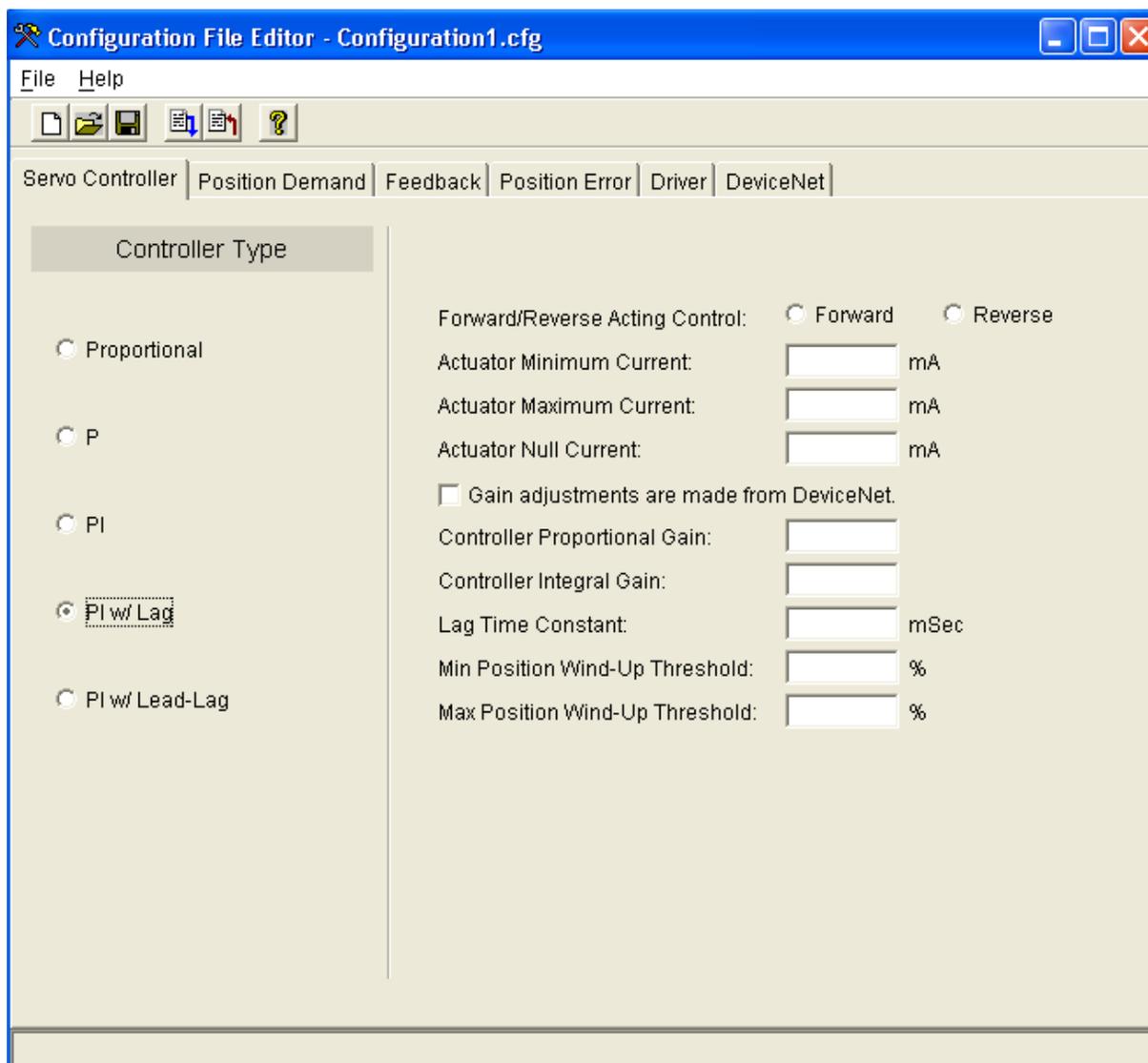


Figure 4-18. PI with Lag-Control Configuration Settings

PI w/Lag—The PI w/Lag controller is a PI controller with a lag block conditioning the demand signal. The lag term may be used to cancel, or partially cancel, a zero in the closed-loop transfer function. Tuning of this control is exactly the same as the PI control. **Use this control if you have a critical process which cannot tolerate overshoots.** *This control will limit actuator response although the lag can be set to a low value to avoid excessive delay.*

Forward/Reverse Acting Control

Selects the sense of the error signal in the controller. For example, when the demanded position exceeds the actual position (positive error), a forward-acting controller drives the output more positive, while a reverse-acting controller drives the output more negative.

Actuator Minimum Current

Determines the most negative actuator current that can be output, and sets the scaling for the -100 % controller output point.

Allowed Range: -250 mA to +250 mA

Actuator Maximum Current

Determines the most positive actuator current that can be output, and sets the scaling for the 100 % controller output point.

Allowed Range: -250 mA to +250 mA

Gain Adjustments are made from DeviceNet or CANopen check box

When checked, the Controller Integral Gain is updated over the DeviceNet or CANopen bus and cannot be modified by the service tool. When unchecked, the Controller Integral Gain may be modified by the service tool.

Controller Proportional Gain

Sets the proportional gain or "P" term of the PI control.

Controller Integral Gain

Sets the integral gain or "I" term of the PI control.

Lag Time Constant

Sets the time constant of the lag block on the position demand input.

Min Position Wind-Up Threshold

Determines the region near the minimum stop where the integrator is turned off to avoid integrator wind-up. When the position demand moves below this value, the integrator is turned off. The integrator turns back on when the position demand exceeds 150 % of the threshold. When the Min Position Wind-Up Threshold is set to 0 % this function is disabled, and the integrator is always enabled regardless of the position demand value. Set the Min Position Wind-Up Threshold as close as possible to the minimum operating point. (Typically set at 1 % above the Minimum Position)

Allowed Range: 0 % to 10 %

Max Position Wind-Up Threshold

Determines the region near the maximum stop where the integrator is turned off to avoid integrator wind-up. When the position demand moves above this value, the integrator is turned off. The integrator turns back on when the position demand moves below (100 % demand - 150 % of the threshold). When the Max Position Wind-Up Threshold is set to 100 % this function is disabled, and the integrator is always enabled regardless of the position demand value. Set the Max Position Wind-Up Threshold as close as possible to the maximum operating point. (Typically set at 1 % below the Maximum Position)

Allowed Range: 90 % to 100 %

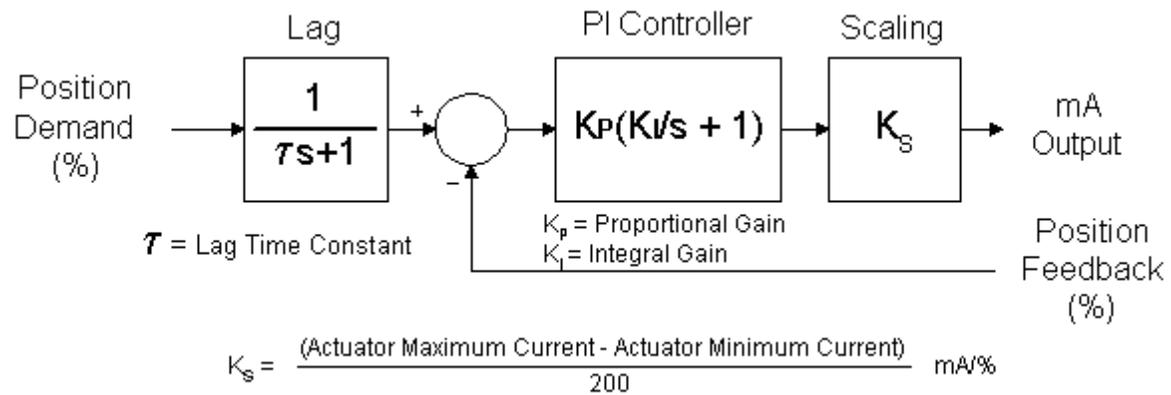


Figure 4-19. PI w/Lag Control Structure

The following procedure may be used as a starting point to finding the optimal dynamic settings:

1. Adjust Controller Integral Gain to a minimum value.
2. Increase Controller Proportional Gain until the actuator just starts to oscillate. Record the Period of the oscillation (Pose) and Controller Proportional Gain (Kosc).
3. Set Controller Proportional Gain = $0.45 K_{osc}$ and Controller Integral Gain = $1.2/P_{osc}$.

This gives stable response. Test the actuator response and further refine the tuning until the desired performance is obtained.

An SPC adjusted to an under-damped condition will be more responsive with less gain margin. It is more susceptible to instability due to changes in the system.

An SPC adjusted to an over-damped condition will have slower response and better stability. It is less susceptible to instability due to changes in the system.

The ideal adjustment is a critically damped condition. This produces the best stability and response combination. Refer to Manual 83402 *PID Control* for additional information on tuning the control.

Configuring and Adjusting a PI w/Lead-Lag Control

(Figures 4-20 and 4-21)

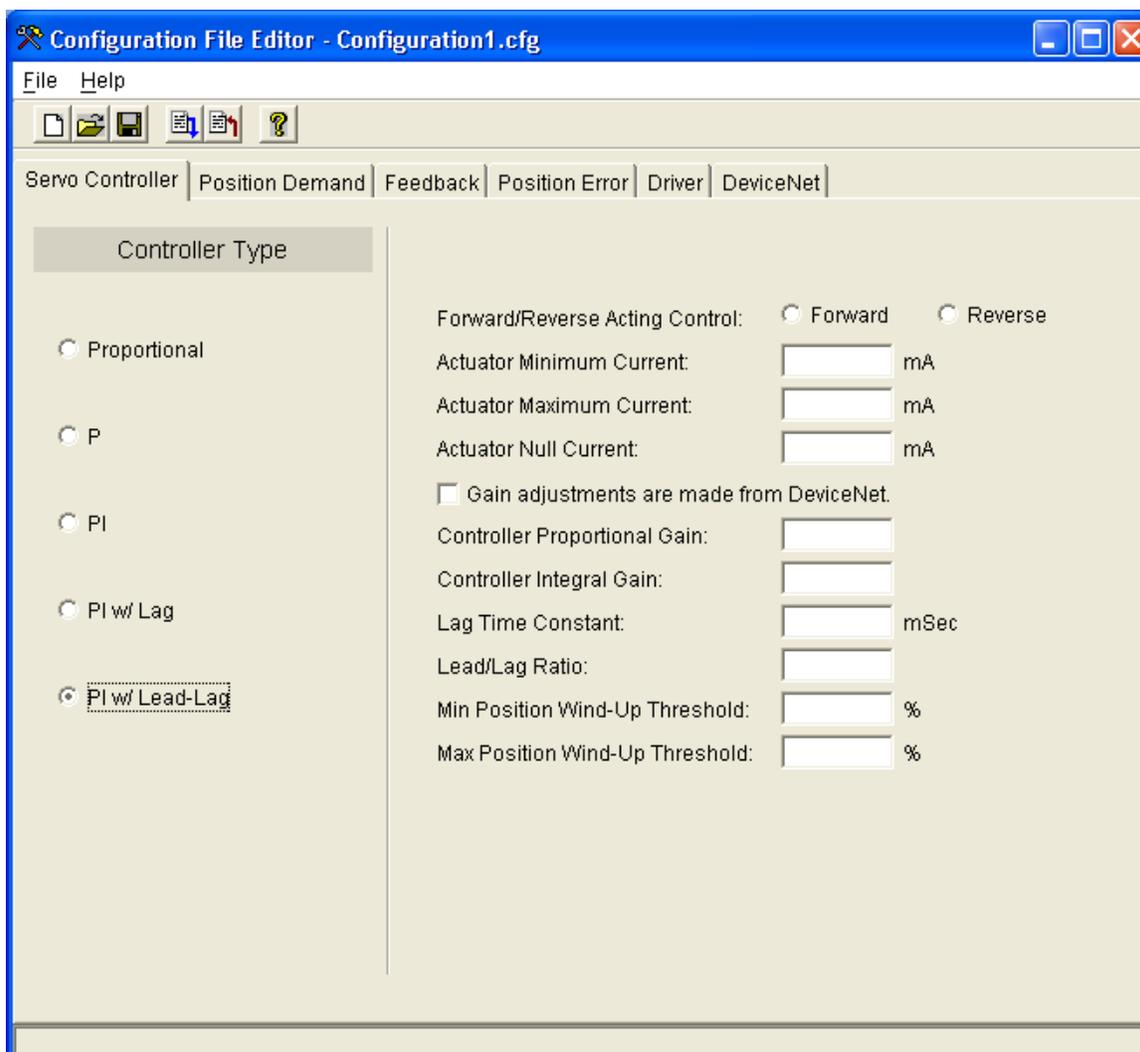


Figure 4-20. PI with Lead-Lag Control Configuration Settings

PI w/Lead-Lag—The PI w/Lead/Lag controller is a PI controller with a lead/lag block conditioning the demand signal. Note that the lead-time constant is not entered directly, but is determined by the Lead Lag Ratio. Tuning this control is the same as the PI control. The lead/lag term may be used to set the actuator response to some ideal value. **The lead/lag may be used for increasing or decreasing the apparent bandwidth of the actuator thereby tailoring performance for the application.** *Of course, the control cannot force the actuator to exceed its physical limits, e.g., slew rate and dead time.*

Forward/Reverse Acting Control

Selects the sense of the error signal in the controller. For example, when the demanded position exceeds the actual position (positive error), a forward-acting controller drives the output more positive, while a reverse-acting controller drives the output more negative.

Actuator Minimum Current

Determines the most negative actuator current that can be output, and sets the scaling for the -100 % controller output point.

Allowed Range: -250 mA to +250 mA

Actuator Maximum Current

Determines the most positive actuator current that can be output, and sets the scaling for the 100 % controller output point.

Allowed Range: -250 mA to +250 mA

Gain Adjustments are made from DeviceNet or CANopen check box

When checked, the Controller Integral Gain is updated over the DeviceNet or CANopen bus and cannot be modified by the service tool. When unchecked, the Controller Integral Gain may be modified by the service tool.

Controller Proportional Gain

Sets the proportional gain or “P” term of the PI control.

Controller Integral Gain

Sets the integral gain or “I” term of the PI control.

Lag Time Constant

Sets the time constant of the lag block on the position demand input.

Lead/Lag Ratio

Sets the lead-time constant to lag time constant ratio of the lead-lag block on the position demand input.

Min Position Wind-Up Threshold

Determines the region near the minimum stop where the integrator is turned off to avoid integrator wind-up. When the position demand moves below this value, the integrator is turned off. The integrator turns back on when the position demand exceeds 150 % of the threshold. When the Min Position Wind-Up Threshold is set to 0 % this function is disabled, and the integrator is always enabled regardless of the position demand value. Set the Min Position Wind-Up Threshold as close as possible to the minimum operating point. (Typically set at 1 % above the Minimum Position)

Allowed Range: 0 % to 10 %

Max Position Wind-Up Threshold

Determines the region near the maximum stop where the integrator is turned off to avoid integrator wind-up. When the position demand moves above this value, the integrator is turned off. The integrator turns back on when the position demand moves below (100 % demand - 150 % of the threshold). When the Max Position Wind-Up Threshold is set to 100 % this function is disabled, and the integrator is always enabled regardless of the position demand value. Set the Max Position Wind-Up Threshold as close as possible to the maximum operating point. (Typically set at 1 % below the Maximum Position)

Allowed Range: 90 % to 100 %

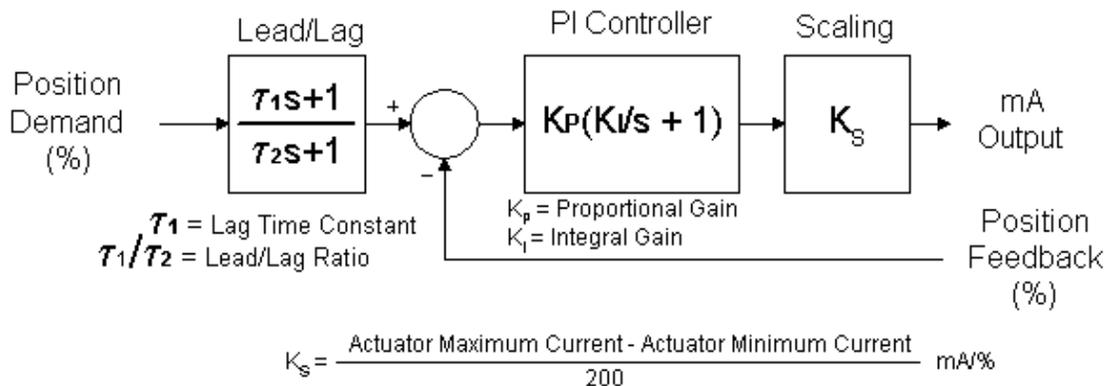


Figure 4-21. PI w/Lead-Lag Structure

The following procedure may be used as a starting point to finding the optimal dynamic settings:

1. Adjust Controller Integral Gain to a minimum value.
2. Increase Controller Proportional Gain until the actuator just starts to oscillate. Record the Period of the oscillation (Posc) and Controller Proportional Gain (Kosc).
3. Set Controller Proportional Gain = 0.45 Kosc and Controller Integral Gain = $1.2/\text{Posc}$.

This gives stable response. Test the actuator response and further refine the tuning until the desired performance is obtained.

An SPC adjusted to an under-damped condition will be more responsive with less gain margin. It is more susceptible to instability due to changes in the system.

An SPC adjusted to an over-damped condition will have slower response and better stability. It is less susceptible to instability due to changes in the system.

The ideal adjustment is a critically damped condition. This produces the best stability and response combination. Refer to Manual 83402 *PID Control* for additional information on tuning the control.

Configuring the Position Demand Source

The position demand source is selected on the **Position Demand** page of the Configuration File Editor.

The SPC can be configured as follows for the Position Demand Source.

Digital Control Only

- The SPC Position Demand is received via the DeviceNet or CANopen bus.

Digital Control Primary

- The SPC position demand is received via the DeviceNet or CANopen bus. The Analog Demand is used as backup.

Analog Only

- The SPC position demand is received on the Analog Demand Input.

Analog Primary

- The SPC position demand is received on the Analog Demand Input and uses the DeviceNet or CANopen bus as the backup.

Operation with Two Position Demand Sources

The SPC uses the following method to determine which position demand source to use when both sources are configured:

- If one source has failed and the other source is functional, use the functional source.
- If using the secondary source because the primary source failed, and the primary source becomes functional, switch back to the primary source IF:
 - The two sources match each other within a configurable amount, and
 - The primary source has been functional for at least five seconds continuously

Digital Control Only

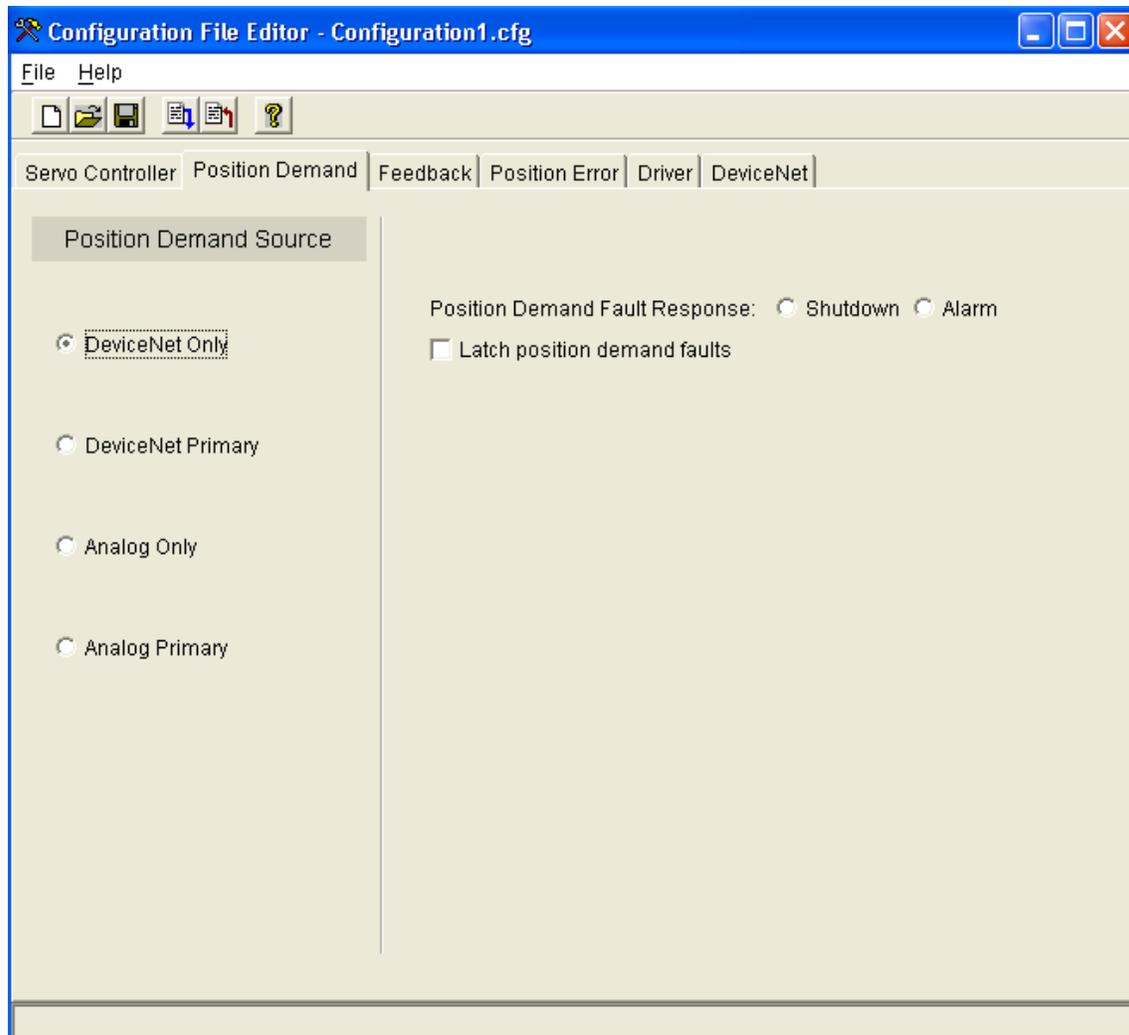


Figure 4-22. Position Demand DeviceNet or CANopen Only

DeviceNet or CANopen Only—The SPC position demand is received on the DeviceNet or CANopen bus.

Position Demand Fault Response

Select Position Demand Fault to respond as an alarm or shutdown.

Latch position demand fault check-box

Check this box if position demand faults should be latched.

Digital Control Primary

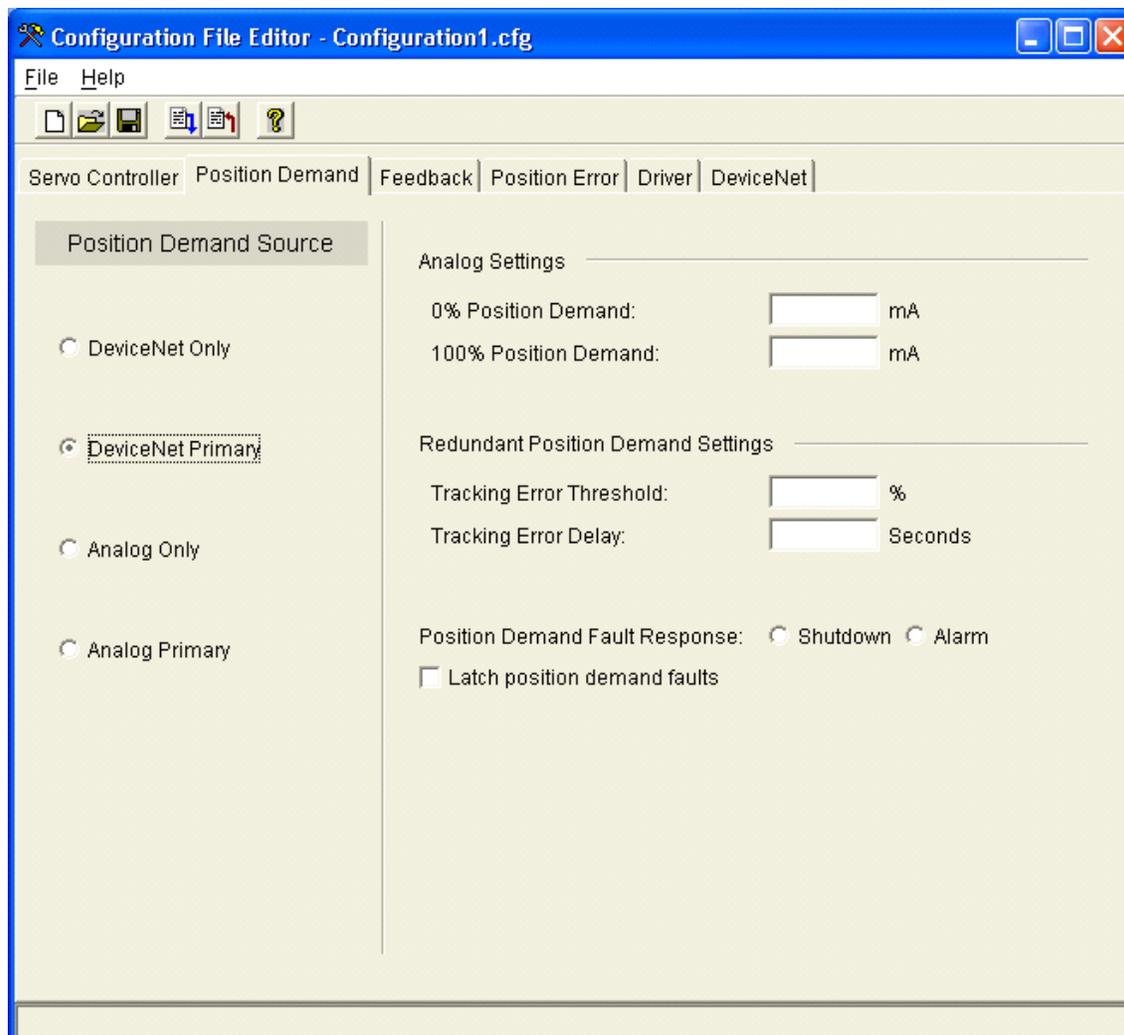


Figure 4-23. Position Demand DeviceNet or CANopen Primary

DeviceNet or CANopen Primary—The SPC position demand is received on the DeviceNet or CANopen bus, and uses the Analog Demand Input as a backup.

Analog 0 % Position Demand

mA value that represents 0 % position demand on the Analog Demand Input.

Analog 100 % Position Demand

mA value that represents 100 % position demand on the Analog Demand Input.

**WARNING**

All SPCs configured for redundant input (CAN/Analog, DeviceNet/Analog or Analog/Analog) must be configured for Fault Response = Shutdown. Please see the SPC Calibration section.

Redundant Demand Settings

Tracking Error Threshold

Threshold for the Position Demand Tracking alarm.

Tracking Error Delay

Delay time for the Position Demand Tracking alarm.

Position Demand Fault Response

Select Position Demand Fault to respond as an alarm or shutdown.

Latch Position Demand Fault Check Box

Check this box if position demand faults should be latched.

Analog Only

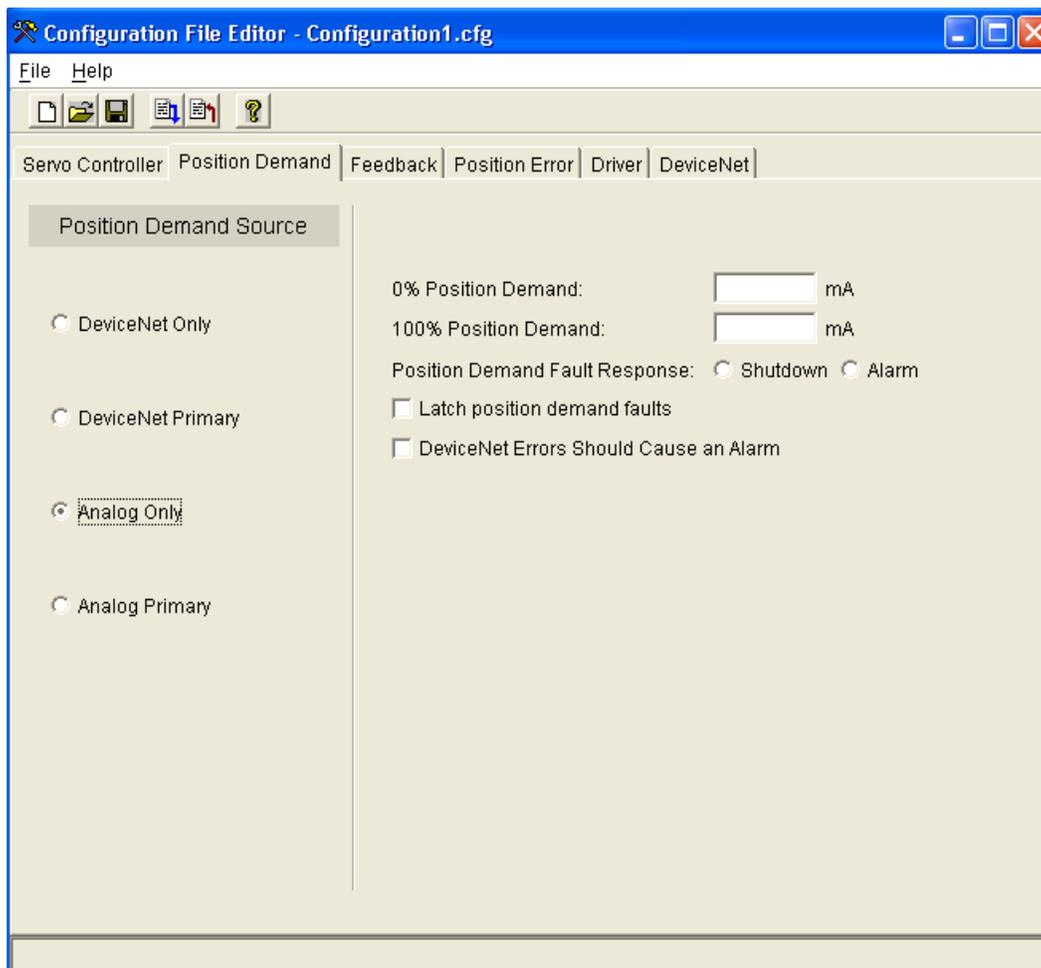


Figure 4-24. Position Demand Analog Only

Analog Only—The SPC position demand is received on the Analog Demand Input.

0 % Position Demand

mA value that represents 0 % position demand on the Analog Demand Input.

100 % Position Demand

mA value that represents 100 % position demand on the Analog Demand Input.

Position Demand Fault Response

Select Position Demand Fault to respond as an alarm or shutdown.

Latch position demand fault check box

Check this box if position demand faults should be latched.

Analog Primary

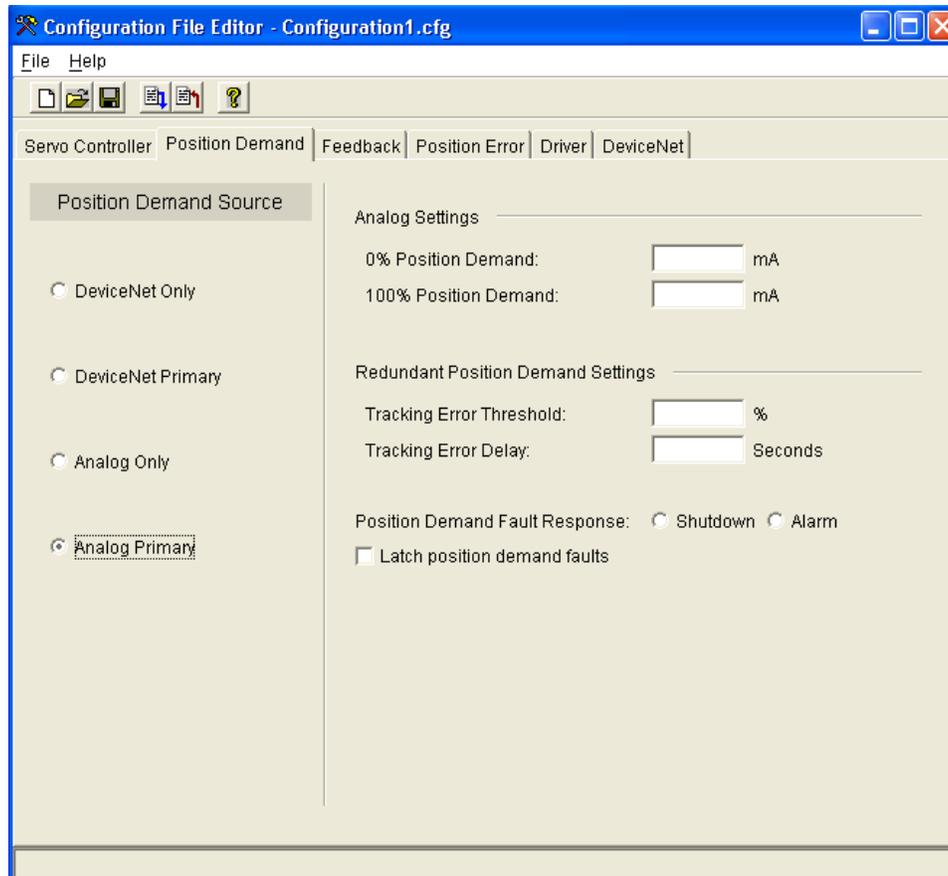


Figure 4-25. Position Demand Analog Primary

Analog Primary—The SPC position demand is received on the Analog Demand Input and uses the DeviceNet or CANopen bus as a backup.

0 % Position Demand

mA value that represents 0 % position demand on the Analog Demand Input.

100 % Position Demand

mA value that represents 100 % position demand on the Analog Demand Input.

Redundant Demand Settings

Tracking Error Threshold

Threshold for the Position Demand Tracking alarm.

Tracking Error Delay

Delay time for the Position Demand Tracking alarm.

Position Demand Fault Response

Select Position Demand Fault to respond as an alarm or shutdown.

Latch position demand fault check box

Check this box if position demand faults should be latched.

Position Feedback Device Configuration

The position feedback devices are selected on the Feedback page of the Configuration File Editor. Read the general information on the type of transducer being used before configuring the feedback:

The SPC accepts position feedback signals from one or two (0 to 10) V output transducers, RVDTs, or LVDTs, or from a single (4 to 20) mA transducer. Refer to the SPC Plant Wiring Diagrams found in Chapter 2 for detailed information on connecting feedback devices to the SPC.

Operation with Redundant Position Feedback Devices

When Configured for dual position feedback devices, the SPC uses the following method to determine the position feedback:

- If either input has failed, use the functional input
- If both inputs are functional:
 - If a tracking fault does not exist, use the weighted average of the two inputs.
 - If a tracking fault exists, use the higher or lower of the two positions according to the configuration.
- Configuring Feedback 1 and Feedback 2

NOTICE

Weighted average logic is available only on the CANopen SPC version. Default weight value is 0.5 and can be adjusted via CAN interface. For the DeviceNet device version constant 0.5 weight is applied for both feedback inputs.

(4 to 20) mA— Position feedback is provided by a (4 to 20) mA output transducer. **Feedback 2 is automatically set to Not Used.**

A Only— Position feedback is provided by a 3-wire or 4-wire RVDT or LVDT. Position feedback may be a (0 to 10) V (dc) transducer.

A–B— Position feedback is provided by a 5-wire or 6-wire RVDT or LVDT whose output type is A–B.

(A–B)/(A+B)— Position feedback is provided by a 5-wire or 6-wire RVDT or LVDT whose output type is (A–B)/(A+B).

DC Voltage—Position feedback is provided by a device that provides a dc voltage proportional to position.

Not Used— *This must be selected for Feedback 2 if the (4 to 20) mA is not selected and there is only one feedback device connected to the SPC.* If Feedback 2 is used, the Redundant Feedback Settings appear.

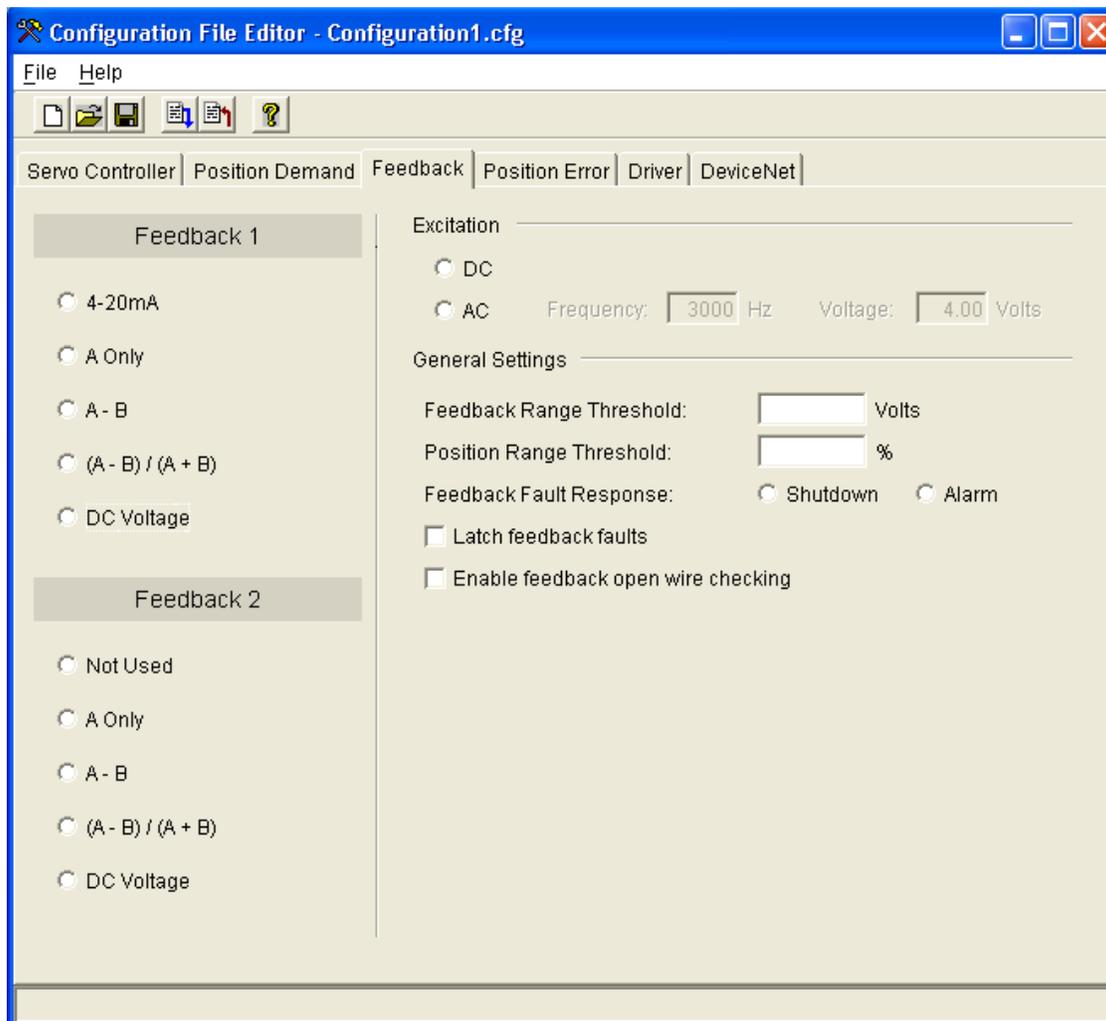


Figure 4-26. Position Feedback Configuration

(4 to 20) mA Position Feedback Devices

There are a variety of position feedback devices available having a (4 to 20) mA current output. When the SPC is configured for a (4 to 20) mA transducer, an external 18 V (dc) power supply will be required to power the transducer.

The output of the transducer need not equal exactly 4 mA and 20 mA at the ends of the actuator stroke, because the SPC will be calibrated to the transducer. The transducer current does not have to increase with position, for example, the output could be 20 mA at minimum position and 4 mA at maximum position.

(0 to 10) V (dc) Position Feedback Devices

The SPC accepts position transducers with dc voltage outputs. The exciter output can be configured to provide 18 V (dc) at the exciter output for powering transducers that require an external power source.

The output of the transducer need not equal exactly 0 V (dc) and 10 V (dc) at the ends of the actuator stroke, because the SPC will be calibrated to the transducer. In fact, it is desirable for the output of the transducer to not reach 0 V (dc) to facilitate checking the transducer health via the Feedback 1 Range Fault or Feedback 2 Range Fault. The transducer voltage does not have to increase with position, for example, the output could be 8 V (dc) at minimum position and 2 V (dc) at maximum position.

RVDT and LVDT Information

(Figures 4-27 through 4-30)

LVDTs (Linear Variable Differential Transformers) and RVDTs (Rotary Variable Differential Transformers) are transformers whose output voltage is linearly proportional to the position of their movable core. An LVDT measures linear position and an RVDT measures angular position.

The SPC provides excitation for the primary winding of the device. The amplitude and frequency of the exciter are configurable.

Types

LVDTs and RVDTs are constructed in various configurations. All will have one pair of input wires to be connected to the SPC excitation output. There may be anywhere from one to four output wires requiring connection to the SPC RVDT/LVDT inputs. In this document, the “n” in “n-wire device” refers to the total number of device wires.

In order to properly configure the SPC, the user must understand how the signals from the transducer are to be interpreted. For devices with two output coils, consult the device manufacturer’s documentation to determine what the input-to-output transfer characteristic is. The SPC uses the convention of assigning the letters “A” and “B” to the output coils.

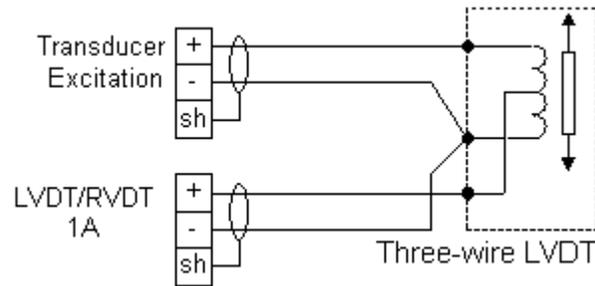


Figure 4-27. 3-wire Device

Three-wire devices have no primary-to-secondary isolation, which prevents the SPC open-wire detection circuit from functioning properly. The “Enable feedback open-wire checking” check box should be unchecked to avoid nuisance Feedback Open Faults.

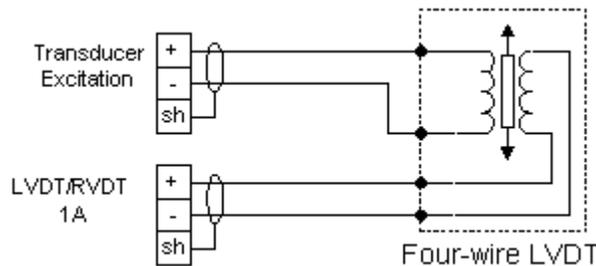


Figure 4-28. 4-wire Device

For the SPC, “+” and “-” designations are arbitrary, and polarity or phase markings on the device can be ignored. Take care with 4-wire devices; however, as **the output voltage must not pass through zero volts within the normal actuator stroke**. Four-wire devices are often constructed with two output coils wired together internally.

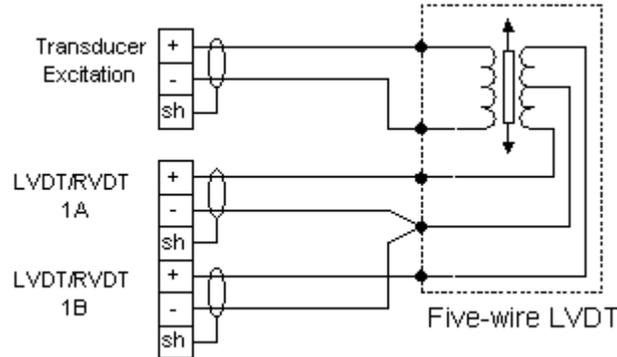


Figure 4-29. 5-wire Device

For the SPC, “+” and “-” designations for the exciter are arbitrary. The (-) side of feedbacks 1A and 1B (or 2A and 2B) should be tied to the output center tap as shown. **The device manufacturer’s documentation should be consulted to determine the output type.** In the SPC, “A-B” denotes a transducer with a simple difference output. “(A-B)/(A+B)” denotes a difference-over-sum, or constant-sum output. This type of output is sometimes represented by the symbol below:

$$\Delta \text{ or } \Delta/\Sigma$$

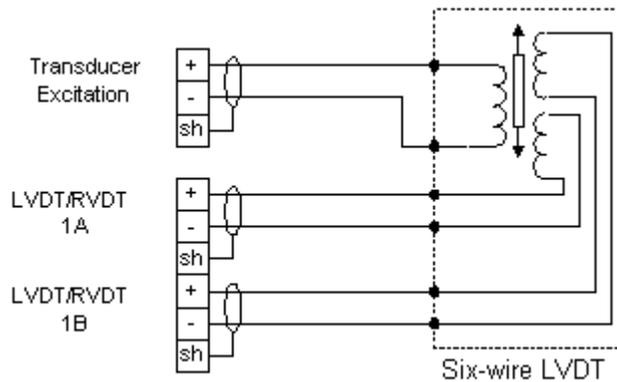


Figure 4-30. 6-wire Device

For the SPC, “+” and “-” designations are arbitrary, and polarity or phase markings on the device can be ignored. Consult the device manufacturer’s documentation to determine the output type. In the SPC, “A-B” denotes a transducer with a simple difference output. “(A-B)/(A+B)” denotes a difference-over-sum, or constant-sum output. This type of output is sometimes represented by the symbol below:

$$\Delta \text{ or } \Delta/\Sigma$$

(4 to 20) mA Feedback Configuration Settings

Position Feedback is provided by a (4 to 20) mA output transducer. Feedback 2 is automatically set to “Not Used”.

Feedback Range Fault

Determines limits for the Feedback 1 Range Fault and Feedback 2 Range Fault.

Feedback Fault Response

Determines whether the Feedback Fault shutdown is alarm or shutdown.

Latch Feedback Fault check box

Determines whether the Position 1 Range Fault and Feedback Fault shutdown are latching or non-latching.

A, A–B, (A–B)/(A+B), DC Voltage Configuration Settings**AC or DC Excitation Selection**

Set to AC for RVDTs and LVDTs. If using a transducer that produces a DC output voltage, selecting DC provides an 18 V (dc) output that may be used for transducer power if required.

Frequency

Exciter output frequency.
Allowed range: (1000 to 5000) Hz

Voltage

Exciter output voltage.
Allowed range: (4 to 10) V (rms)

IMPORTANT

Excitation values above 8 V (rms) are intended for transducers with low gain. The SPC RVDT/LVDT inputs accept 8 V (rms) maximum. When using higher gain devices, setting the excitation voltage higher than 8 V (rms) may cause the maximum RVDT/LVDT input voltage to be exceeded.

Feedback Range Threshold

Determines limits for the Feedback 1 Range Fault and Feedback 2 Range Fault.

Feedback Fault Response

Determines whether the Feedback Fault shutdown is used. If set to “alarm”, Feedback Fault is not displayed and only specific feedback faults such as Feedback 1 Open Fault appear on the Alarms and Shutdowns screen.

Latch feedback fault check box

Determines whether feedback faults are latching or non-latching. The affected feedback faults are Excitation Fault Feedback Fault, Feedback 1 Open Fault, Feedback 2 Open Fault, Feedback 1 Range Fault, Feedback 2 Range Fault, Feedback Tracking Fault 1, and Feedback Tracking Fault 2.

Enable feedback open wire checking check box

Check to enable Feedback 1 Open Fault and Feedback 2 Open Fault. The open-wire check is intended for transducers with isolated outputs only.

If Feedback 2 is used, the Redundant Feedback Settings must also be configured.

Position Error Configuration

The SPC continuously compares the position demand to the position feedback and generates position error faults if they do not match. The SPC implements two separate position error faults with independent thresholds and delays. Position Error Fault 1 is an alarm, and Position Error Fault 2 can be configured to be an alarm or shutdown. The position error settings are entered on the Position Error page of the Configuration File Editor.

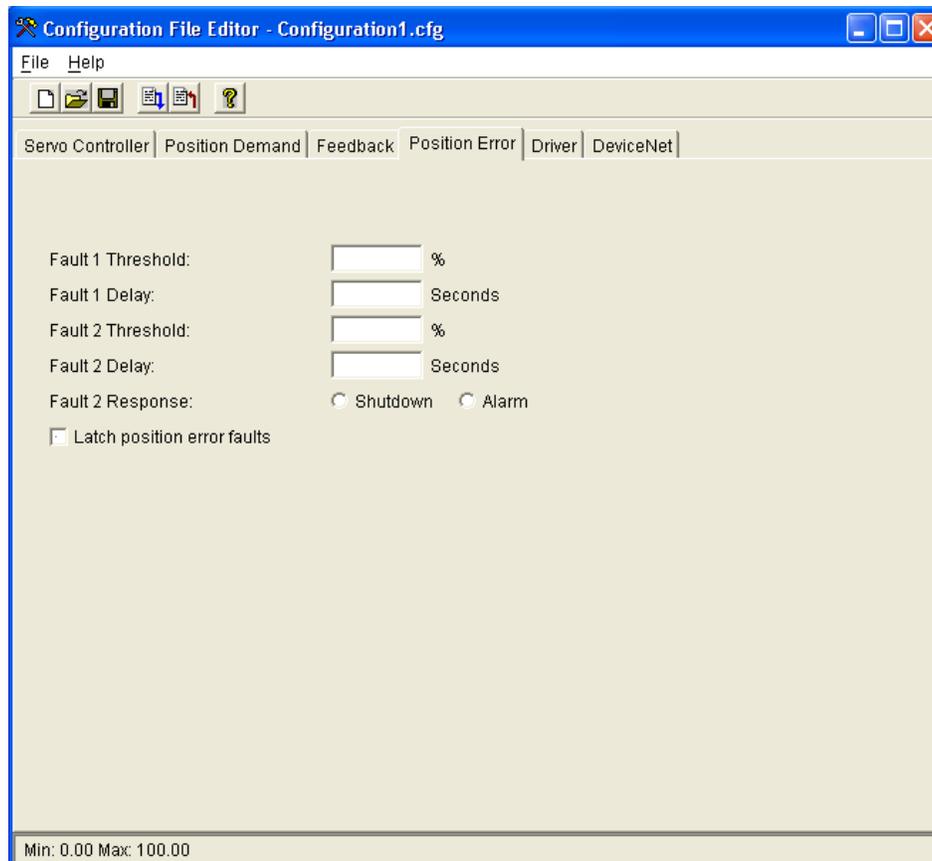


Figure 4-31. Position Error Settings

Fault 1 Threshold

Threshold for Position Error Fault 1.

Fault 1 Delay

Delay time for Position Error Fault 1.

Fault 2 Threshold

Threshold for Position Error Fault 2.

Fault 2 Delay

Delay time for Position Error Fault 2.

Fault 2 Response

Determines whether Position Error Fault 2 is an alarm or a shutdown.

Latch position error fault check box

Determines whether Position Error Fault 1 and Position Error Fault 2 are latching or non-latching.

Driver Configuration

The SPC monitors the actuator driver terminals to detect open or shorted actuator coils, and driver current errors or over currents. The driver settings are entered on the Driver page of the Configuration File Editor.

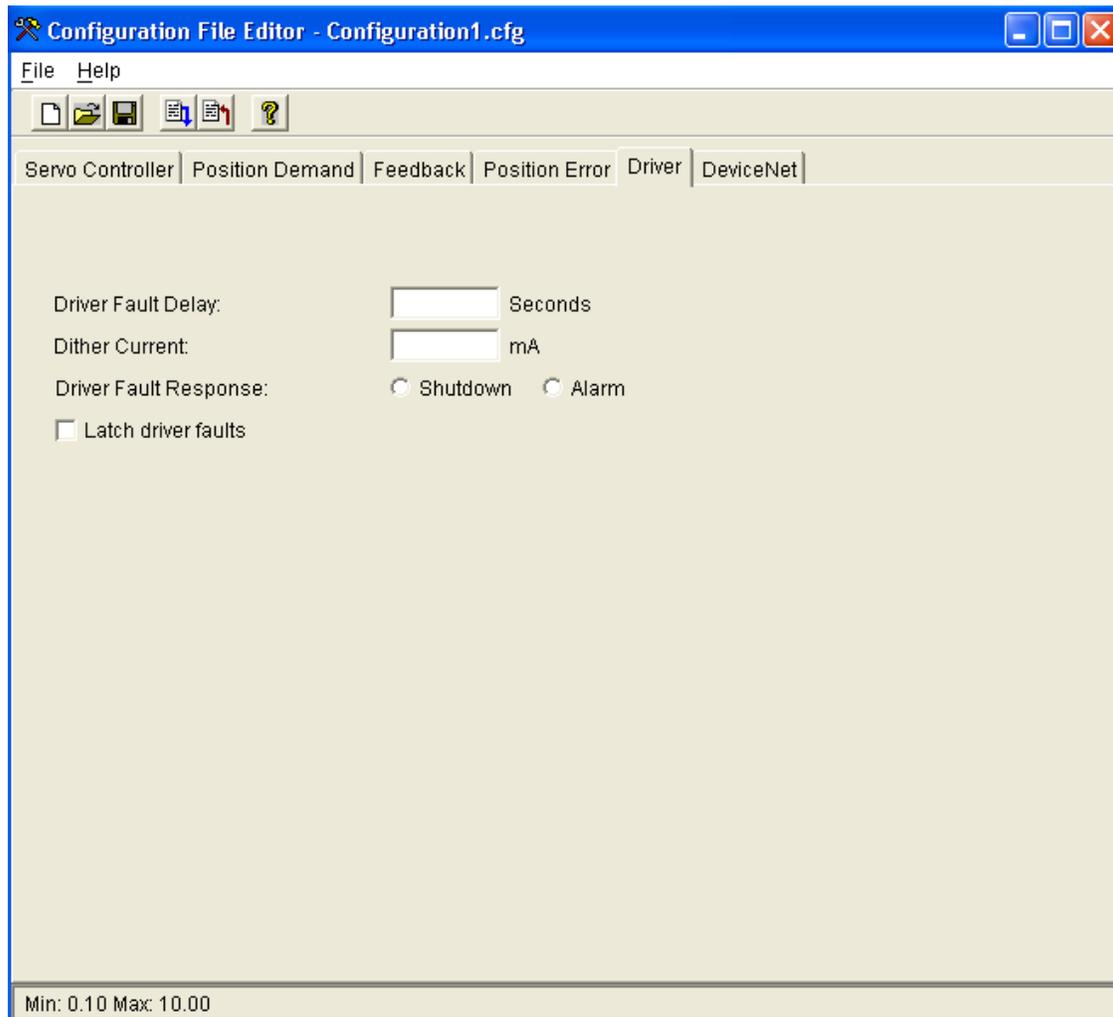


Figure 4-32. Driver Configuration

Driver Configuration Settings

Driver Fault Delay

Determines the delay time for all driver faults.

Dither Current

Sets the driver dither current amplitude.

Driver Fault Response

Determines whether driver faults are alarms or shutdowns.

Latch Driver Fault check box

Determines whether driver faults are latching or non-latching.

DeviceNet Configuration Settings

Firmware versions 5418-2322 and previous.

The DeviceNet settings are entered on the DeviceNet page of the Configuration File Editor.

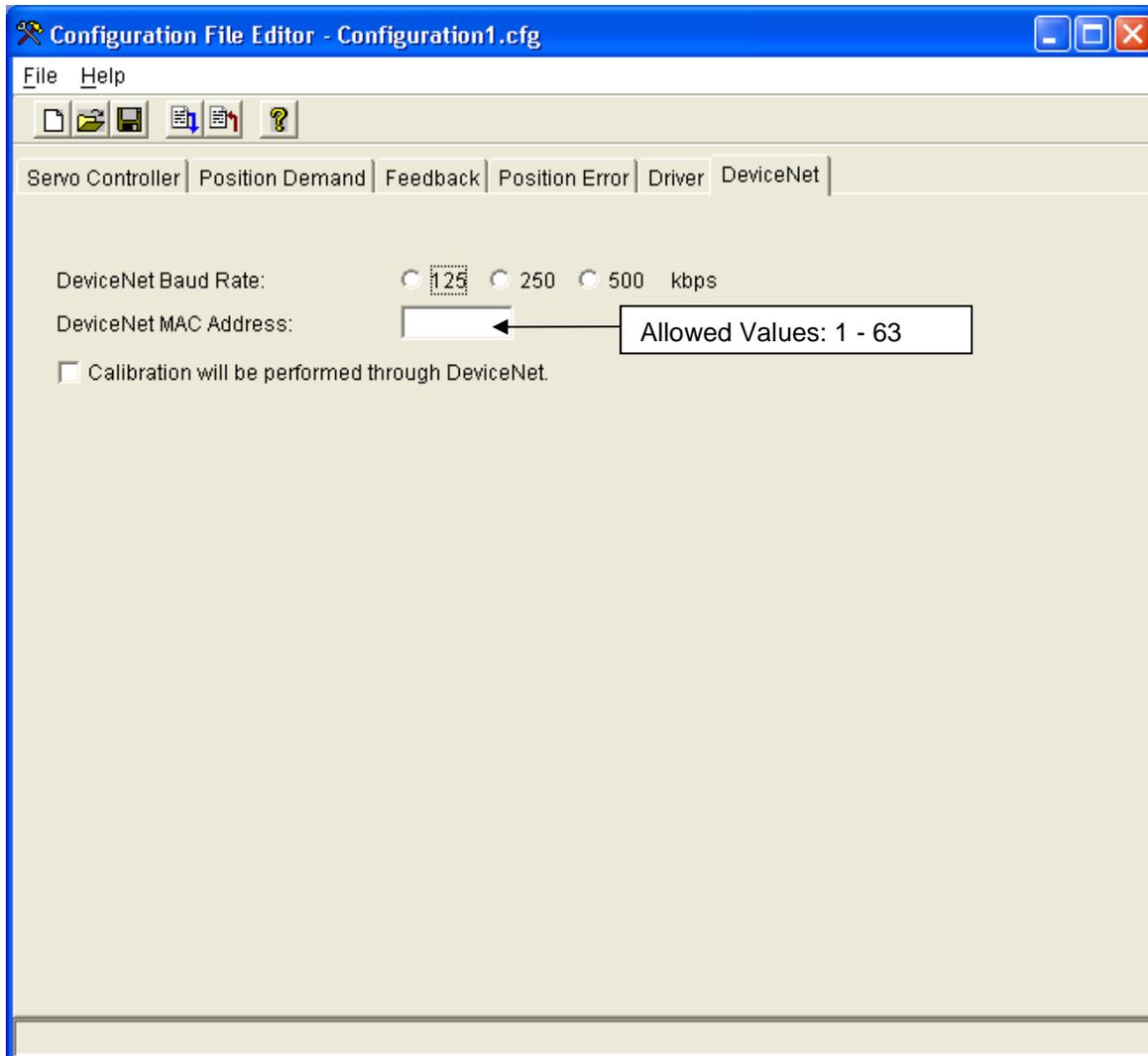


Figure 4-33. DeviceNet Configuration

DeviceNet Baud Rate

Sets the DeviceNet baud rate.

DeviceNet MAC Address

Sets the DeviceNet MAC address.

Allowed values: 1–63

Calibration will be performed through DeviceNet check box

Determines whether calibration will be performed with the service tool or through the DeviceNet port.

CANopen Configuration Settings

The CANopen settings are entered on the CANopen page of the Configuration File Editor.

Firmware versions 5418-7615 and newer.

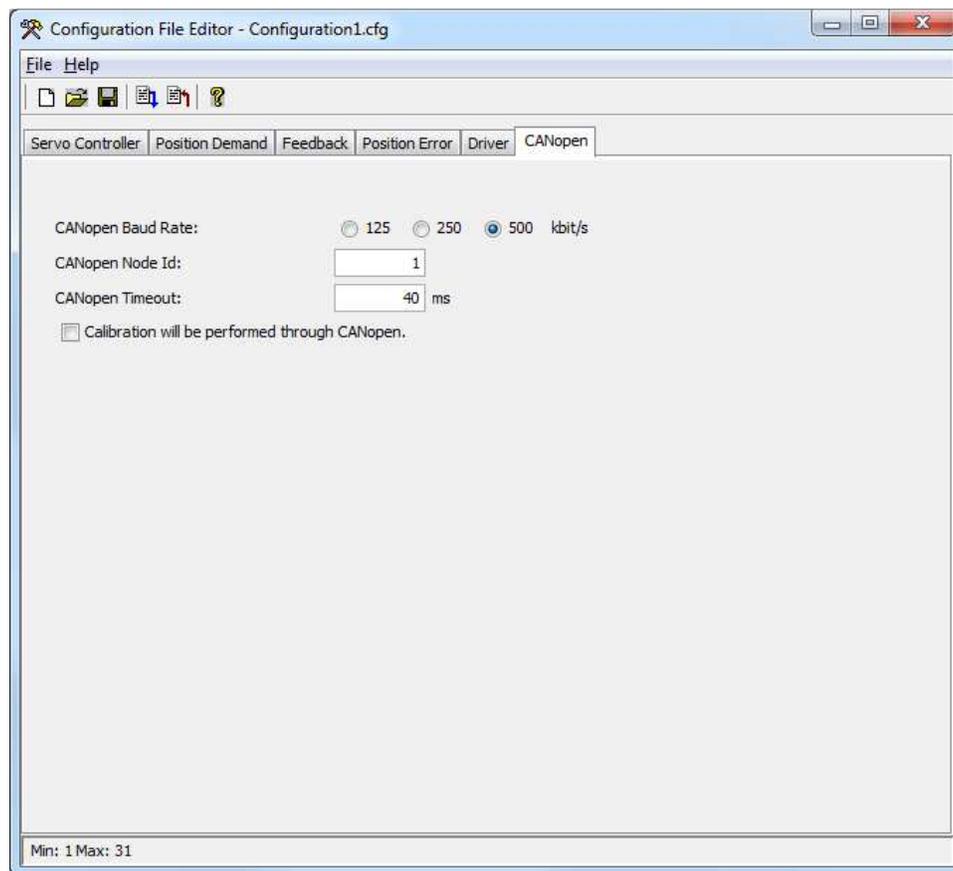


Figure 4-33a. CANopen Configuration

CANopen Baud Rate

Sets the CANopen baud rate.

CANopen Node Id

Sets the CANopen Node Id.

Allowed values: 1–31

Calibration will be performed through CANopen check-box

Determines whether calibration will be performed with the service tool or through the CANopen port.

SPC Calibration

The SPC must be calibrated to the specific position feedback device on an actuator. There are two methods to accomplish this—calibration using the SPC service tool, and calibration through the Digital Control bus. The SPC service tool guides the user through the calibration procedure. Calibration through the Digital Control bus places a burden on the control system application software to perform all the required steps in the proper order. Please consult the control system documentation for information on performing calibration over the Digital Control bus.

Calibrating from the SPC Service Tool

The SPC Service Tool includes a “wizard”, called the Calibration Assistant, to guide you step-by-step through the calibration procedure. To use the service tool to calibrate, the **Calibration will be performed through DeviceNet or CANopen** checkbox in the Overview page of the SPC Service Tool window must be unchecked.

To begin calibrating, select **Action** and then **Calibrate SPC...** from the menu. The Calibration Assistant window will appear. **The SPC must be shut down in order to begin calibration.** The calibration procedure will vary depending on whether a proportional or integrating actuator controller has been configured on the **Servo Controller** page of the Configuration Editor. At each step, click on the **Next** button to proceed to the next step of the procedure or click on the **Cancel** button to terminate the calibration process and revert back to the existing calibration, if one existed.

The Calibration Assistant presents the following five steps:

1. **Introduction**

This opening step explains the purpose and use of the Calibration Assistant.

2. **Minimum**

This step defines the 0 % position point. Alarm and shutdown conditions are checked by the SPC during this step, but **a shutdown will not force the actuator current to zero**. Use the Null Current Offset to adjust the actuator to the Minimum position.

IMPORTANT

Position value is not valid until calibrated.

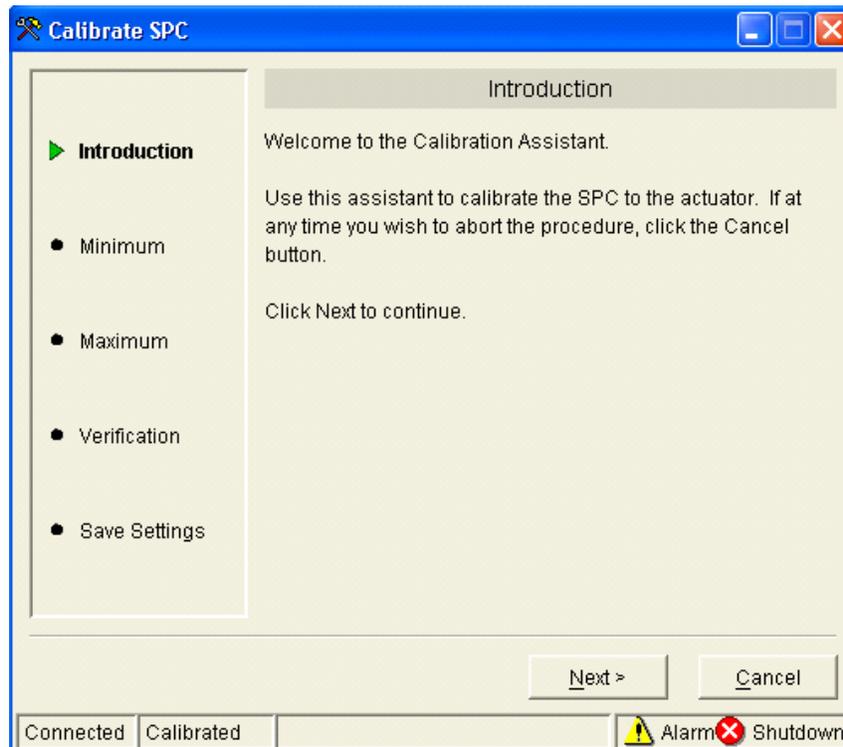


Figure 4-34. Introduction

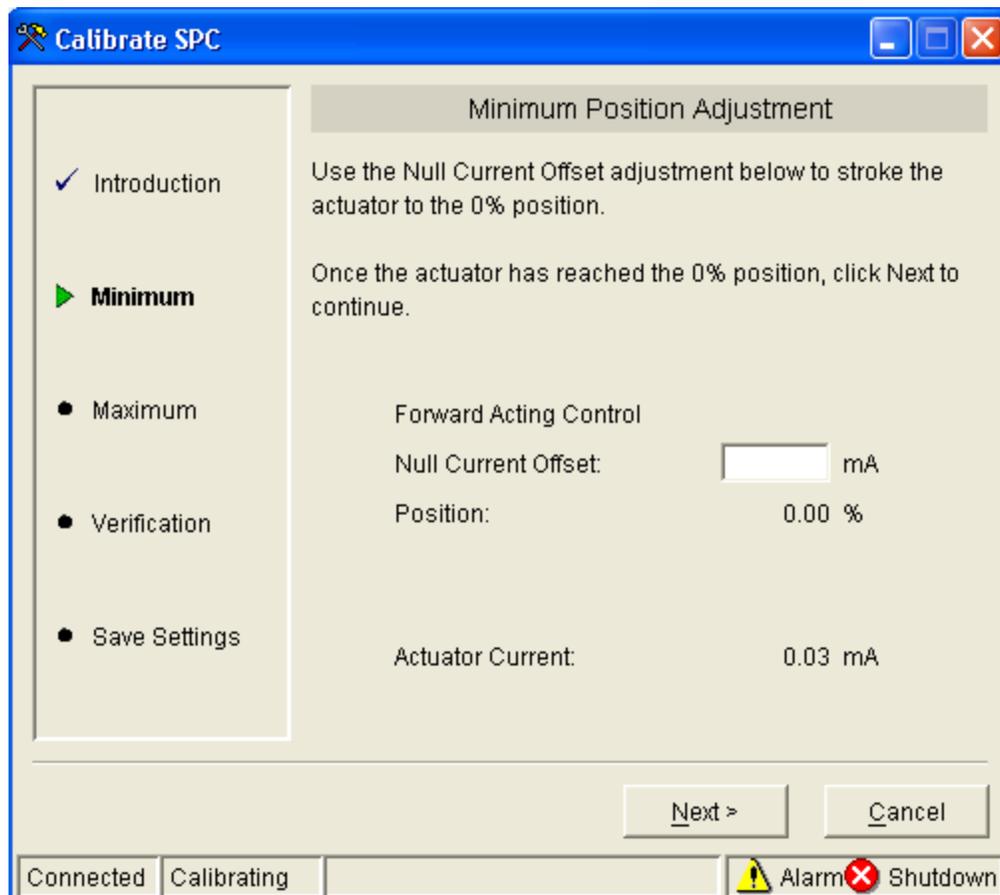


Figure 4-35. Minimum Position Adjustment

3. Maximum

This step defines the Maximum position point. Alarm and shutdown conditions are checked by the SPC during this step, but **a shutdown will not force the actuator current to zero**. Use the Null Current Offset to adjust the actuator to the Maximum position.

IMPORTANT

Position value is not valid until calibrated.

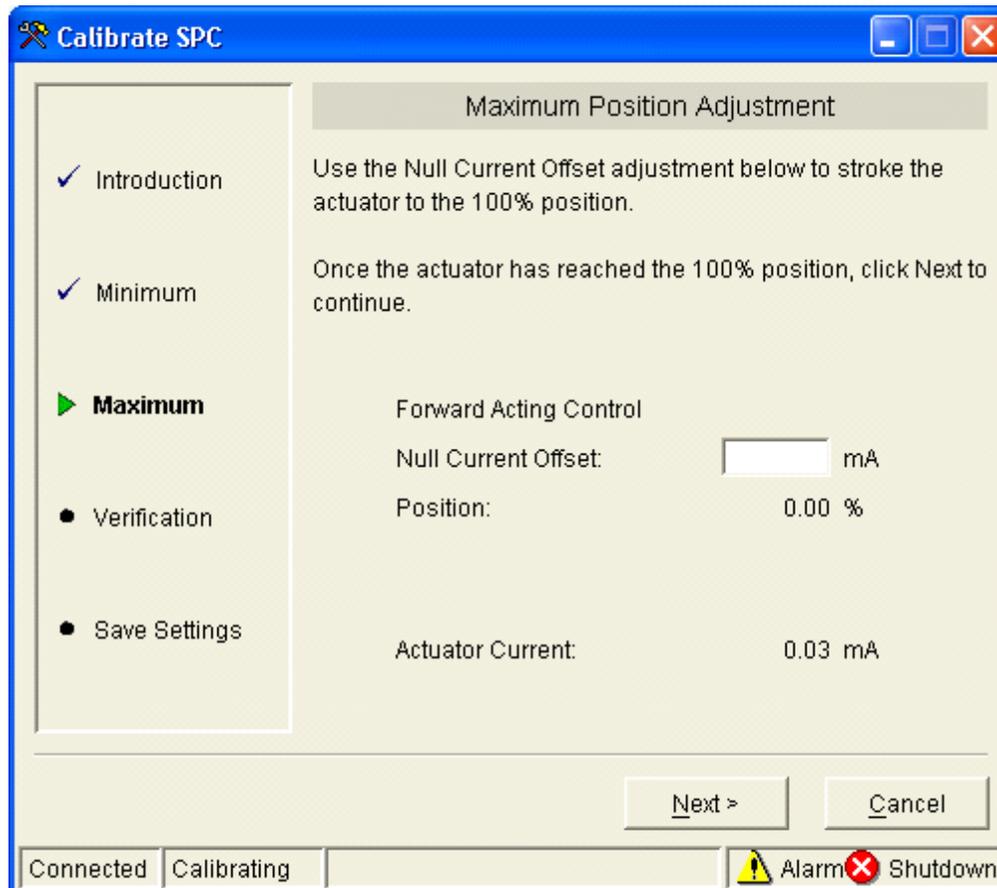


Figure 4-36. Maximum Position Adjustment

4. Verification

The new position settings can be verified at this step. Two set points are provided to allow easy step response testing. Dynamics settings and alarm and shutdown settings may be modified, if needed.

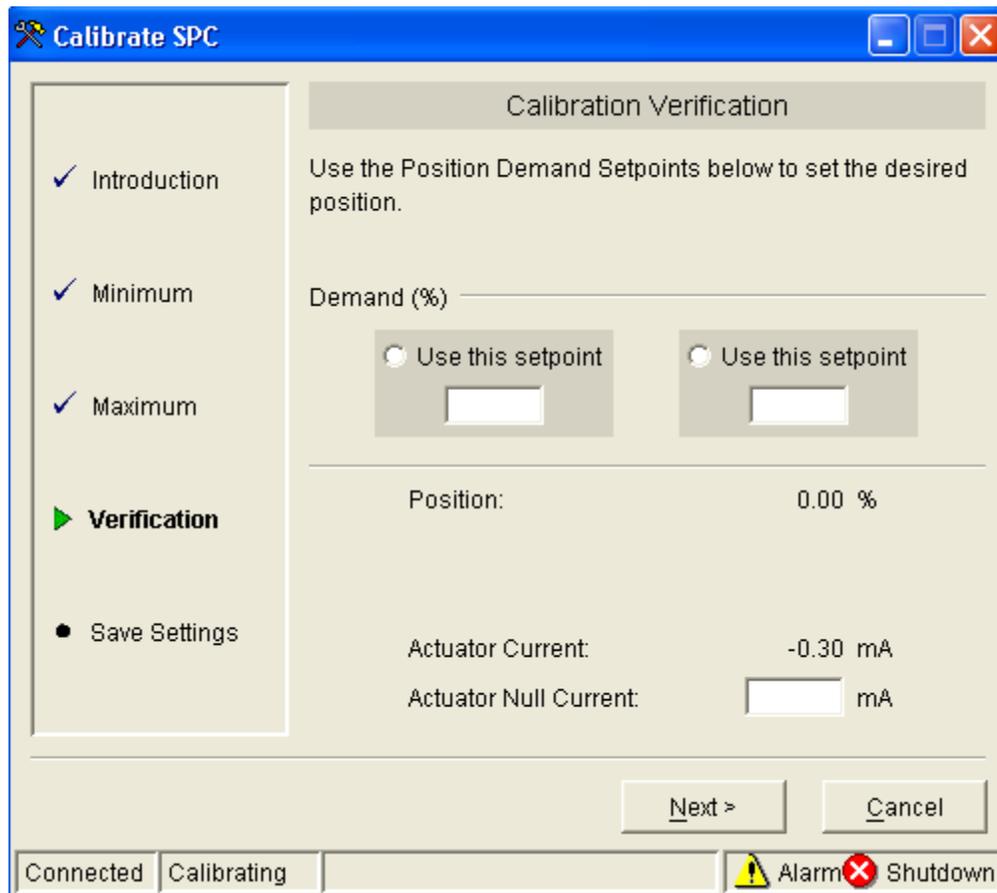


Figure 4-37. Calibration Verification

5. Save Settings

The final step of the calibration procedure is to save the calibration settings within the SPC.

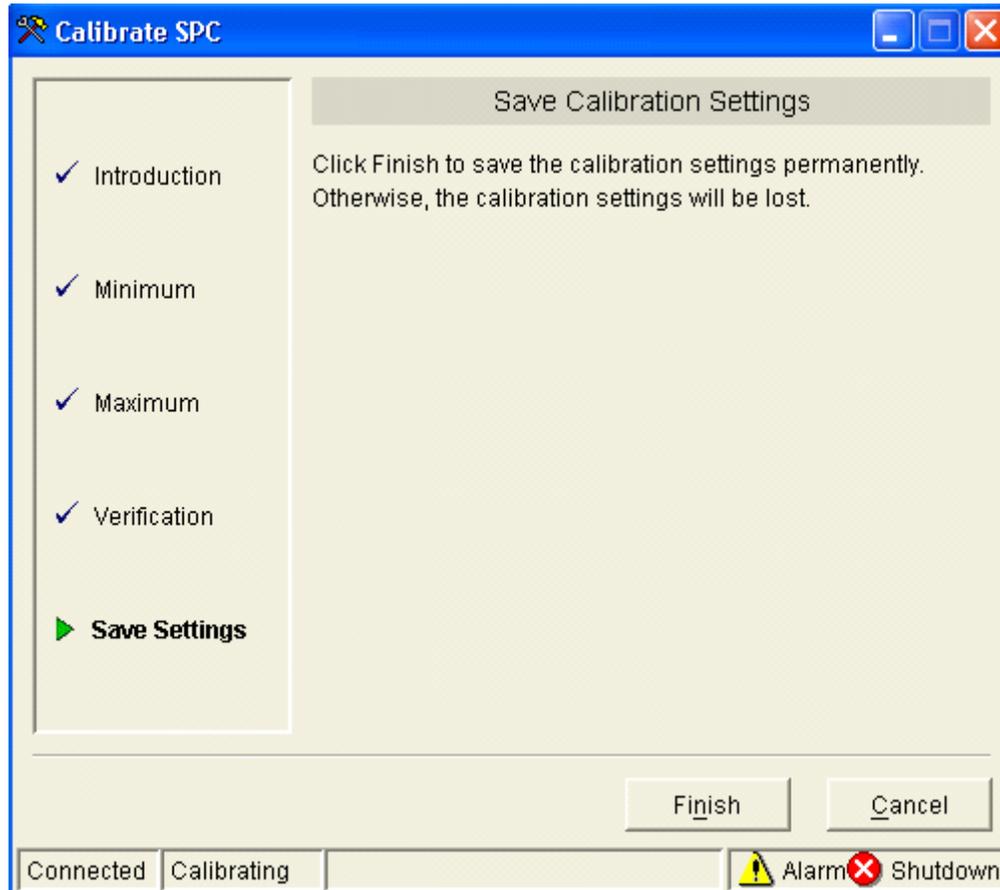


Figure 4-38. Saving the Calibration Settings

IMPORTANT

The SPC remains in the calibration mode until told to run by selecting *Action*, then selecting *Run* from the SPC Service Tool menu.

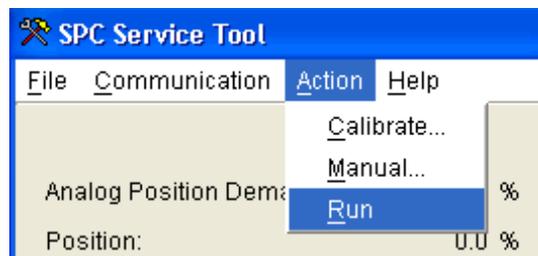


Figure 4-39. Selecting "Run"

Working with a Running SPC

Monitoring the SPC with the Input/Output Lines

The SPC has several I/O functions available for control and monitoring. These are:

Analog (4 to 20) mA Position Demand Input

The scaling for the analog position demand is user-configurable, that is, the 0 % and 100 % positions need not correspond exactly to 4 mA and 20 mA.

Position Monitor Output

The position monitor output gives an indication of the actuator position measured by the SPC. This output has fixed scaling such that 0 % position gives 4.0 mA and 100 % position gives 20.0 mA.

Shutdown Input

The SPC shuts down whenever the shutdown input terminals are open. For normal operation, the shutdown input terminals must be shorted.

Alarm/Shutdown Reset Input

The Alarm/Shutdown reset input provides a way to reset alarms and shutdowns using a contact closure. The reset function is triggered by an open-to-closed transition on the reset input terminals.

Shutdown Status Output

The shutdown status output indicates when the SPC shuts down for any reason. A relay connected to this output can be made to de-energize whenever the SPC is shut down.

Alarm Status Output

The alarm status output indicates whether any SPC alarm conditions are present. A relay connected to this output can be made to de-energize whenever an alarm is active.

Making Adjustments with the SPC Service Tool

The SPC Service Tool window has several tabbed pages that allow adjustments to be made to the SPC.

The **Overview** page includes a check box labeled **Calibration will be performed through DeviceNet or CANopen**. When this box is checked, calibration can only be performed through Digital Interface. When this box is unchecked, calibration can only be performed using the service tool.

The **Dynamics** page includes various parameters depending on the controller type that has been configured.

The **Alarm Setup** page allows you to change alarm and shutdown settings. See Changing Alarm and Shutdown Settings for more information.

Making adjustments will often change the configuration of the SPC, and you may want to save this configuration to a file. After you are finished making changes, read the SPC's configuration in to a Configuration Editor window. Then save the configuration to a file. Finally, to have the configuration identifier in the SPC updated with the file name and date, load the configuration back into the SPC. See Configuring the SPC for detailed instructions.

When editing numeric parameters, you must press Enter on the keyboard or select another item for changes to take place.

Monitoring Operation with the SPC Service Tool

The SPC Service Tool window has several tabbed pages that allow adjustments to be made to the SPC.

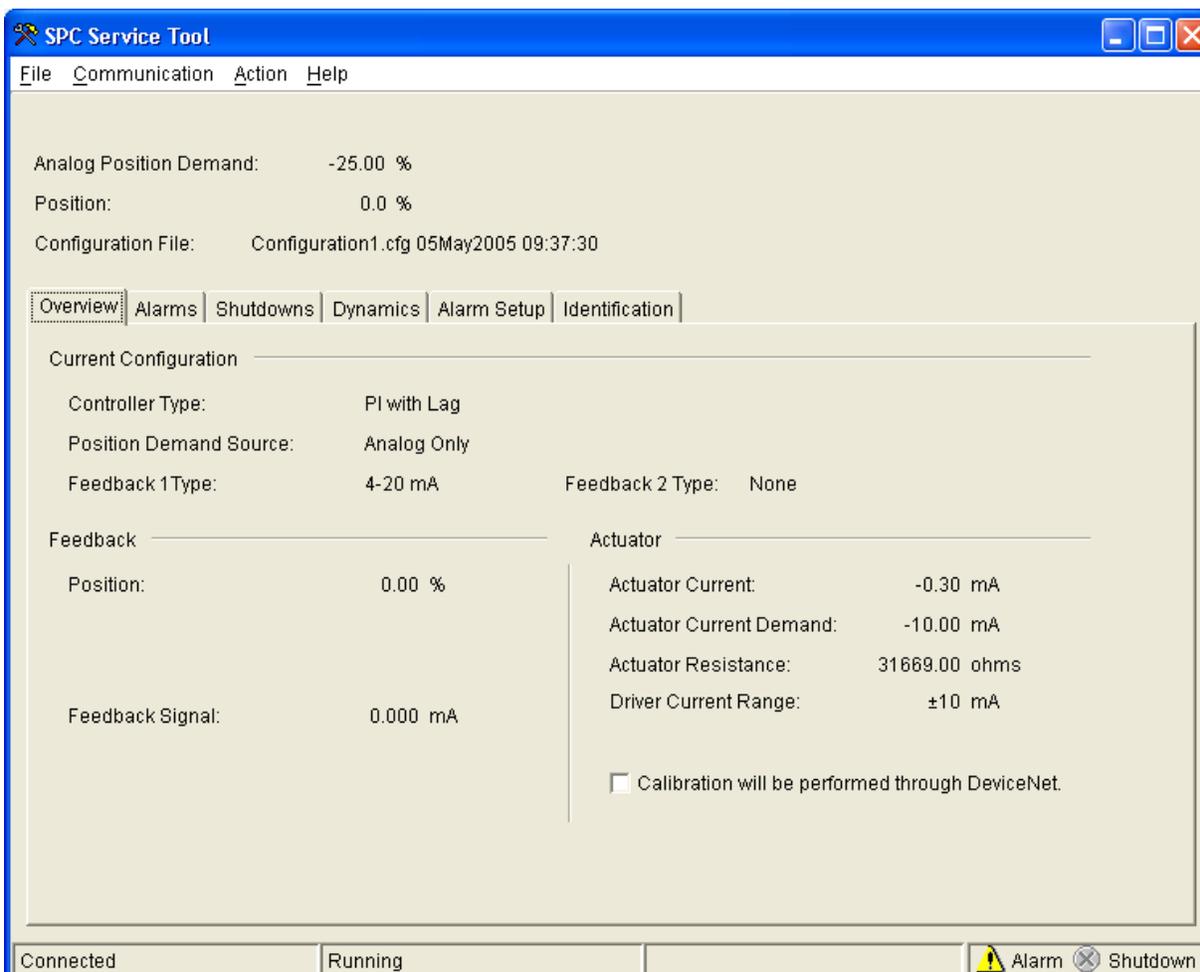


Figure 4-40. SPC Service Tool Overview Tab

Overview Tab

The following items are displayed on the SPC Service Tool Overview Tab.

- **Position Demand**
If more than one position demand source is configured, both sources are displayed with the word “active” next to the demand that is currently being used.
- **Position Feedback**
If more than one feedback device is configured, the individual position feedbacks as well as the position feedback value used by the servo controller are displayed.
- **Configuration Identifier**
The name and date of the configuration file associated with the current SPC configuration. The file name will be blank if any settings have been changed since saving to a file. (The complete configuration can be viewed by opening the SPC’s configuration in the Configuration Editor. See Configuring the SPC for more information.)
- **Controller Type**
Indicates if the controller is being used as a Proportional, P, PI, PI with Lag, or PI with Lead-Lag.
- **Position Demand Source**
Identifies if the Position Demand Source is DeviceNet or CANopen or Analog.
- **Feedback Type**
Identifies the Feedback 1 and Feedback 2 devices being used in the SPC.

- **Feedback Position**
Feedback Position between (0 to 100) %
- **Feedback Signal**
Current Feedback Signal
- **Actuator Current**
The actuator coil current being measured by the SPC. This value is not updated when the SPC is not actively positioning the actuator.
- **Actuator Current Demand**
The actuator current being requested by the servo controller.
- **Actuator Resistance**
The measured actuator resistance. This value is not updated when the SPC is not positioning the actuator or when the actuator current is too low to allow reasonably accurate ohms calculations.
- **Driver Current Range**
The driver operates in one of five different hardware current ranges. The range is selected by the SPC based on the current range defined in the servo controller configuration.

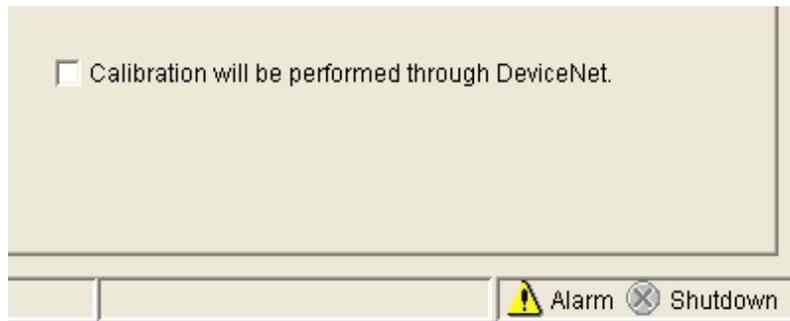


Figure 4-41. Calibration will be Performed through DeviceNet or CANopen

The Overview page includes a check box labeled **Calibration will be performed through DeviceNet or CANopen**. When this box is checked, calibration can only be performed through Digital Interface. When this box is unchecked, calibration can only be performed using the service tool.

Understanding SPC Alarms and Shutdowns

An **alarm** is an indication to the user that there is a condition which may require specific action on the user's part. A **shutdown** causes the SPC to take action by forcing the actuator current to zero. Some conditions are pre-defined to be either an alarm or a shutdown, while other conditions can be configured to be either.

When shut down, the SPC driver output current is forced to zero. The SPC being shut down does not imply that the valve is at minimum position, only that the actuator current is zero. A specific actuator's design and setup determine its behavior when the current is zero.

Threshold and Delay Settings:

Many SPC alarms and shutdowns include threshold and delay adjustments. This means that a value must exceed the threshold continuously for a duration equal to the delay time before the alarm or shutdown becomes active.

Latching and Non-Latching Response:

All SPC alarms and shutdowns are either latching or non-latching. Some alarms and shutdowns are pre-defined to be either latching or non-latching, while other alarms and shutdowns can be configured to be either. A non-latching alarm or shutdown will go away if the cause of the alarm or shutdown goes away. A latching alarm or shutdown does not go away until the alarm or shutdown cause goes away and an alarm/shutdown reset is performed.

Alarm and Shutdown Reset:

Alarms

If the source of an alarm is still present, a reset has no effect on the alarm. If the source of a latched alarm is no longer present, a reset clears the alarm.

Shutdowns

Performing a reset on an SPC when it is shut down causes it to restore current to the actuator and attempt to position the actuator. If the shutdown cause is still present, the SPC will shut down again.

See also:

- SPC alarm/shutdown structure
- Viewing and resetting alarms and shutdowns
- Changing alarm and shutdown settings
- Alphabetical list of alarms and shutdowns

SPC Alarm/Shutdown Structure

The SPC groups alarms and shutdown conditions as shown below. All alarm conditions are combined to generate a master alarm which is indicated on applicable service tool screens and the alarm status relay driver. All shutdown conditions are combined to generate a master shutdown, which is indicated on applicable service tool screens and the shutdown status relay driver.

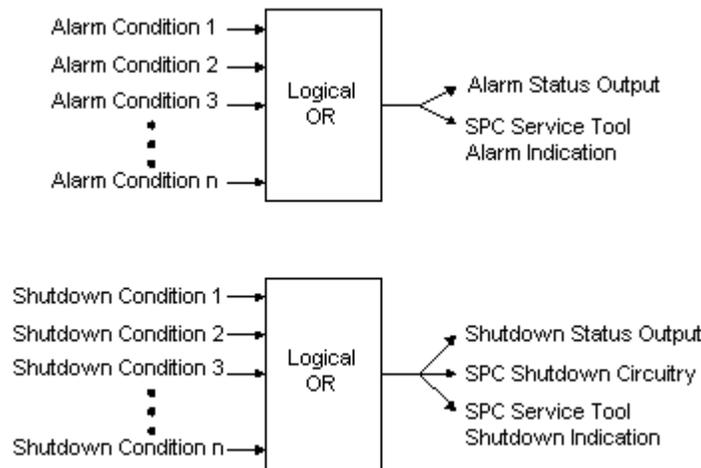


Figure 4-42. Alarm Structure

Viewing and Resetting Alarms and Shutdowns

SPC alarms and shutdowns can be viewed and reset using the SPC Service Tool. In the SPC Service Tool window, there is a page for alarms and a page for shutdowns. Each page shows the possible alarms/shutdowns, which may change with changes to the configuration. Indicators adjacent to each alarm/shutdown are gray when the alarm/shutdown is inactive and colored when active. When an alarm is present, a warning indicator  will be displayed. When a shutdown is present, an error indicator  will be displayed. Latched alarms and shutdowns can be reset by pressing the Reset Alarms and Shutdowns button from either page.

See also: Understanding Alarms and Shutdowns. An Alphabetical List of SPC Alarms and Shutdowns is at the end of this chapter.

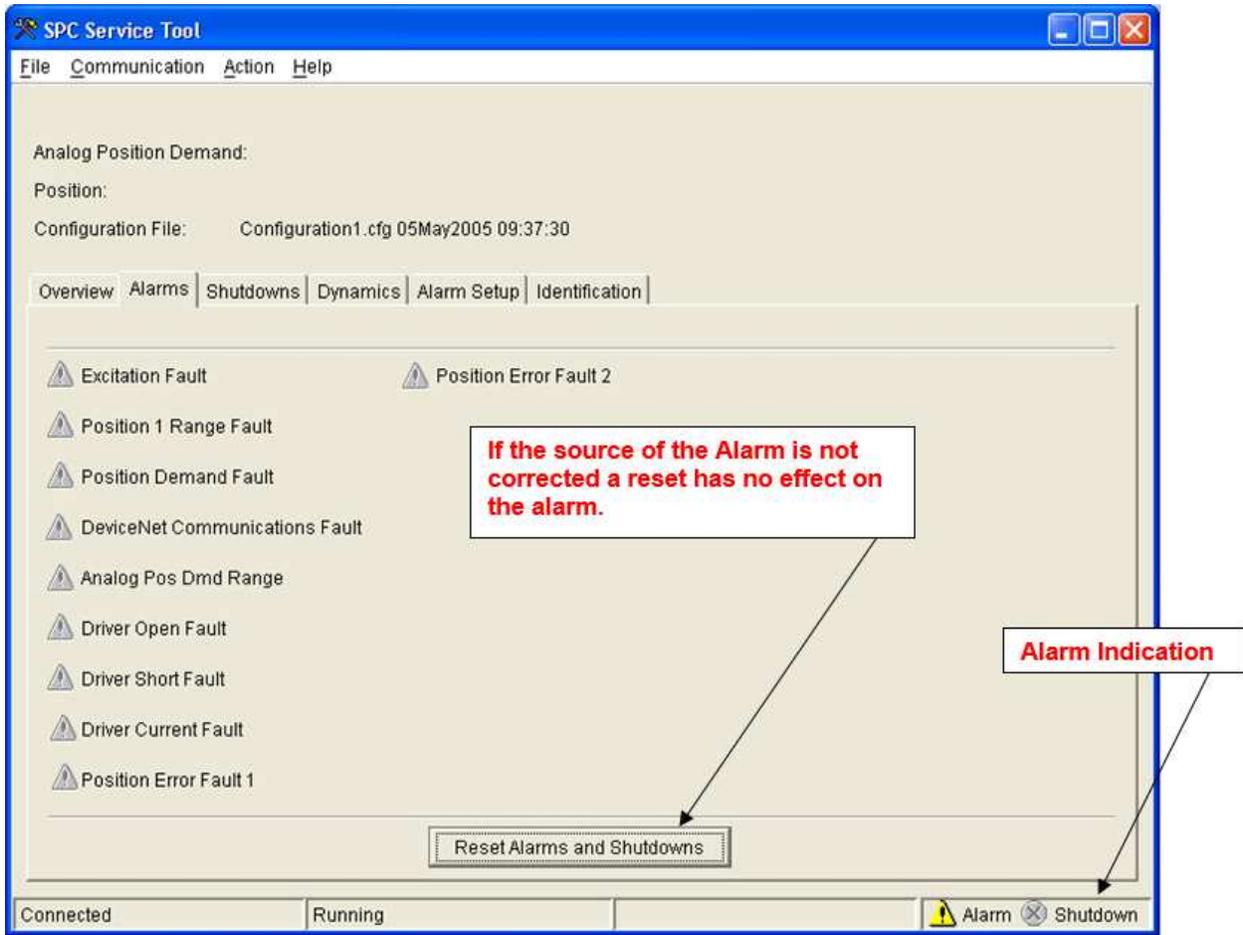


Figure 4-43. Alarms

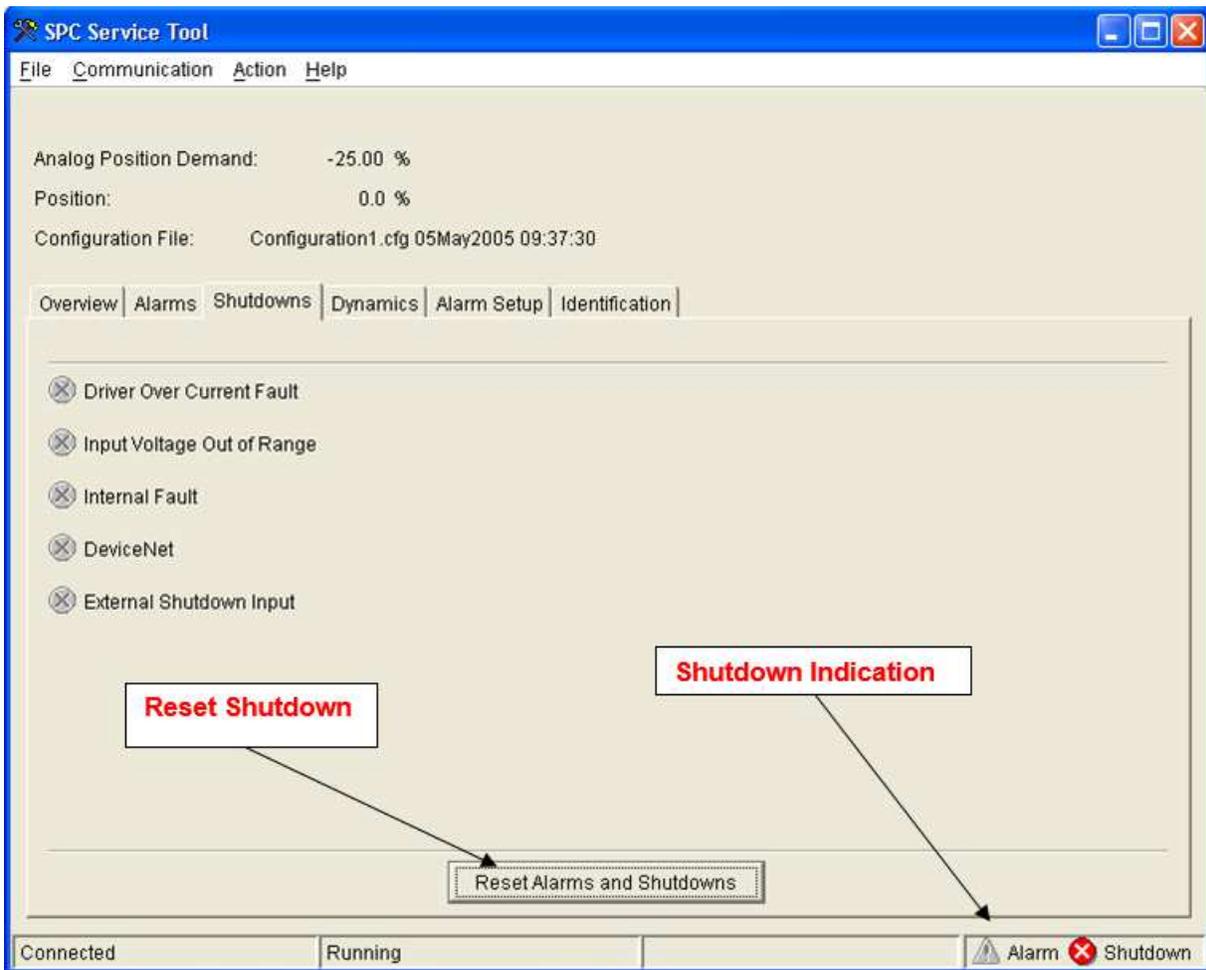


Figure 4-44. Driver Fault Error Shutdown

Performing a "Reset Alarms and Shutdowns" on the SPC when it is in the shutdown condition will cause it to restore current to the actuator and attempt to position the actuator. If the cause of the shutdown has not been corrected, the SPC will shut down again.

SPC Dynamics

The Dynamics page includes various parameters depending on the controller type that has been configured. The controller dynamics, dither current, etc. can be adjusted on the Dynamics Tab of the Service Tool while the SPC is running.

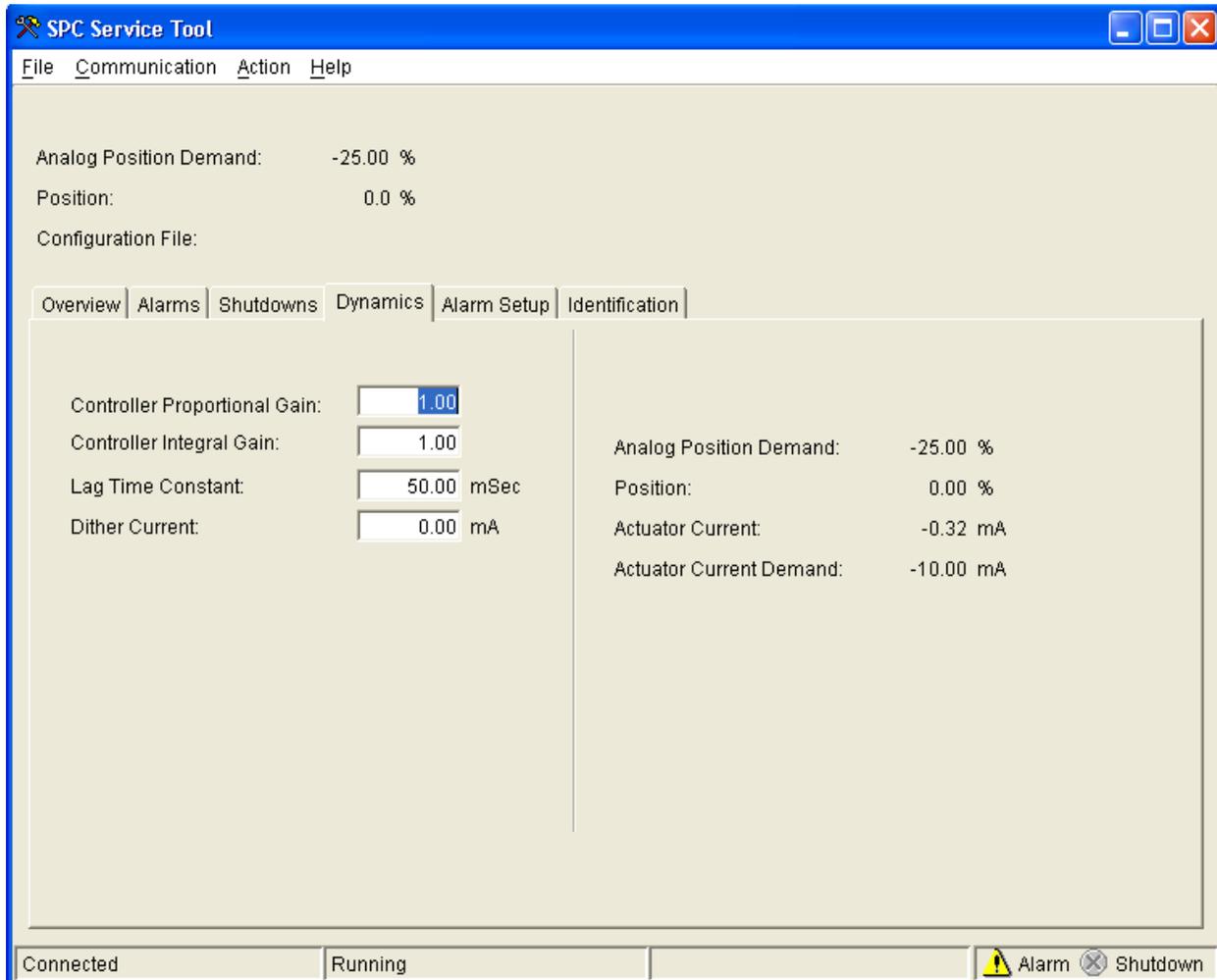


Figure 4-45. Dynamic Settings

The Position Demand In, Position, Actuator Current and Actuator Current Demand are only displayed on the Dynamics portion of the Service Tool.

Changing Alarm and Shutdown Settings

SPC alarm and shutdown settings can be changed using the SPC Service Tool. In the SPC Service Tool window there is a page named Alarm Setup for this purpose. The SPC implements two separate position error faults with independent thresholds and delays.

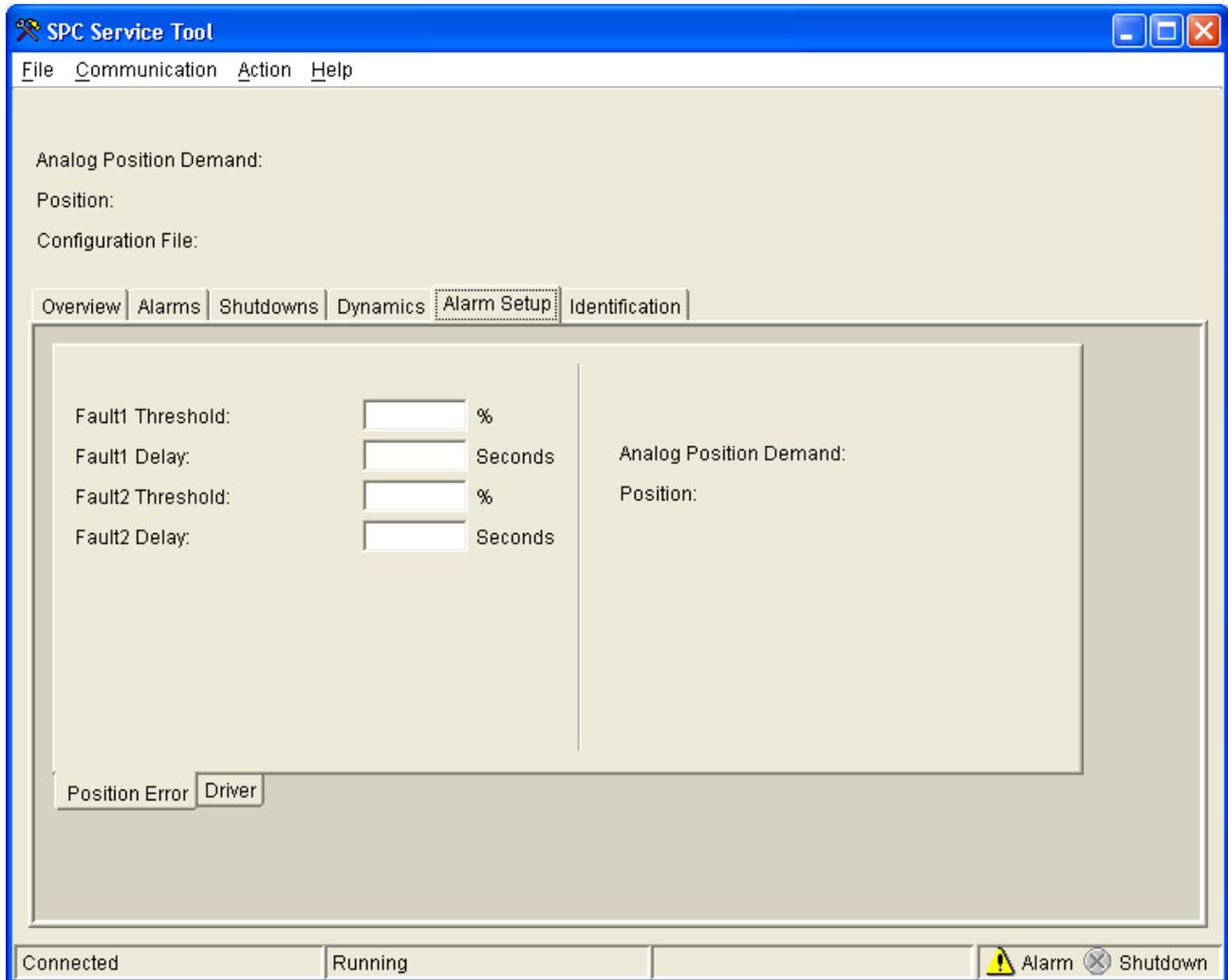


Figure 4-46. Position Error Alarms

Fault 1 Threshold

Threshold for Position Error Fault 1

Fault 1 Delay

Delay time for Position Error Fault 1

Fault 2 Threshold

Threshold for Position Error Fault 2

Fault 2 Delay

Delay time for Position Error Fault 2

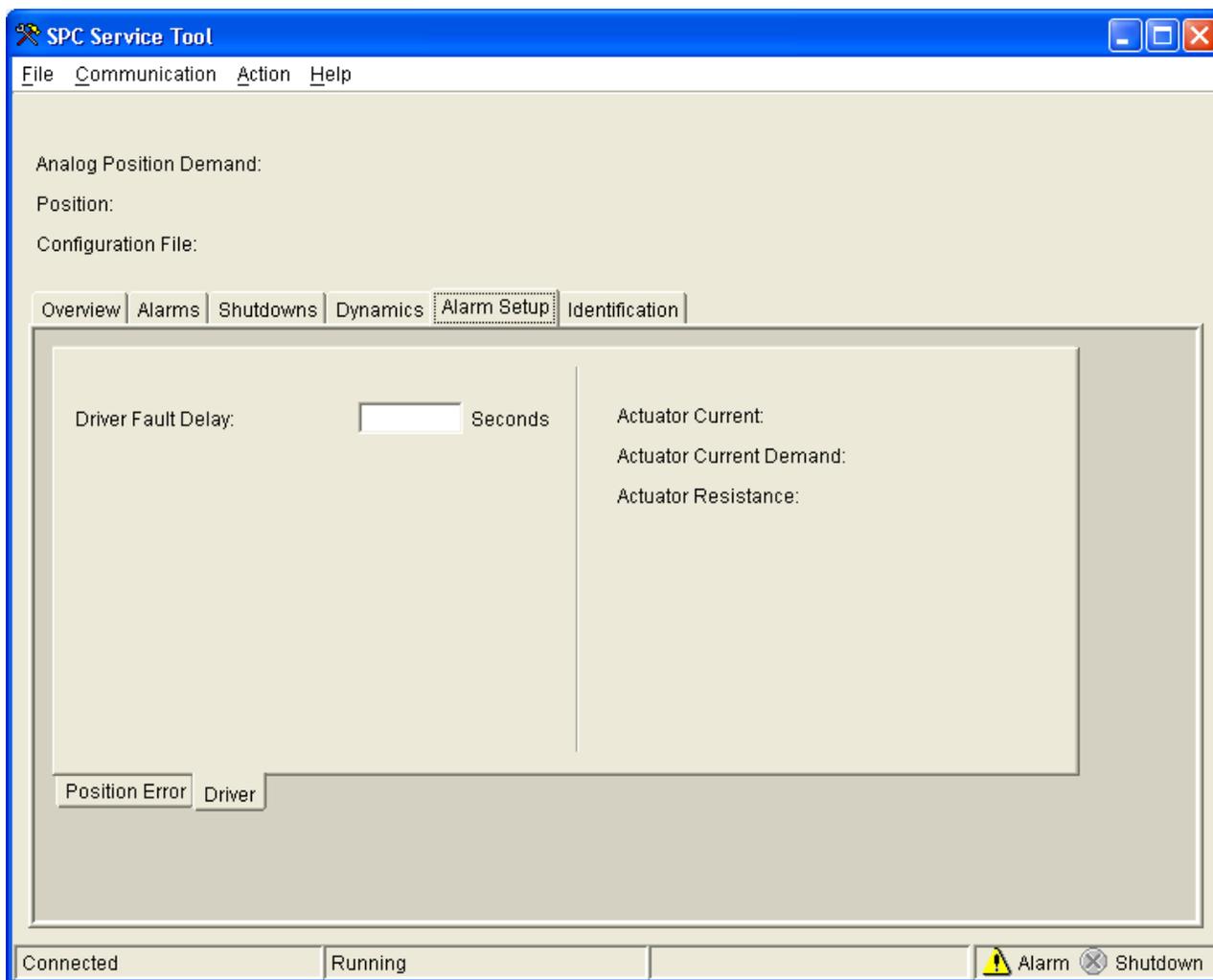


Figure 4-47. Driver Fault Error Alarms

Alarm Threshold and Delay Settings

A value must exceed the threshold continuously for a duration equal to the delay time before the alarm or shutdown becomes active.

Latching and Non-Latching Response

A non-latching alarm or shutdown will be removed if the cause of the alarm or shutdown is corrected. A latching alarm or shutdown will remain active until the cause of the alarm or shutdown is cleared and the "Reset Alarms and Shutdowns" is selected.

SPC Identification Information

The following items are displayed on the SPC Service Tool Identification Tab.

- SPC Serial Number
The SPC serial number will also be displayed on the nameplate.
- Software Part Number
The SPC application software part number, including revision letter

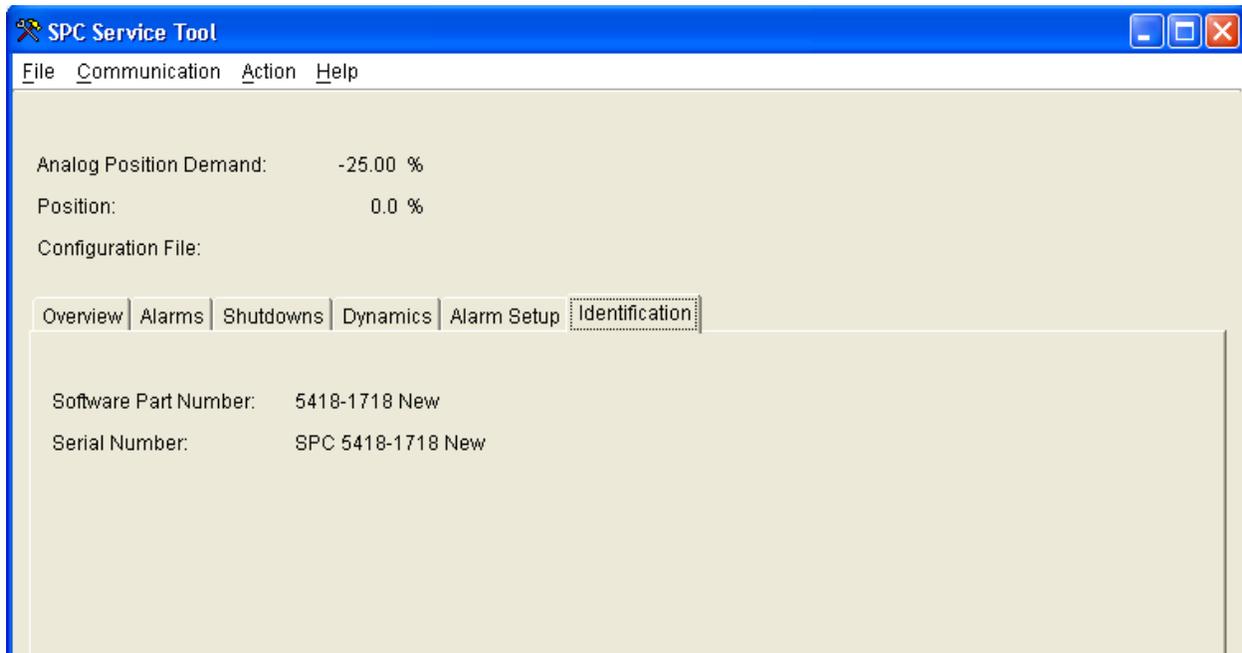


Figure 4-48. SPC Service Tool Identification Tab

Manually Stroking the Actuator

To enter the manual stroke mode, select **Action** from the SPC Service Tool menu, and then select **Manual...** An error message is displayed if the SPC is not shut down.



Figure 4-49. Selecting Manual Stroking

The SPC allows the user to enter a manual position demand. Manually stroking the actuator is considered to be a distinct operating mode, and **the SPC must be shut down before manual stroking can be performed.**

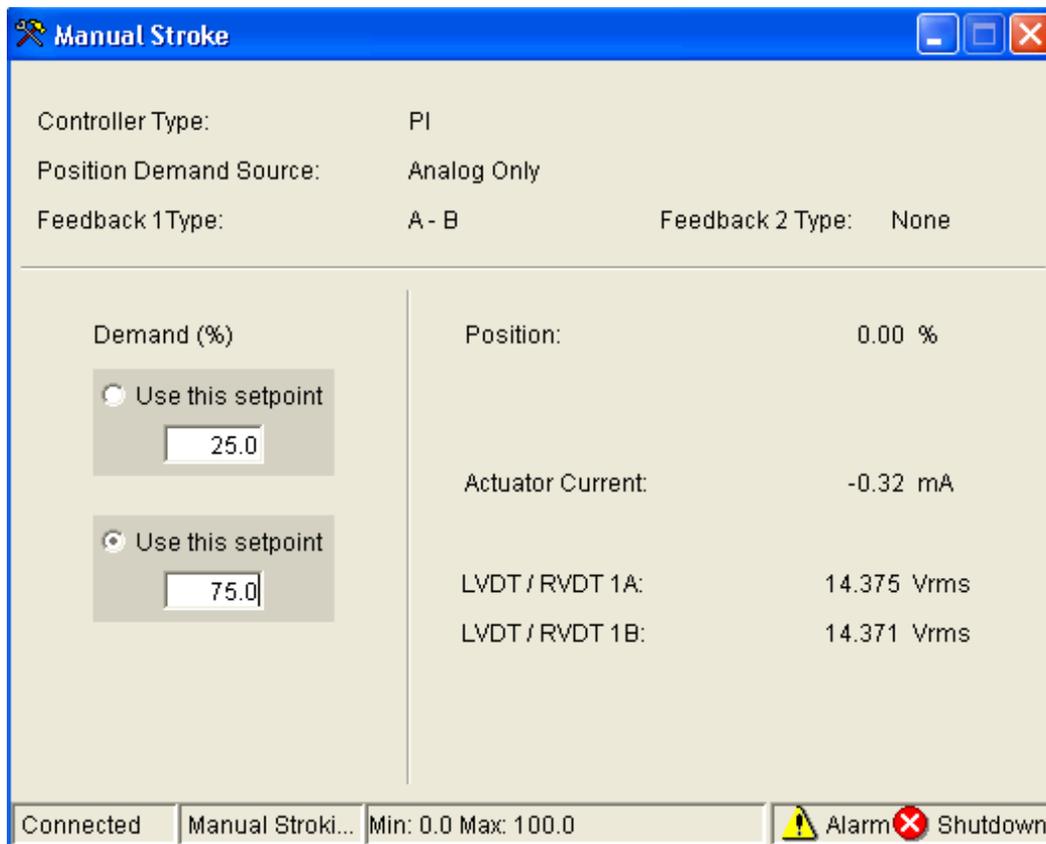


Figure 4-50. SPC Service Tool Manual Stroking

Two demand set points provide a means to quickly step between two pre-defined positions for testing the step response of the actuator. The controller dynamics, dither current, etc., can be adjusted on the **Dynamics** tab of the SPC Service Tool. Alarm and shutdown settings can be adjusted on the Alarm Setup tab. SPC operation can be viewed on the **Overview** tab and the **Alarms** and **Shutdowns** tabs.

Quick Reference—Alarms & Shutdowns

Alphabetical List of SPC Alarms and Shutdowns

	<i>Shutdown</i>		<i>Alarm</i>
1	 Analog Pos Dmd Range	1	 Analog Pos Dmd Range
2	 Both Feedbacks Failed	2	 DeviceNet Communications Fault
3	 Both Position Demands Failed	3	 Driver Current Fault
4	 DeviceNet	4	 Driver Open Fault
5	 DeviceNet Communications Fault	5	 Driver Short Fault
6	 Driver Current Fault	6	 Excitation Fault
7	 Driver Open Fault	7	 Feedback 1 Open Fault
8	 Driver Over Current Fault	8	 Feedback 1 Range Fault
9	 Driver Short Fault	9	 Feedback 2 Open Fault
10	 Excitation Fault	10	 Feedback 2 Range Fault
11	 External Shutdown Input	11	 Feedback Tracking Fault 1
12	 Feedback 1 Open Fault	12	 Feedback Tracking Fault 2
13	 Feedback 1 Range Fault	13	 Position 1 Range Fault
14	 Feedback Tracking Fault 2	14	 Position 2 Range Fault
15	 Input Voltage Out of Range	15	 Position Demand Tracking
16	 Internal Fault	16	 Position Error Fault 1
17	 Position 1 Range Fault	17	 Position Error Fault 2
18	 Position Error Fault 2		

	Alarms Only
	Shutdown Only
	Both: Alarm & ShtDwn

Note: Both indicates configurable

Alarm (displayed on the status bar)  Alarm  Shutdown

- This indicates that one or more alarms on the Alarms and Shutdown screen are active. This also reflects the state of the hardware Shutdown Status output.

Shutdown (displayed on the status bar)  Alarm  Shutdown

- This indicates that one or more shutdowns on the Alarms and Shutdown screen are active. This also reflects the state of the hardware Alarm Status output.

Analog Position Dmd Out of Range

- This fault indicates that the (4 to 20) mA analog position demand current is below 1 mA or above 24 mA.
- Type (alarm or shutdown): configurable [If in **Alarm** state and Analog Pos Dmd Range or Both Analog Pos Dmd Range & DeviceNet Comm Fault signals are lost the SPC will Shutdown]
- Latching/non-latching response: configurable

CANopen Communication Fault

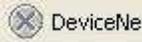
- The CANopen Communication Fault goes true when any of the following conditions exists:
 - No CANopen NMT Go to 'operational' command has been received. The CANopen RXPDO1 and SYNC messages are not received within configured time.
 - There is a problem with the CAN bus which is preventing the SPC from communicating.
- Type (alarm or shutdown): configurable if SPC is configured to accept a CANopen position demand, status otherwise. When defined as status, it will not generate an Alarm indication on the status bar. [When in **Alarm** state and CANopen Comm Fault or Both Analog Pos Dmd Range & CANopen Comm Fault signals are lost - the SPC will Shutdown]
- Latching/non-latching response: configurable

CANopen Shutdown  **(Not Active – Refer to CANopen Communication Fault)**

- A shutdown command is being received over the CANopen bus.
- Type : Shutdown
- Latching/non-latching response: non-latching

DeviceNet Communication Fault

- The DeviceNet Communication Fault goes true when any of the following conditions exists:
 - No DeviceNet master has established communications with the SPC. The DeviceNet Position Demand value is being received slower than a minimum rate specified by the bus master.
 - The configured MAC ID is the same as the MAC ID of another device already established on the bus.
 - There is a problem with the CAN bus which is preventing the SPC from communicating.
 - The DeviceNet master goes into an Idle condition.
- Type (alarm or shutdown): configurable if SPC is configured to accept a DeviceNet position demand, status otherwise. When defined as status, it will not generate an Alarm indication on the status bar. [When in **Alarm** state and DeviceNet Comm Fault or Both Analog Pos Dmd Range & DeviceNet Comm Fault signals are lost - the SPC will Shutdown]
- Latching/non-latching response: configurable

DeviceNet Shutdown  **(Not Active – Refer to DeviceNet Communication Fault)**

- A shutdown command is being received over the DeviceNet bus.
- Type : Shutdown
- Latching/non-latching response: non-latching

Driver Current Fault

- This fault indicates that the actual driver current does not match the commanded driver current within 15 % of the full-scale current.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: latching

Driver Open Fault

- This fault indicates that the SPC has detected an open actuator coil.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: latching

Driver Overcurrent Fault

- This fault indicates that the actual driver current exceeds the commanded driver current by more than 20 % of the full-scale current.
- Type : Shutdown
- Latching/non-latching response: latching

Driver Short Fault

- This fault indicates that the SPC has detected a shorted actuator coil. There must be sufficient current demand to the actuator for a short to be detected.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: latching

Excitation Fault (Feedback Fault Response)

- This fault indicates that the excitation voltage is not within 0.2 V (rms) of the configured value.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: configurable

External Shutdown Input

- This Shutdown indicates that the external shutdown contact input is open.
- Type : Shutdown
- Latching/non-latching response: non-latching

Feedback Fault

- When the Feedback alarms have occurred, this indicates that there is no valid position feedback. If there is a "single" position feedback device, this fault indicates that one or more feedback-related faults (Feedback 1 Open Fault, Feedback 1 Range Fault, Position 1 Range Fault, Excitation Fault) are true. If there are "two" position feedback devices, this fault indicates that there are feedback-related faults on **Both** feedback devices.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: configurable

Feedback 1 Open Fault

- This fault indicates that the SPC has detected an open wire in the position feedback 1 transducer circuit.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: configurable

Feedback 2 Open Fault

- This fault indicates that the SPC has detected an open wire in the position feedback 2 transducer circuit.
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

Feedback 1 Range Fault

- This fault indicates that the voltage on the LVDT/RVDT 1A or 1B inputs has exceeded the normal voltage range by the Feedback Range Threshold value. The normal voltage range is determined during calibration. For example, suppose that the voltage on the LVDT/RVDT 1A input changed from 2 volts to 6 volts during the calibration procedure, and Feedback Range Threshold is 0.3 V.
- A Feedback 1 Range fault will occur if the voltage on the LVDT/RVDT 1A input is less than 1.7 V or greater than 6.3 V.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: configurable

Feedback 2 Range Fault

- This fault indicates that the voltage on the LVDT/RVDT 2A or 2B inputs has exceeded the normal voltage range by the Feedback Range Threshold value. The normal voltage range is determined during calibration. For example, suppose that the voltage on the LVDT/RVDT 2A input changed from 2 volts to 6 volts during the calibration procedure, and Feedback Range Threshold is 0.3 V. A Feedback 2 Range fault will occur if the voltage on the LVDT/RVDT 2A input is less than 1.7 V or greater than 6.3 V.
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

Feedback Tracking Fault 1

- This fault indicates that the difference between Position 1 and Position 2 exceeds the Tracking Fault 1 Threshold for longer than the Tracking Fault 1 Delay time.
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

Feedback Tracking Fault 2

- This fault indicates that the difference between Position 1 and Position 2 exceeds the Tracking Fault 2 Threshold for longer than the Tracking Fault 2 Delay time.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: configurable

Input Voltage Out of Range

- This Shutdown indicates that the SPC input voltage is below 17 V (dc) or above 33 V (dc).
- Type : Shutdown
- Latching/non-latching response: latching

Internal Fault

- This Shutdown indicates that an internal problem with the SPC has occurred. If this shutdown is still present after turning power to the SPC off, then on, the SPC is faulty and must be replaced.
- Type : Shutdown
- Latching/non-latching response: latching

Position Demand

- When the Position demand alarms have occurred this indicates that there is no valid position demand. If a “single” position demand source is configured, then an **alarm** corresponding to that source produces a Position Demand shutdown. If “both” position demand sources are configured, alarms corresponding to both sources must occur to produce a Position Demand shutdown. Related alarms: “Analog Position Dmd Out of Range”, “DeviceNet or CANopen Communications Fault”, Related Shutdown: Both Position Demands Failed; Timeout.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: configurable

Position Demand Tracking

- This fault indicates that the difference between Analog Position Demand and DeviceNet or CANopen Position Demand exceeds the Tracking Fault Threshold for longer than the Tracking Fault Delay time.
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

Position Error Fault 1

- This fault indicates that the difference between Position Demand and Position Feedback exceeds the position error Fault 1 Threshold for longer than the Fault 1 Delay time.
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

Position Error Fault 2

- This fault indicates that the difference between Position Demand and Position Feedback exceeds the position error Fault 2 Threshold for longer than the Fault 2 Delay time.
- Type (alarm or shutdown): configurable
- Latching/non-latching response; configurable

Position 1 Range Fault

- This fault indicates that the Position 1 is less than (0 % - Position Range Threshold) or greater than (100 % + Position Range Threshold).
- Type (alarm or shutdown): configurable
- Latching/non-latching response: configurable

Position 2 Range Fault

- This fault indicates that the Position 2 is less than (0 % - Position Range Threshold) or greater than (100 % + Position Range Threshold).
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

Chapter 5.

Product Support and Service Options

Product Support Options

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

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

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

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

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

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

Product Service Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

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

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

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

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in "like-new" condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

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

When shipping the item(s), attach a tag with the following information:

- Return authorization number
- Name and location where the control is installed
- Name and phone number of contact person
- Complete Woodward part number(s) and serial number(s)
- Description of the problem
- Instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:

- Protective caps on any connectors
- Antistatic protective bags on all electronic modules
- Packing materials that will not damage the surface of the unit
- At least 100 mm (4 inches) of tightly packed, industry-approved packing material
- A packing carton with double walls
- A strong tape around the outside of the carton for increased strength

NOTICE

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

Replacement Parts

When ordering replacement parts for controls, include the following information:

- The part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- The unit serial number, which is also on the nameplate

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

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

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

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

For information on these services, please contact us via telephone, email us, or use our website: www.woodward.com.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at www.woodward.com/directory, which also contains the most current product support and contact information.

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

**Products Used in
Electrical Power Systems**

<u>Facility</u>	<u>Phone Number</u>
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 (124) 4399500
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**

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
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**

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (124) 4399500
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

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 _____

Turbine Model Number _____

Type of Fuel (gas, steam, 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.

DRFD to SPC Cross Reference

Table A-1 shows which SPC models replace various DRFD (Digital Remote Final Driver) models.

Table A-1. DRFD to SPC Cross Reference

8239-	Channels	Power Supply	Xdcr	Shutdown	Action	Driver Ranges (3) (4)	Comments	SPC Replacement Comments
005	1	redun	ac	nlatch	fwd	± 20, 40, 125, 250 mA	(5) cascade control, pilot valve fb	No replacement verified
006	2	redun	ac	latch	fwd	± 20, 40, 125, 250 mA		2 SPCs will work - PS redundancy must be performed externally. SPC has 100 mA range not 125 mA range.
007	2	single	dc	nlatch	rev	± 10, 20, 100, 250 mA	lead/lag control	2 SPCs will work - May have to re-tune speed control loop.
008	1	single	dc	nlatch	rev	± 10, 20, 100, 250 mA	lead/lag control	1 SPC will work - May have to re-tune speed control loop.
009	1	redun	ac	latch	fwd	± 20, 40, 125, 250 mA		1 SPC will work - PS redundancy must be performed externally. SPC has 100 mA range not 125 mA range.
010	1	redun	dc	latch	fwd	± 20, 40, 125, 250 mA	redun reference	1 SPC will work - PS redundancy must be performed externally. SPC does not offer redundant ref (high signal select). SPC has 100 mA range not 125 mA range.
011	1	redun	ac	latch	fwd	± 20, 40, 125, 250 mA	redun reference	1 SPC will work - PS redundancy must be performed externally. SPC does not offer redundant ref (high signal select). SPC has 100 mA range not 125 mA range.
014	2	redun	dc	nlatch	rev	± 10, 20, 100, 250 mA	lead/lag control	2 SPCs will work - PS redundancy must be performed externally. May have to re-tune speed control loop.
016	1	redun	ac	nlatch	fwd	± 20, 40, 125, 250 mA		1 SPC will work - PS redundancy must be performed externally. SPC has 100 mA range not 125 mA range.
030	2	redun	dc	latch	rev	± 10, 20, 100, 250 mA		2 SPCs will work - PS redundancy must be performed externally.
031	2	redun	dc	latch	fwd	± 10, 20, 100, 250 mA		2 SPCs will work - PS redundancy must be performed externally.
033	2	redun	no ne	latch	fwd	± 10, 20, 100, 250 mA	proportional actuator (1)	2 SPCs will work - PS redundancy must be performed externally. SPC position readback only reflects sensed valve xducer position.
035	1	single	ac	latch	fwd	± 20, 40, 125, 250 mA		1 SPC will work - SPC has 100 mA range not 125 mA range.
036	2	single	ac	latch	fwd	± 20, 40, 125, 250 mA		2 SPCs can work - SPC has 100 mA range not 125 mA range.
041	2	single	ac	latch	fwd	± 20, 40, 125, 250 mA	PI Controller	2 SPCs can work - SPC has 100 mA range not 125 mA range.
063	2	single	dc	nlatch	rev	± 10, 20, 100, 250 mA	lead/lag control (EHPC) (2)	2 SPCs can work - Must use external power source for EHPC xducer. May have to re-tune speed control loop.
065	2	redun	dc	nlatch	rev	± 10, 20, 100, 250 mA	lead/lag control (EHPC) (2)	2 SPCs can work - Must use external power source for EHPC xducer. PS redundancy must be performed externally. May have to re-tune speed control loop.

8239-	Channels	Power Supply	Xdcr	Shutdown	Action	Driver Ranges (3) (4)	Comments	SPC Replacement Comments
070	2	redun	dc	latch	fwd	± 20, 40, 100, 250 mA	SAE 8239-031, different driver ranges	2 SPCs will work - PS redundancy must be performed externally.
077	1	redun	dc	nlatch	rev	± 20, 40, 100, 250 mA	lead/lag ctrl, redun reference (EHPC) (2)	1 SPC will work - Must use external power source for EHPC xducer. PS redundancy must be performed externally. SPC does not offer redundant ref (high signal select). May have to re-tune speed control loop.
078	1	single	dc	nlatch	rev	± 10, 20, 100, 250 mA	lead/lag control (EHPC) (2)	1 SPC will work - Must use external power source for EHPC xducer. May have to re-tune speed control loop.
079	1	redun	dc	nlatch	rev	± 10, 20, 100, 250 mA	lead/lag control (EHPC) (2)	1 SPC will work - Must use external power source for EHPC xducer. PS redundancy must be performed externally. May have to re-tune speed control loop.
200	1	redun	dc	nlatch	fwd	± 10, 20, 100, 250 mA	lead/lag control (EHPC) (2)	1 SPC will work - Must use external power source for EHPC xducer. PS redundancy must be performed externally. May have to re-tune speed control loop.
201	2	single	dc	nlatch	fwd	± 10, 20, 100, 250 mA	lead/lag control (EHPC) (2)	2 SPCs will work - Must use external power source for EHPC xducer. May have to re-tune speed control loop.

Table Notes:

1. Meter is connected to **driver current** instead of position feedback.
2. EHPC controls includes **+24 V (dc) transducer power supply**. All controls include **±15 V transducer power supply**.
3. Unipolar ranges are not shown. Example: ±100 mA bipolar becomes (0 to 200) mA if unipolar is selected.
4. If all driver range jumpers are installed, the **maximum output current** is the sum of the ranges.
5. Non-linear circuit is provided for pilot valve loop.

Additional comments that apply to all units:

- DRFD enclosures are NEMA 4 rated. The SPC is not.
- Power input to DRFD is 120 V (dc) or V (ac). SPC is (18 to 32) V (dc).
- The SPC provides an NC status contact rather than a configurable one (NO or NC contact).
- The status contact on the DRFD is rated for 125 V (ac). The SPC's contact is only rated (18 to 32) V (dc).
- SPC only provides 18 V transducer power.
- SPC maximum output current is 250 mA.

Appendix B.

SPC DeviceNet Address Information

	BYTE	BIT	Data Type	Raw Low	Raw High	Eng Low	Eng High	Eng Units	INDEX	SPC DeviceNet	Woodward GAP Block
FAST TO SPC	0		UINT	0	65535	-10	110	PERCENT		Pos Demand LSB	DEMAND
	1			0	65535	-10	110			Pos Demand MSB	DEMAND
	2	0								Shutdown	SD
	2	1								Alarm Reset	ALM_RST
	2	2								Feedback Difference Override	FBDIFF_OVR
	3									Position Error Override	POSERR_OVR
	4									Command Trip Enable	CT_ENABLE
	5									Reserved	
	6									Reserved	
	7									Reserved	
	3									Reserved	Internal (INDEX_OUT)
	4									Index	
	5									Slow Data	
SLOW TO SPC	5		REAL			0	500		0	Reserved	KP (Proportional Gain)
			REAL			0	500		4	Reserved	KI (Integral Gain)
			REAL						8	Reserved	NULL_I (Actuator Null Current Setpoint)
			REAL						12	Reserved	NULL_I_OFF (Null Current Offset)
			REAL					PERCENT	16	Reserved	MANUAL_IN (Manual Position Demand)
			REAL						20	Reserved	MA_MIN_POS (mA at Min Position)
			REAL						24	Reserved	MA_MAX_POS (mA at Max Position)
									28	Reserved	Internal (CAL_STAT_R)(Calibration Request)
		0							30	Reserved	CAL_MODE_E (Enable Calibration)
		1		BOOL						Reserved	Internal (Calibration Permissive)
		2								Reserved	
		3								Reserved	
		4								Reserved	
		5								Reserved	
		6								Reserved	
	7								Reserved		
	8								Reserved		
	9								Reserved		
	10								Reserved		
	11								Reserved		
	12								Reserved		
	13								Reserved		
	14								Reserved		
	15								Reserved		
FAST FROM SPC	0		UINT	0	65535	-10	110	PERCENT		Position Feedback (LSB)	POS_RDBK
	1		UINT	0	65535	-10	110			Position Feedback (MSB)	POS_RDBK
	2		INT	-32768	32768	-250	250	mA		Actuator Current Demand LSB	CURRENT_DMD
	3		INT	-32768	32768	-250	250	mA		Actuator Current Demand MSB	CURRENT_DMD
	4	0							Reserved		
	1		WORD						Shutdown	SPC_SD	
	2		WORD						Alarm	SPC_AL	
	3		WORD						Position Demand Shutdown	DEMAND_SD	
	4		WORD						Position Demand Alarm		
	5		WORD						Driver Fault	DRV_FLT	
	6								Reserved		
	7		WORD						Position Error Shutdown	POS_ERR_SD	
	5	0	WORD						Position Error Alarm	POS_ERR_AL	
	1		WORD						Feedback Difference Shutdown	FB_DIF_SD	
	2		WORD						Feedback Difference Alarm	FB_DIF_ALM	
	3		WORD						Feedback Fault Shutdown	FB_FLT_SD	
	4		WORD						Feedback Fault Alarm	FB_FLT_ALM	

BYTE	BIT	Data Type	Raw Low	Raw High	Eng Low	Eng High	Eng Units	INDEX	SPC DeviceNet	Woodward GAP Block
	5								Reserved	
	6								Reserved	
	7								Reserved	
	6	USINT							Index	Internal (INDEX_LAST)
	7	USINT							Slow Data	
SLOW FROM SPC	7	REAL						0	Analog Position Demand	ANALOG_DMD
		REAL						4	DeviceNet Position Demand	FLDBUS_DMD
		REAL						8	Position Demand	POSN_DMD
		REAL						12	Feedback 1	POS_RDBK_1
		REAL						16	Feedback 2	POS_RDBK_2
		REAL				VRMS		20	Feedback V1A	FDBK_V_1A
		REAL				VRMS		24	Feedback V1B	FDBK_V_1B
		REAL				VRMS		28	Feedback V2A	FDBK_V_2A
		REAL				VRMS		32	Feedback V2B	FDBK_V_2B
		REAL				mA		36	Measured Actuator Current	MA_OUT
		UJINT				OHMS		40	Actuator Ohms	ACT_OHMS
		UJINT						42	Calibration Status	SPC_CAL_ST
		UJINT						44	Operation Status	OP_STATUS
								46	Active Position Demand	ACTIVE_DMD
	0							48	External Shutdown	EXTERN_SD
	1								DeviceNet Shutdown	FB_SD
	2								Reserved	
	3								Invalid Configuration	
	4								Internal Fault	INTERN_FLT
	5								Input Voltage Out of Range	IN_V_ERR
	6								Position Demand Tracking Alarm	DMD_TRK_AL
	7								DeviceNet Position Demand Rate Alarm	D_RATE_FLT
	8								DeviceNet Demand Alarm	FB_DMD_AL
	9								Analog Position Demand Alarm	AN_DMD_AL
	10								Driver Current Fault	CURR_FLT
	11								Driver Short Fault	DRV_SHORT
	12								Driver Open Fault	DRV_OPEN
	13								Excitation Fault	EXC_FLT
	14								Position Range 1 Fault	POS_RNG_1
	15								Position Range 2 Fault	POS_RNG_2
	0							50	Feedback 1 Range Fault	FB_RNG_1
	1								Feedback 2 Range Fault	FB_RNG_2
	2								Feedback 1 Open Fault	FB_OPEN_1
	3								Feedback 2 Open Fault	FB_OPEN_2
	4								Feedback 1 Fault	
	5								Feedback 2 Fault	
	6								Driver Overcurrent Fault	DRV_OVRCT
	7								Slow Data Fault	
	8								Reserved	
	9								Reserved	
	10								Reserved	
	11								Reserved	
	12								Reserved	
	13								Reserved	
	14								Reserved	
	15								Reserved	

Appendix C.

SPC Driver with Pollution Resistance

SPC Part Number	Rev	Description
8200-226	C	Servo Position Controller with silicon coating
8200-226	D	Servo Position Controller with polyacrylate coating

SPC revisions prior to Rev C are coated with a silicon coating material.

Appendix D.

CANopen Communication

Introduction

IMPORTANT

The CANopen communications described in this manual are a typical Woodward implementation.

The CAN network that is used for the CANopen communication with the SPC has one NMT Master (Network Master Management Node). This node is responsible for starting communication and the timing of the CAN messages. There can be up to 30 slave devices (depending on network load and timing).

Network Architecture

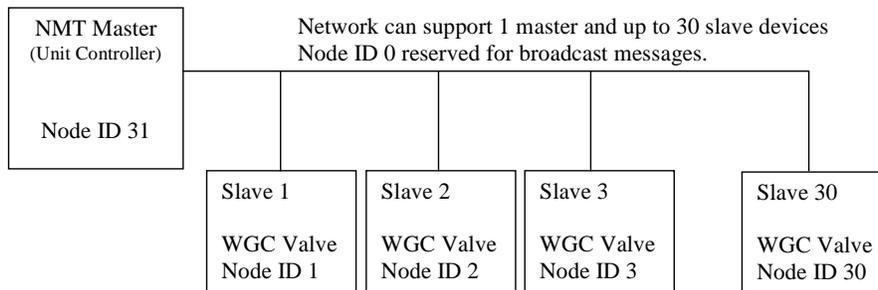


Figure D-1. Network Architecture

Addressing can support up to 31 devices. To meet the 10 ms timing requirement, only 10 devices can be used at 500 kbaud.

NMT Master Functions

There are four distinct functions the master can perform. The slave units will respond to these functions.

NMT Block Diagram (Woodward Implementation)

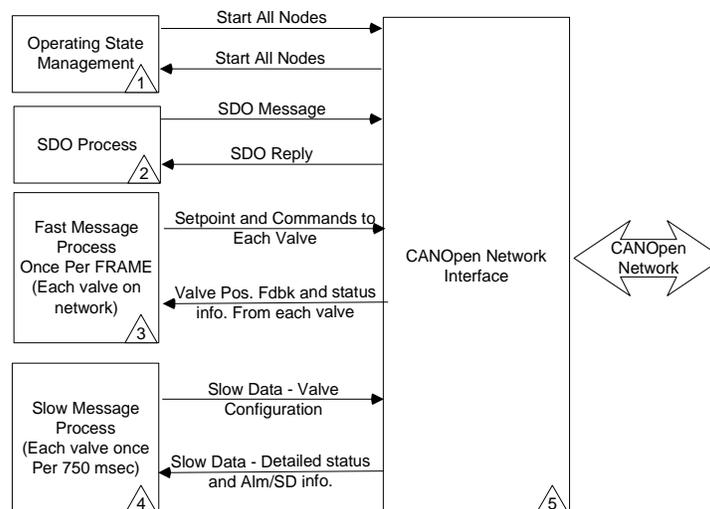


Figure D-2. NMT Block Diagram

- 1) Operating state management: This function is used to change the operational state of the slave devices.
- 2) SDO process: This function is used to read and/or write SDO data into or out of the slave devices. SDO data is typically non-time critical data.
- 3) Fast Message process: This function will read and write the fast messages (once every frame) to the slave devices. This is time critical data and needs to have priority over the other messages. There is also a synch message supported for timing purposes.
- 4) Slow Message process: This function will read and write the slow messages to and from the slaves. Typical update rate is 750 ms.

Operating State Management

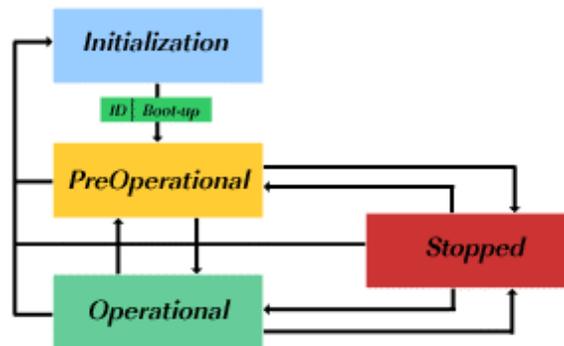


Figure D-3. CANopen Slave State Diagram

The above state diagram is taken from the CANopen specification.

Initialization:

NMT and SPC: The initialization state is used to open the CAN ports and to initialize the CANopen stack. After this is done the SPC, will go to the NMT Pre-Operational state automatically. It will send the Boot up message. The Boot up message is the Heartbeat message. Once the Boot up message is sent, the Heartbeat message is disabled.

Pre-Operational:

SPC: In this state, the SPC is waiting for the "Start All Nodes" message. When the message is received, the SPC will go to the Operational state.

NMT Master: In this state, the NMT will transmit a "Start All Nodes" Message. This message will also be received by the NMT Master and will cause the Master to transition to the Operational State.

Operational:

SPC: In this state the SPC is in operational mode and will perform all send and receive functions.

NMT Master: In this state NMT will execute all functions.

- Operational state management.
- SDO process.
- Fast messages
- Slow Messages

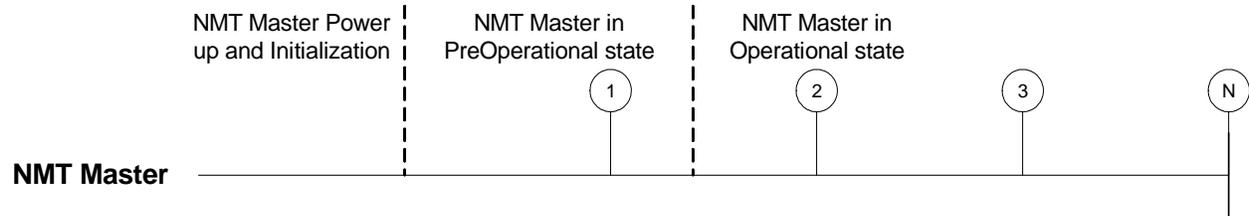
The NMT master will transmit "Start All Nodes" broadcast message every 1 Sec. By sending this message at a periodical cycle we make sure that nodes that are added or power cycles will go back to the operational state without having to reset the NMT Master.

Stopped:

The Stopped state is not used.

Timing:

In a timing diagram, the process will look like this:



- ① NMT Master Transmits "Start All Nodes"
- ② NMT Master Transmits "Start All Nodes" (Time = 0 Sec)
- ③ NMT Master Transmits "Start All Nodes" (Time = 1 Sec)
- ④ NMT Master Transmits "Start All Nodes" (Time = N Sec)

Note: Other messages not shown.

Figure D-4. Process Timing Diagram

SDO Process

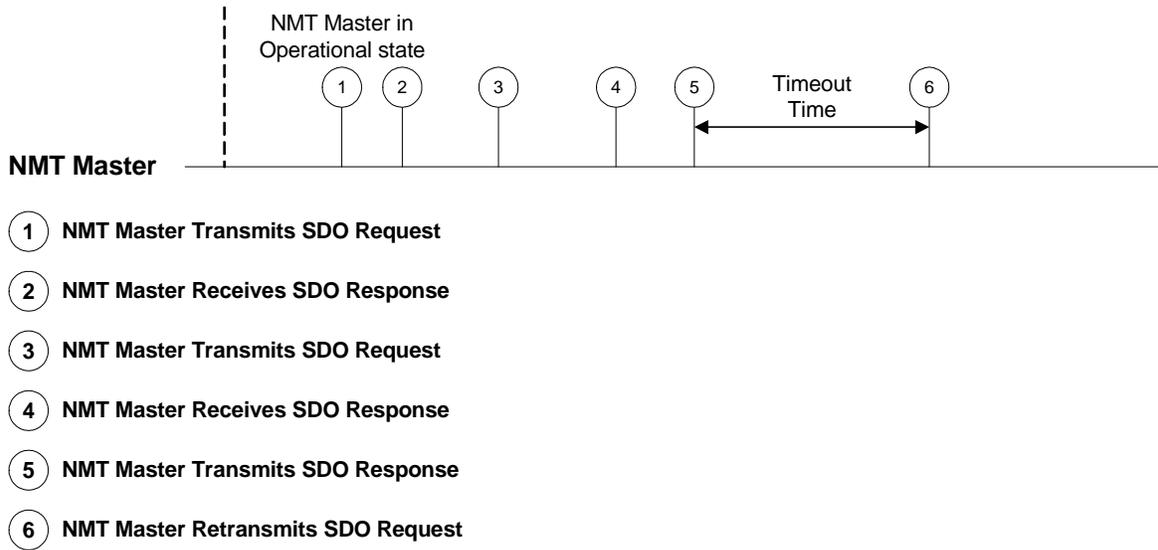
Master will send SDO messages to each valve to retrieve SPC specific information such as serial number, part number, etc.

All SDO data will be requested when the NMT master goes from Pre-Operational to Operational. Woodward gives the designed application the option to request all this information under application control. This is to make sure that when the slave devices are powered, cycled, or added, their information is updated.

The SDO protocol only allows one request message to be sent. The next message will be sent after a response has been received for the previous message. If no response will be received the NMT master must timeout. The timeout time typical used is 1 second.

Timing:

In a timing diagram, the process will look like this:



Note: Other messages not shown.

Figure D-5 SDO Process Timing Diagram

Fast Message Process

There are three messages needed to make this process work.

- Fast message to slave
- Fast message from slave
- Synch message to slave

Fast Message to slave: NMT will send a message to the slave within one Frame. This data is processed but not used until the synch message is received. Typical data is the position demand, shutdown flags etc.

Fast messages from the slave: Slave will send a message to the NMT. Typical data is the actual position, the shutdown status of the slave etc.

The sent synch message from the master to the slave will do two things.

- If the slave receives the synch, it will update the fast message information and start using this information.
- If the slave receives the synch, it will send back the fast messages from slave.



WARNING

CANopen communication link has a timeout value between 0 ms to 30000 ms and it can be specified through Service tool. It is important to insure the CANopen timeout is set accordingly and use discrete output as shutdown in case of error detection.

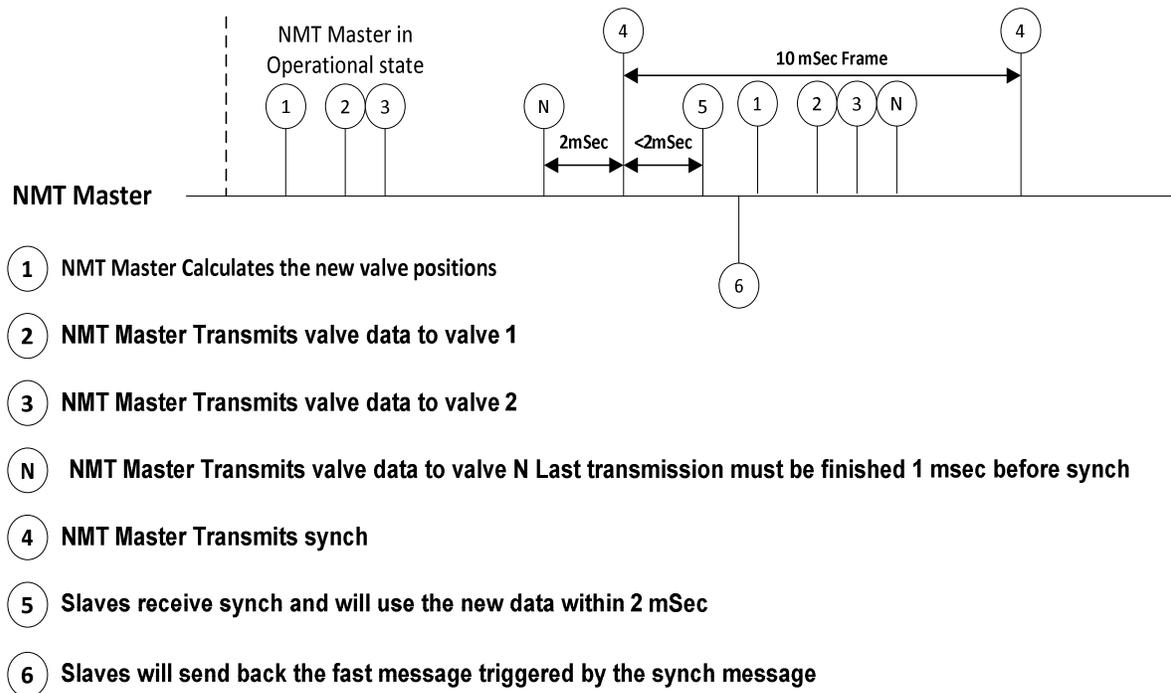
Error Detection:

The slave's error detection is done by checking if the synch message and the fast data message is received within a given timeout time. Typical timeout time is set to 40 ms for a 10 ms rate group and can be changed using the Service tool. This timeout time is variable depending on the turbine performance and application. It is up to the system integrator to determine this timeout number.

The master error detection is the same as the slave error detection with the exception it will look to the fast message from slave to determine if the communication is failed. Again, the system integrator must determine if the timeout time is acceptable for the system/turbine.

Timing:

In a timing diagram, the process will look like this:



Note: Other messages not shown.

Figure D-6 Fast Message Process Timing Diagram

Slow Message Process

The slow messages are used to get additional status information and set parameters in the slave device. To make sure the CAN bus is not overloaded, the NMT master must send slow messages at a rate that will allow all messages to be sent and received. Woodward spaces the messages so that all slaves are addressed once every 750 ms.

The control will send a slow message every 2 ms, then wait 75 ms after the first slow message is sent before the control starts sending to the next valve. Thus, each valve will receive and transmit slow messages within 75 ms. Max number of SPCs in the network is 10.

So the total update time for all valves will be $10 * 75 \text{ ms} = 750 \text{ ms}$.

The Slave will **not** send any slow messages until the first slow messages (this is RxPDO2, slow message number 1) is received. This way the NMT master can control the bus loading by determining which slave will reply with its slow messages. The Slave slow message data is sent on a 2 ms tick. The slave will use default data when no slow messages have been received.

Timing:

In a timing diagram, the process will look like this:

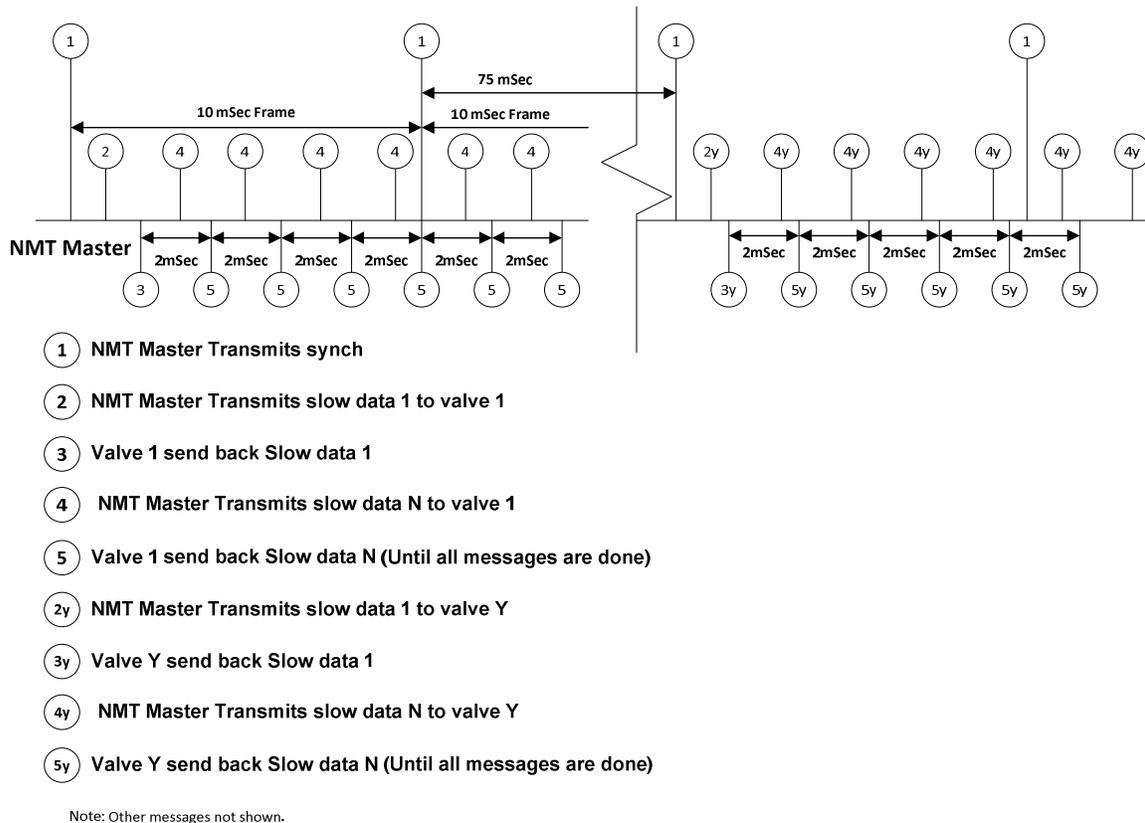


Figure D-7 Slow Message Process Timing Diagram

Putting it all together

Assumptions for calculations:

# of bytes in fast Messages to SPC:	5
# of bytes in fast Messages from SPC:	15
# of bytes in synch message:	1
# of slow messages to SPC:	4
# of slow messages from SPC:	5
# of data byte in slow message:	8
# of SDO messages per 10 ms:	2
# of SDO bytes:	8
CAN link running at:	500 KBits = 2 μ s per bit
Frame Rate:	10 ms
Max number of SPCs:	10
Message overhead is:	51 Bits

All Message Sent in a Frame

Fast Messages:

If we have 10 valves on the network, the NMT master will send 10 fast messages and we will receive 20 fast messages.

The control also needs to send a synch message.

Total Fast message time = Valve's * (((Overhead + (TxBytes * 8)) * Tperbit) + ((Overhead + (RxBytes * 8)) * Tperbit))

$$10 * (((51 + (5 * 8)) * 2 \text{ uSec}) + (((2*51) + (15 * 8)) * 2 \text{ uSec})) = 6.26 \text{ mSec}$$

Total Synch message time is = ((Overhead + (SynchDatabytes * 8)) * Tperbit)

$$((51 + (1 * 8)) * 2 \text{ uSec}) = 118 \text{ uSec}$$

Total time is: 6.26 mSec + 0.118 mSec = 6.378 mSec

Total Load is: (6.378 mSec / 10 mSec) * 100 = 63.78%

Slow messages:

Number of slow messages sent and received in one frame is 4 + 5 = 9 (total number of slow messages to/from one SPC). Slow messages are sent every 2 mSec.

Total Slow message time = Number of messages * ((overhead + (RXTxbytes * 8)) * Tperbit)

$$9 * ((51 + (84 * 8)) * 2 \text{ uSec}) = 2.07 \text{ mSec}$$

Total peak Load is: (2.07 mSec / 10 mSec) * 100 = 20.70%

SDO messages:

We can send and receive one SDO message per frame that is two messages.

SDO message time is = 2 * ((Overhead + (SDO bytes * 8)) * Tperbit)

$$2 * ((51 + (8 * 8)) * 2 \text{ uSec}) = 460 \text{ uSec}$$

$$\text{Total load} = (0.46 \text{ mSec} / 10 \text{ mSec}) * 100 = 4.6\%$$

The CAN link load is now:

$$63.78\% + 20.70\% + 4.6\% = 89.08\%$$

Definitions

Frame

One frame is defined as the time that it takes to process the input IO, transfer this data to the application level, calculate a new valve setpoint, send a fast message to each valve driver, and finally send a SYNC message out on the CANopen Network.

Example: In Woodward Controllers one FRAME is defined by the rate group that is specified in the CANopen interface block. This is typically 10 ms but can also be 5 ms, 20 ms, 40 ms, or 80 ms.

IMPORTANT

The required FRAME time is a function of the application requirements and is the responsibility of the system integrator to define the requirements for FRAME time. Woodward typical values apply to Woodward systems only. In Woodward systems, all controller-timing parameters (latency, jitter, execution times, etc.) are known and are considered in the calculation of FRAME times.

Simple Block Diagram to Define Frame Time

Frame time is the time that it takes for the turbine controller to sample the inputs, execute the main application code, and send the SYNC message out on the CANopen network.

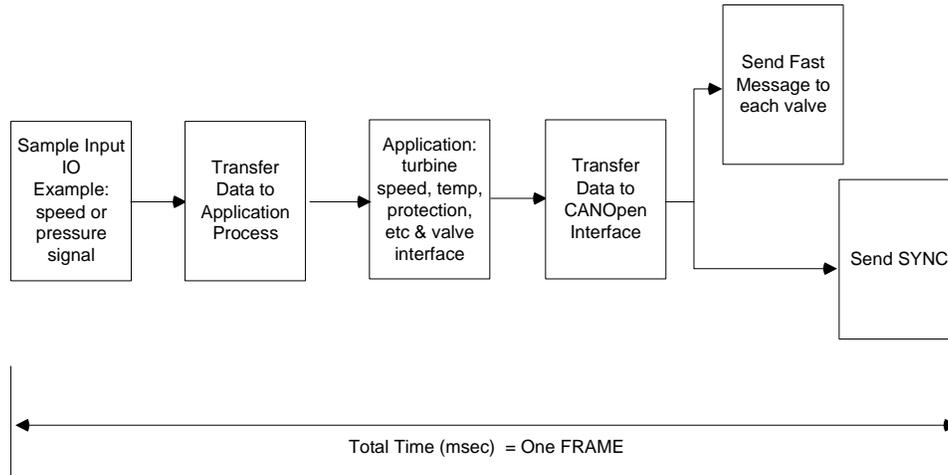


Figure D-8 Frame Time Diagram

Transmit PDO Summary

Table D-1. Transmit PDO Summary

Id base	Tx PDOs	Name	CAN Byte	Message or Data Type	Mfr # hex
0x180	PDO1	Fast Message		Sync	
		Actual position	0,1	uint16	2034
		Actual Current	2,3	uint16	2035
		Status	4,5	Array[16] Boolean	2036
		Feedback Faults	6	Array[8] Boolean	2301
0x280	PDO2	Fast Message 2 nd		Sync	
		Feedback 1A Voltage	0-1	uint16	2302
		Feedback 1B Voltage	2-3	uint16	2302
		Feedback 2A Voltage	4-5	uint16	2302
		Feedback 2B Voltage	6-7	uint16	2302
0x380	PDO3	Position Demand		Async	
		Analog Position Demand	0-3	float	2303
		CANopen Position Demand	4-7	float	2304
0x480	PDO4	Position Demand/Act Current		Async	
		Position Demand	0-3	float	2305
		Actuator Current	4-7	float	2035
0x1E0	PDO5	Position Feedback 1/2		Async	
		Position Feedback 1	0-3	float	203B
		Position Feedback 2	4-7	float	203C
0x2E0	PDO6	Act Ohms and Calibration		Async	
		Actuator Ohms	0,1	uint16	2306
		Calibration Status	2,3	uint16	2307
		Operational Status	4,5	uint16	2308
		Active Position Demand	6,7	uint16	2309

Id base	Tx PDOs	Name	CAN Byte	Message or Data Type	Mfr # hex
0x3E0	PDO7	Status Error Register 1		Async	
		Status Error Register 1	0,1	Array[16] Boolean	203F

Receive PDO Summary

IMPORTANT

The manufacturer numbers given here for SDO access are for reference. SDO writes are not supported, the data must be written with the PDOs.

Table D-2. Receive PDO Summary

Id base (hex)	Rx PDOs	Name	CAN Byte	Type	Mfr # (hex)
0x200	PDO1	Fast Message			
		Position Demand	0,1	uint16	2022
		Command Bits	2	Array[8] Boolean	2023
		WTA Feedback 1 weighted average ratio	3,4	uint16	230A
		Unused	5-7		
0x300	PDO2	Gains			
		Proportional Gain	0-3	float	230B
		Integral Gain	4-7	float	230C
0x400	PDO3	Calibration Currents 1			
		Actuator Null Current	0-3	float	230D
		Null Current Offset	4-7	float	230E
0x500	PDO4	Calibration Currents 2			
		Min Position Current	0-3	float	2311
		Max Position Current	4-7	float	2312
0x260	PDO5	Calibration			
		Manual Position Input	0-3	float	2313
		Calibration Status Request	4-5	uint16	230F
		Calibration Commands	6-7	uint16	2310

Receive (Rx) PDO Definitions

IMPORTANT

Data length must be sent as specified.

Receive PDO 1 – Realtime “Fast Message” with Demand and Command Bits

This and a sync message need to be received within the configured timeout.

IMPORTANT

If PDO 1 is not received within the configured timeout SPC will enter shutdown state if it is configured only for CANopen use or switch to analog position demand if both analog and CANopen position inputs are enabled. Last received feedback weight will be used for position feedback calculation if both position feedbacks are used and Feedback 1 and 2 External Failure flags will default to 0 (operational).

Message type: “SYNC” (requires SYNC message)
 COB Id: 512+Node Id (0x200+NodeId)
 Data length: 5 bytes

Data:**Byte 1-2:** Position Demand

Data length: 2 bytes, byte1 is LSB, byte 2 MSB.
 Resolution: 16 bits
 Units: %
 Scaling: (0 to 65535) for (-10% to 110%)

Byte 3: Command Byte 1

Data length: 1 byte

Bit 0: Shutdown. If this bit is "1", the SPC will shutdown and set the Shutdown bit.

Bit 1: Reset diagnostics bits. On a "0" to "1" transition (Edge triggered,) the SPC will reset from a shutdown or alarm condition and reset all the diagnostic bits.

Bit 2: Feedback override. If it is set to 1, prevents the Feedback Difference Alarm and Feedback Difference Shutdown outputs from causing an alarm and a shutdown, respectively

Bit 3: Position Error override. If it is set to 1, prevents the Position Error Alarm and Position Error Shutdown outputs from causing an alarm and a shutdown, respectively

Bit 4: Trim enable. If it is set to 1, the proportional control attempts to match the position feedback to the position demand.

Bit 5: Feedback 1 External Failure. If it is set to 1, it will cause external feedback 1 fault set.

Bit 6: Feedback 2 External Failure. If it is set to 2, it will cause external feedback 2 fault set.

Bit7: Reserved. Sent as 0.

Bytes 4-5: WTA Feedback 1 weighted average ratio.

Data length: 2 bytes, byte1 is LSB, byte 2 MSB.
 Resolution: 16 bits
 Units: n/a
 Scaling: (0 to 65535) for (0 to 1)

Bytes 6-8: These bytes are unused.

Receive PDOs 2-5 – Parameter Based “Slow Messages”

If slow messages are not received, the SPC uses values that are in RAM. During start-up the RAM will be filled with the EEPROM parameters. The variables in RAM will be used when the parameters is updated from the Service Tool.

If the slow messages are received, the SPC will use these parameters. The exception is if the ENABLE bits are not set, then the SPC will continue using the RAM parameters.

IMPORTANT

If the ENABLE bit is toggled from ENABLE true to ENABLE false, the control will use the RAM and the last value received from the CANopen link.

Receive PDO 2 – Slow Message: #1 Proportional and Integral Gain

Message type: “ASYNC”
 COB Id: 768+Node Id (0x300+NodeId)
 Data length: 8 bytes

Data:

Byte 1-4: Proportional Gain

Data length: 4 bytes, Float.
 Units: n/a
 Range: 0 to 500

Byte 5-8: Integral Gain

Data length: 4 bytes, Float.
 Units: n/a
 Range: 0 to 500

Receive PDO 3 – Slow Message: #2 Actuator Null Current and Offset

Message type: “ASYNC”
 COB Id: 1024+Node Id (0x400+NodeId)
 Data length: 8 bytes

Data:

Byte 1-4: Actuator Null Current

Data length: 4 bytes, Float.
 Units: mA
 Range: -250 to 250 mA

Byte 5-8: Null Current Offset

Data length: 4 bytes, Float.
 Units: mA
 Range: -250 to 250 mA

Receive PDO 4 – Slow Message: #3 Current at Minimum and Maximum Position

Message type: “ASYNC”
 COB Id: 1280+Node Id (0x500+NodeId)
 Data length: 4 bytes

Data:

Byte 1-4: Minimum Position Current

Data length: 4 bytes, Float.
 Units: mA
 Range: -250 to 250 mA

Byte 5-8: Maximum Position Current

Data length: 4 bytes, Float.
 Units: mA
 Range: -250 to 250 mA

Receive PDO 5 – Slow Message: #4 Calibration and Manual Position Input

Message type: "ASYNC"
 COB Id: 608+Node Id (0x260+NodeId)
 Data length: 2 bytes

Data:**Byte 1-4: Manual Position Input**

Data length: 4 bytes, Float.
 Units: %
 Range: -10 to 110%

Bytes 5-6: Calibration Status Request

Data length: 2 bytes, Enum
 Units: n/a
 Values: 0 – No Request
 1 – Set Minimum Position
 2 – Set Maximum Position
 3 – Verify Field Calibration
 4 – Save Calibration
 5 – Manual Stroke
 6 – Clear Calibration

Bytes 7-8: Calibration Mode Request

Data length: 2 bytes, Boolean
 Units: n/a
 Range: 0 for False, 1 for True

Transmit (Tx) PDO Definitions

There are two "Fast Message" sent from the SPC.
 There are additional "Slow Message" sent for monitoring purposes.

Transmit PDO 1 – Actual Position, Current and Status**Realtime Fast Message**

Message type: Transmitted in Response to NMT Sync Message.
 COB Id: 384+Node Id (0x180+NodeId)
 Data length: 7 bytes

Data:**Byte 1-2: Actual Position**

Data length: 2 bytes, byte1 is LSB, byte 2 MSB.
 Resolution: 16 bits
 Units: %
 Scaling: (0 to 65535) for (-10% to 110%)

Byte 3-4: Actual Current

Data length: 2 bytes, byte1 is LSB, byte 2 MSB.
 Resolution: 16 bits
 Units: Amps
 Scaling: (0 to 65535) for (-250mA to 250mA)

Byte 5-6: SPC Status Bits

Data length: 2 bytes

- Bit 0: Not Used
- Bit 1: SPC Shutdown
- Bit 2: SPC Alarm
- Bit 3: Position Demand Fault
- Bit 4: Position Demand Alarm
- Bit 5: Driver Fault
- Bit 6: Not Used
- Bit 7: Position Error Shutdown
- Bit 8: Position Error Alarm
- Bit 9: Feedback Difference Shutdown
- Bit 10: Feedback Difference Alarm
- Bit 11: Feedback Fault Shutdown
- Bit 12: Feedback Fault Alarm
- Bit 13-15: Not Used

Byte 7-8: Feedback Status Bits

Data length: 2 bytes

- Bit 0: Feedback 1 Range Fault
- Bit 1: Feedback 2 Range Fault
- Bit 2: Position 1 Range Fault
- Bit 3: Position 2 Range Fault
- Bit 4: Feedback 1 Open Fault
- Bit 5: Feedback 2 Open Fault
- Bit 6-15: Not Used

Transmit PDO 2 – Feedback Voltages

Message type: Transmitted in Response to NMT Sync Message.

COB Id: 640+Node Id (0x280+NodeId)

Data length: 8 bytes

Data:**Byte 1-2: Feedback 1A Voltage**

Data length: 2 bytes, fixed point 5.11 format.

Units: Volts

Byte 3-4: Feedback 1B Voltage

Data length: 2 bytes, fixed point 5.11 format.

Units: Volts

Byte 5-6: Feedback 2A Voltage

Data length: 2 bytes, fixed point 5.11 format.

Units: Volts

Byte 7-8: Feedback 2B Voltage

Data length: 2 bytes, fixed point 5.11 format.

Units: Volts

Transmit PDO 3 – Slow Message #1: Analog/CANopen Position Demand

Message type: Transmitted after receipt of Receive PDO 2.

COB Id: 896+Node Id (0x380+NodeId)

Data length: 8 bytes

Data:**Byte 1-4: Analog Demand**

Data length: 4 bytes, Float.

Units: %

Byte 5-8: CANopen Demand

Data length: 4 bytes, Float.

Units: %

Transmit PDO 4 – Slow Message #2: Position Demand and Actuator Current

Message type: Transmitted 2 ms after receipt of Receive PDO 2.

COB Id: 1152+Node Id (0x480+NodeId)

Data length: 8 bytes

Data:**Byte 1-4: Actual Position Demand**

Data length: 4 bytes, Float.

Units: %

Byte 5-8: Actuator Current

Data length: 4 bytes, Float.

Units: mA

Transmit PDO 5 – Slow Message #3: Position Feedback 1/2

Message type: Transmitted 4 ms after receipt of Receive PDO 2.

COB Id: 480+Node Id (0x1E0+NodeId)

Data length: 4 bytes

Data:**Byte 1-4: Position Feedback 1**

Data length: 4 bytes, Float

Units: %

Byte 5-8: Position Feedback 2

Data length: 4 bytes, Float

Units: %

Transmit PDO 6 – Slow Message #4: Actuator Ohms and Device Status

Message type: Transmitted 6 ms after receipt of Receive PDO 2.

COB Id: 736+Node Id (0x2E0+NodeId)

Data length: 8 bytes

Data:**Byte 1-2: Actuator Resistance**

Data length: 2 bytes

Units: Ohms

Byte 3-4: Calibration Status

Data length: 2 bytes, Enum

Units: n/a

Values:

- 0 – Not Calibrated
- 1 – Waiting for Minimum
- 2 – Waiting for Maximum
- 3 – Verifying Calibration
- 4 – Manual Stroking
- 5 – Calibration Complete

Byte 5-6: Operational Status

Data length: 2 bytes, Enum

Units: n/a

Values: 0 – Power up self-test
1 – Configuration
2 – Run
3 – Field Calibration
4 – Factory Calibration

Byte 7-8: Active Position Demand

Data length: 2 bytes, Enum

Units: n/a

Values: 0 – Demand is Analog Demand
1 – Demand is CANopen Demand

Transmit PDO 7 – Slow Message #5: Status Error Flags

Message type: Transmitted 8 ms after receipt of Receive PDO 2.

COB Id: 992+Node Id (0x3E0+NodeId)

Data length: 2 bytes

Byte 1-2: Error Status

Data length: 2 bytes

Bit 0: External Shutdown

Bit 1: CANopen Shutdown

Bit 2-3: Not Used

Bit 4: Internal Fault

Bit 5: Input Voltage Fault

Bit 6: Demand Tracking Alarm

Bit 7: CANopen Demand Alarm

Bit 8: Driver Overcurrent Fault

Bit 9: Analog Demand Alarm

Bit 10: Driver Current Fault

Bit 11: Driver Short Fault

Bit 12: Driver Open Fault

Bit 13: Excitation Fault

Bit 14-15: Not Used

Revision History

Changes in Revision W—

- Added Warning box below Figure 4-23 on Page 52

Changes in Revision V—

- Added SPC information throughout the manual
- New part numbers to Chapter 1
- New Figures 2-3, 2-4a, and 2-4b
- New tables and content in CANopen Interface section of Chapter 2.
- Deleted Appendix C and added Appendix D

Changes in Revision U—

- Updated Compliance Section
- Added Mechanical Specification to Chapter 3
- Updated Declaration of Conformity

Changes in Revision T—

- Updated ATEX to comply with EN60079-0:2012/A11:2013 and EN60079-15:2010
- Removed LCIE as the notified body
- Updated Declaration of Conformity

Changes in Revision R—

- Updated table in Appendix B
- Updated Declaration of Conformity

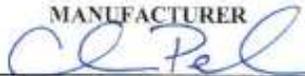
Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.: 00170-04-EU-02-01
Manufacturer's Name: WOODWARD INC.
Manufacturer's Contact Address: 1041 Woodward Way
 Fort Collins, CO 80524 USA
Model Name(s)/Number(s): Servo Position Controller
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation: Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
 Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)
Markings in addition to CE marking:  Category 3 Group II G, Ex nA IIC T4X Gc IP20
Applicable Standards: EN 61000-6-4, 2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments
 EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
 EN60079-0, 2012: Explosive Atmospheres - Part 0: Equipment – General requirements
 EN60079-15, 2010: Explosive Atmospheres - Part 15: Equipment protection by type of protection "n"

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

MANUFACTURER



Signature

Christopher Perkins

Full Name

Engineering Manager

Position

Woodward, Fort Collins, CO, USA

Place

Date

01 - JUN - 2016

5-09-1183 Rev 26

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication **26236**.



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