



## **SPC Servo Position Controller**

**8200-226 (CE, ATEX, CSA, Marine)  
plus older models 8200-224 & 8200-225**

**Installation and Operation Manual**

## IMPORTANT



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

## DEFINITIONS

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

## WARNING

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.



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



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

## NOTICE

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

## 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*.

Revisions—Text changes are indicated by a black line alongside the text.

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## Regulatory Compliance

### European Compliance for CE Marking:

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

**ATEX Explosive Atmospheres Directive:** Declared to 94/9/EEC COUNCIL DIRECTIVE of 23 March 1994 or the approximation of the laws of the Member States concerning equipments and protective systems intended for use in potentially explosive atmospheres.

### 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

### Other European and International Compliance:

**GOST R:** Certified for use in ordinary locations with the Russian Federation per GOST R certificate  
POCC US.MJ03.B00628

## 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.
- The Servo Position Controller is suitable for use in European Zone 2, Group IIC environments per LCIE certification.
- 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.
- To meet the requirements for European Zone 2 Hazardous Location, the SPC must be mounted in an enclosure with ingress protection of IP54 or greater.

- 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.



**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.**



**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.**

## Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).
2. 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.
3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.
4. 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.

### **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*.



# Chapter 1.

## General Information

The 8200-226 is the latest released model of the SPC (Servo Position Controller). It replaces models 8200-224 and 8200-225.

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™ \*, (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.

\*—DeviceNet is a trademark of Open DeviceNet Vendor Association, Inc (ODVA)

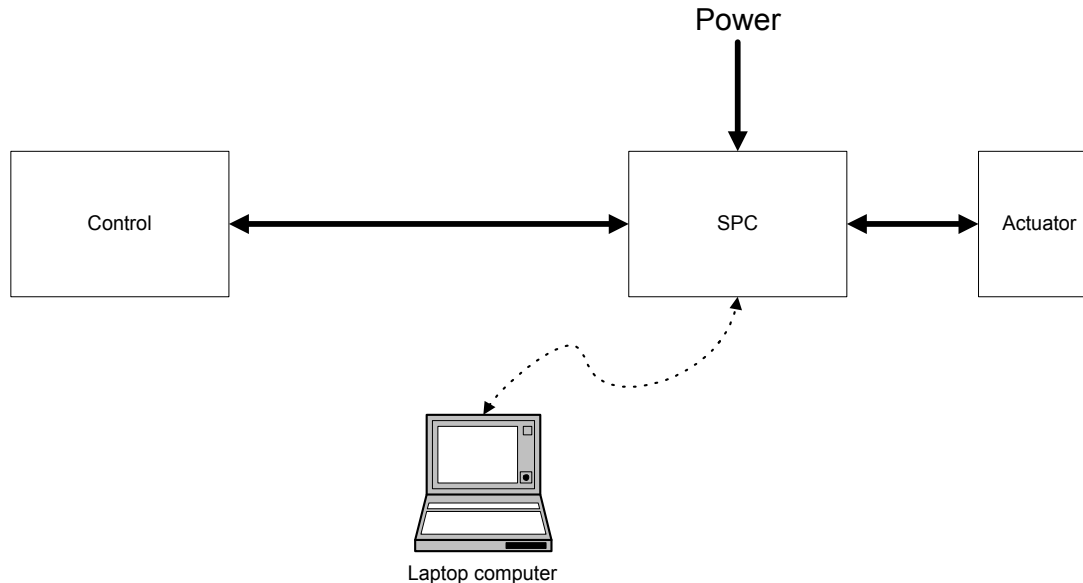


Figure 1-1. SPC Connections

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 DeviceNet link. 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.

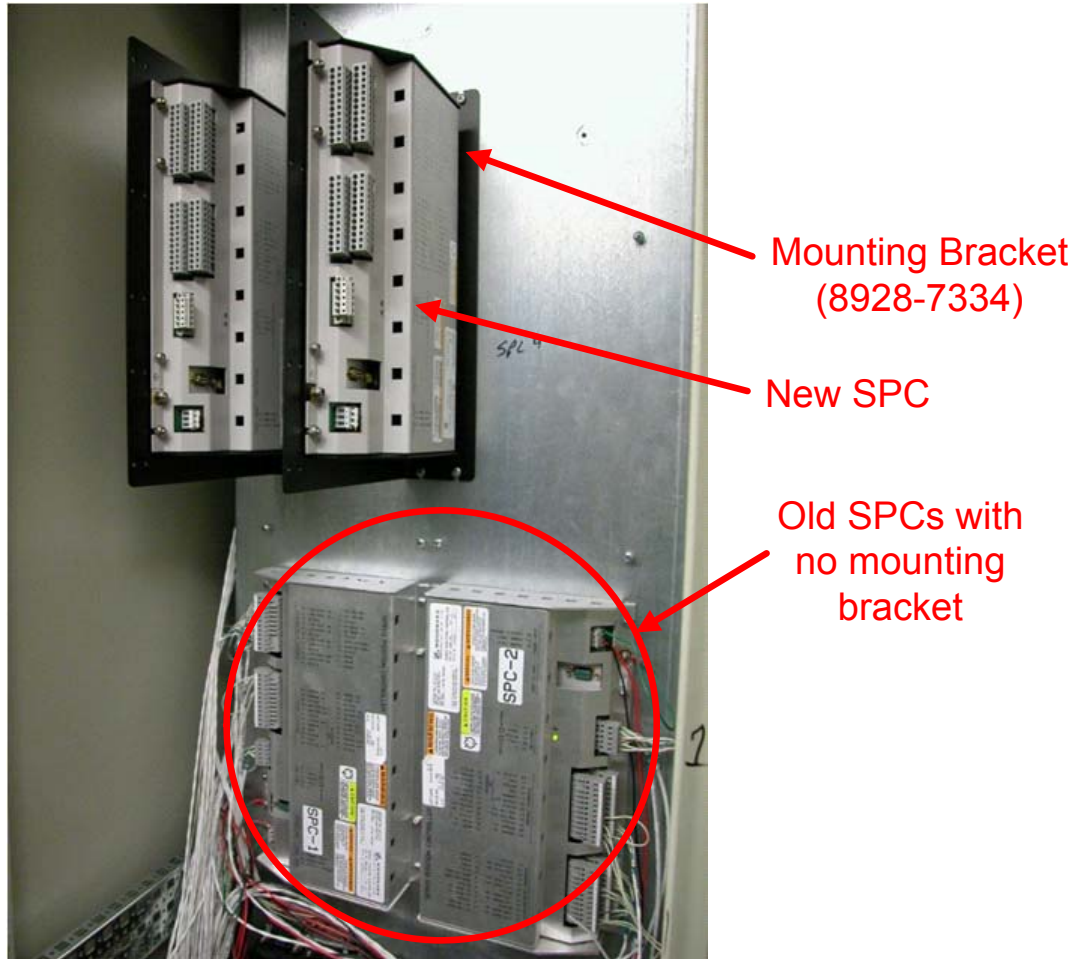
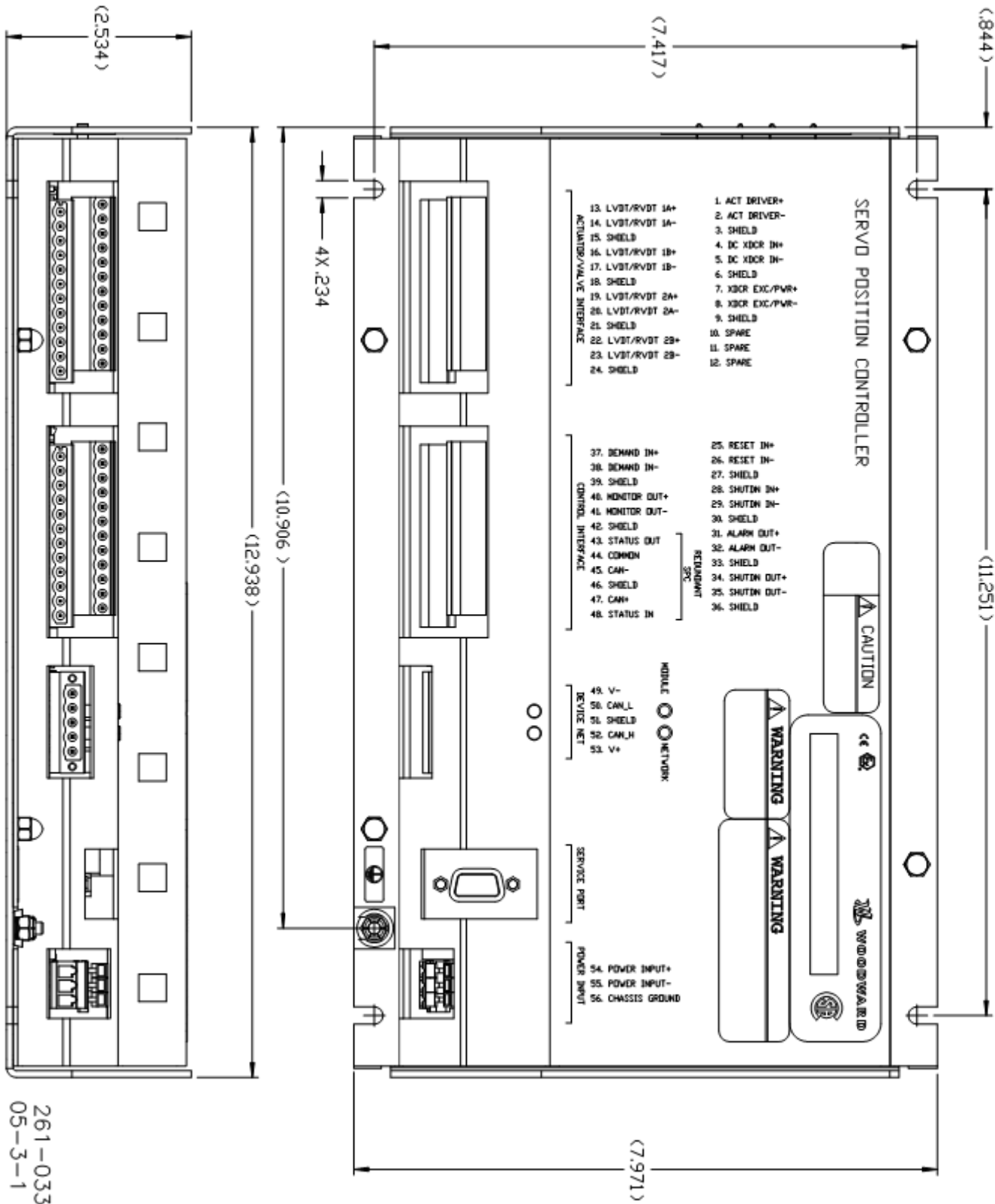


Figure 2-1. Optional SPC Mounting Bracket

## 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 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 screwless 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) mm<sup>2</sup> / (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  $\pm 10$  mA,  $\pm 25$  mA,  $\pm 50$  mA,  $\pm 100$  mA and  $\pm 250$  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.

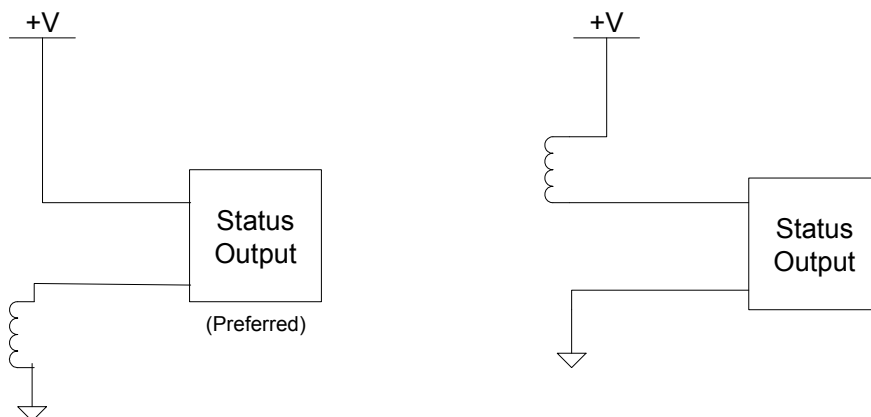


Figure 2-3. Status Relay Driver Output Wiring

**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**

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.

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](http://www.woodward.com/software), select **DeviceNet Electronic Data Sheets (EDS)**.

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

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.

**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.

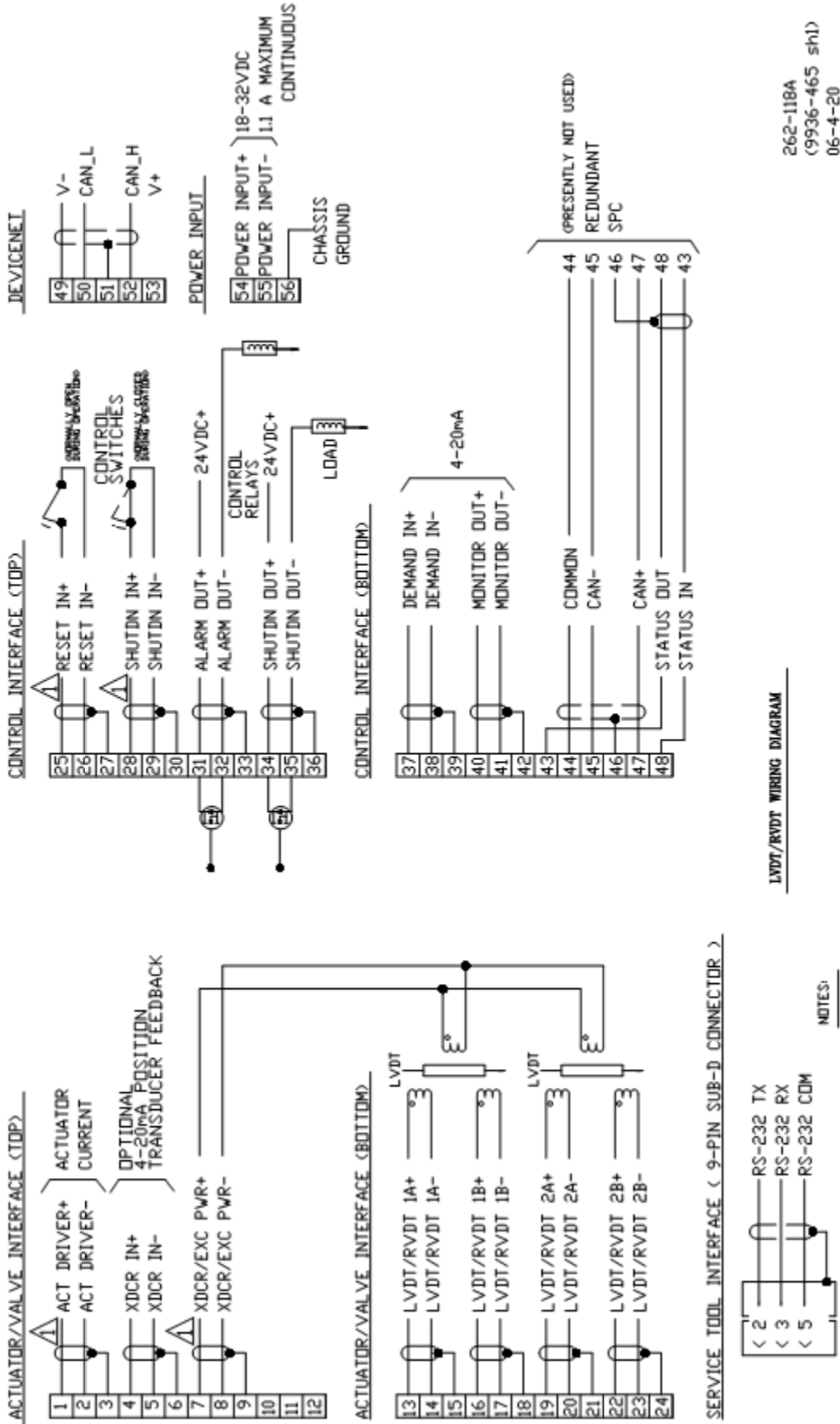


Figure 2-4a. SPC Wiring Diagram



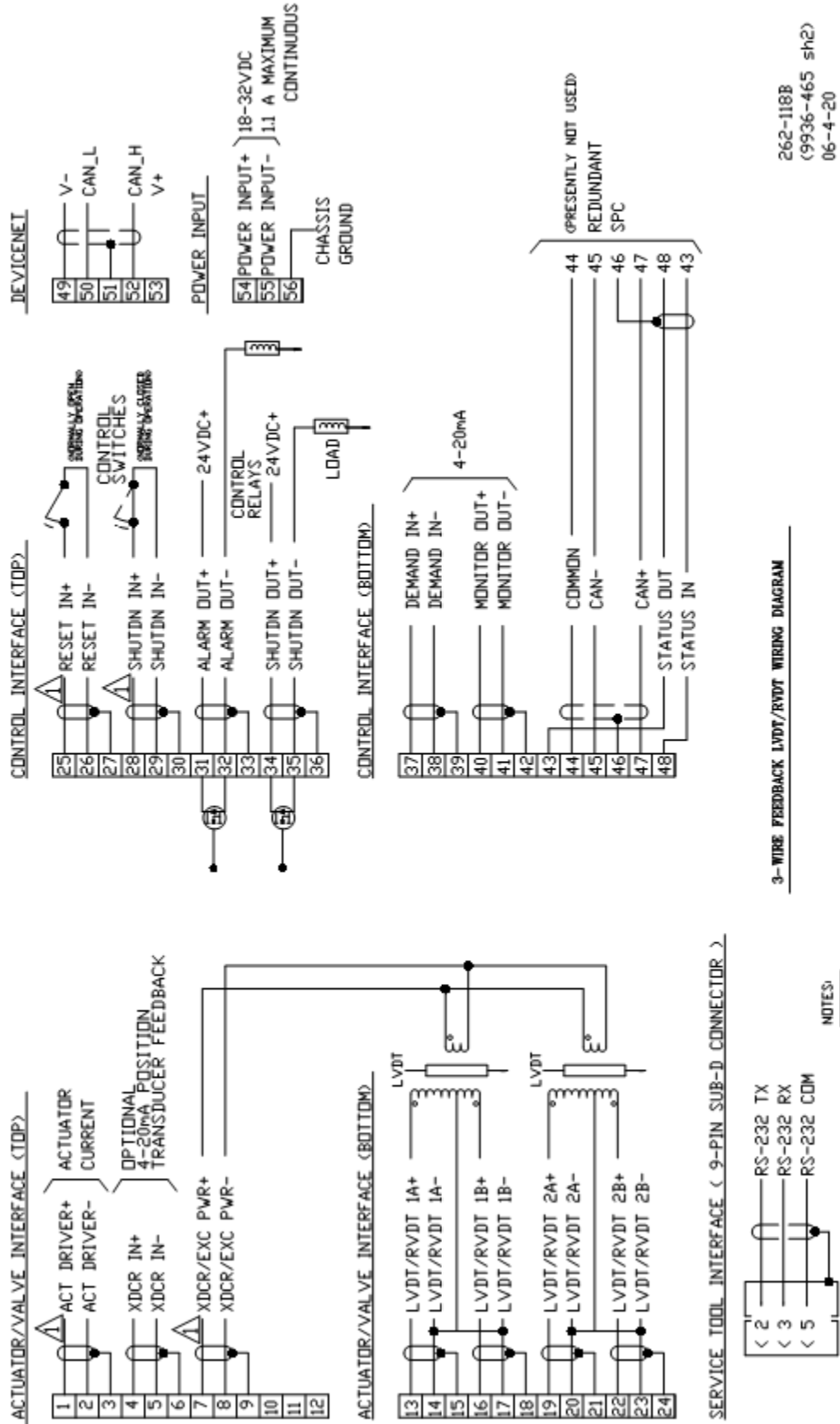


Figure 2-4b. SPC Wiring Diagram

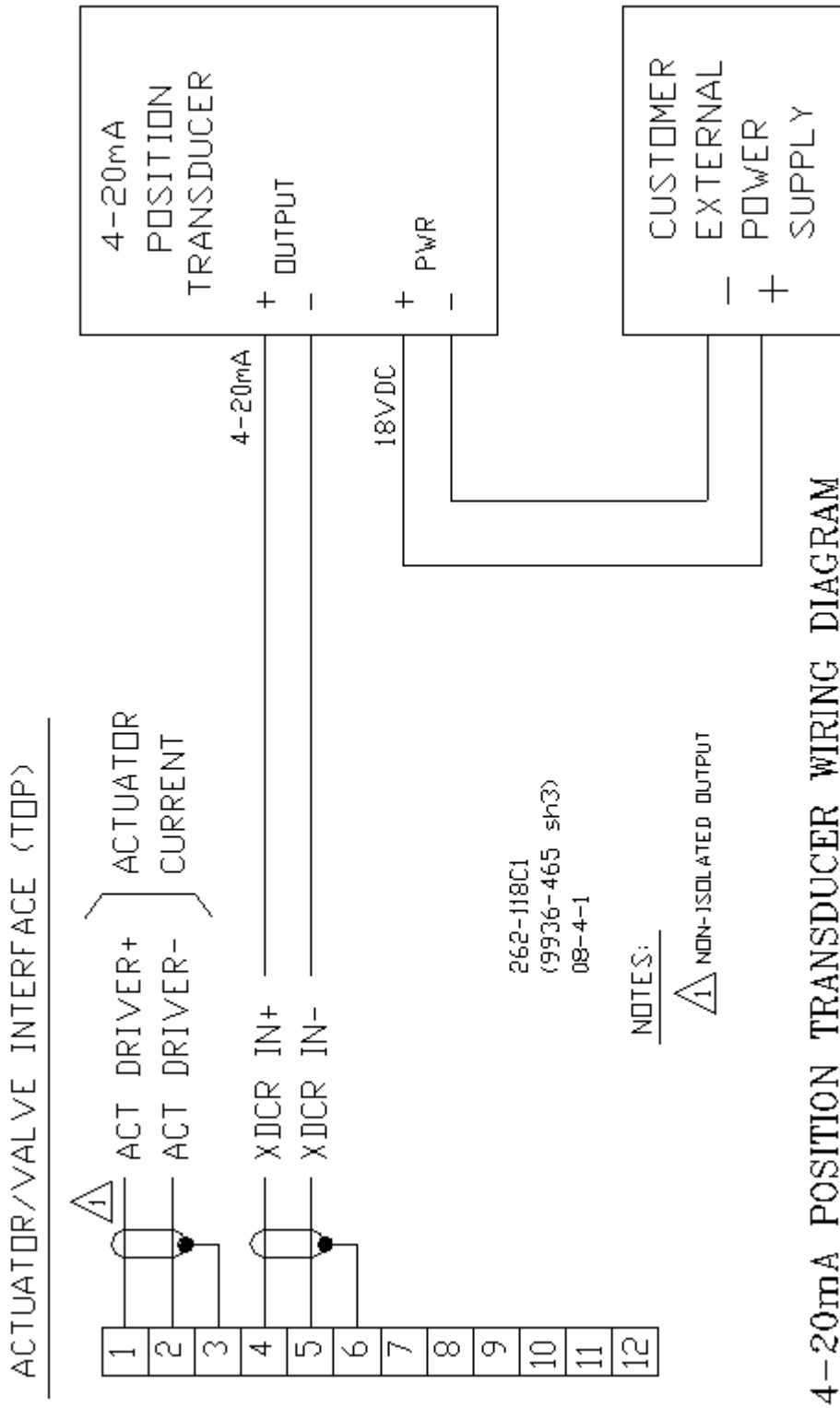
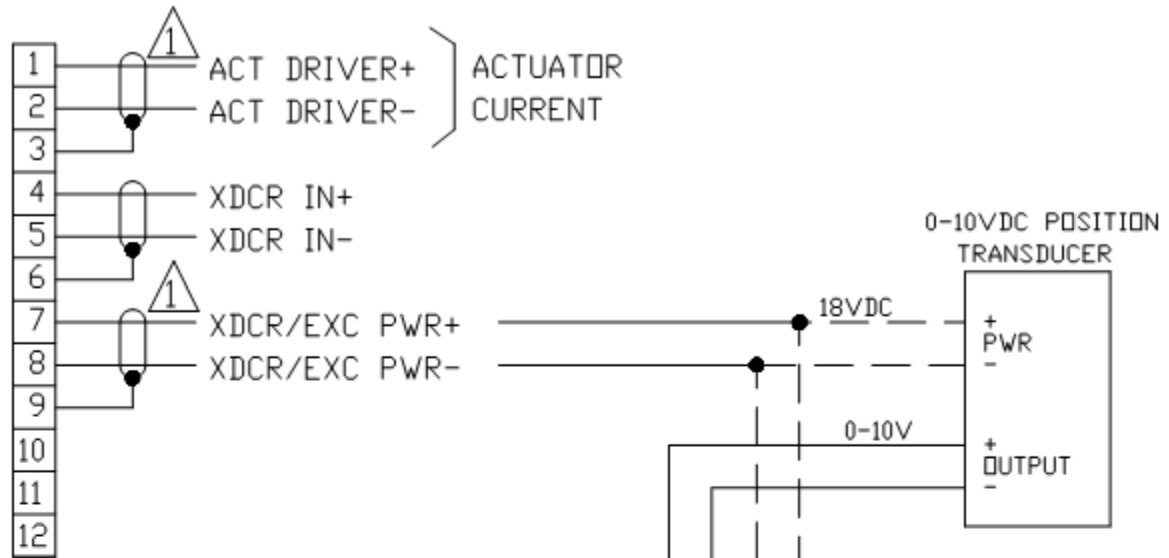
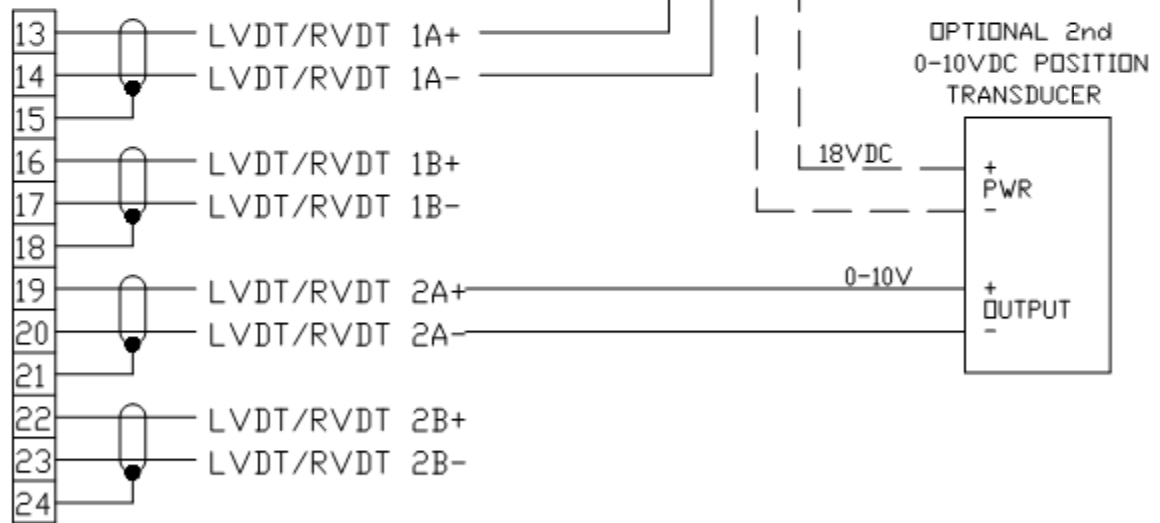


Figure 2-4c. SPC Wiring Diagram

ACTUATOR/VALVE INTERFACE (TOP)



ACTUATOR/VALVE INTERFACE (BOTTOM)



0-10VDC POSITION TRANSDUCER WIRING DIAGRAM

NOTES:

 NON-ISOLATED OUTPUT

262-118D  
 (9936-465 sh4)  
 06-4-20

Figure 2-4d. SPC Wiring Diagram

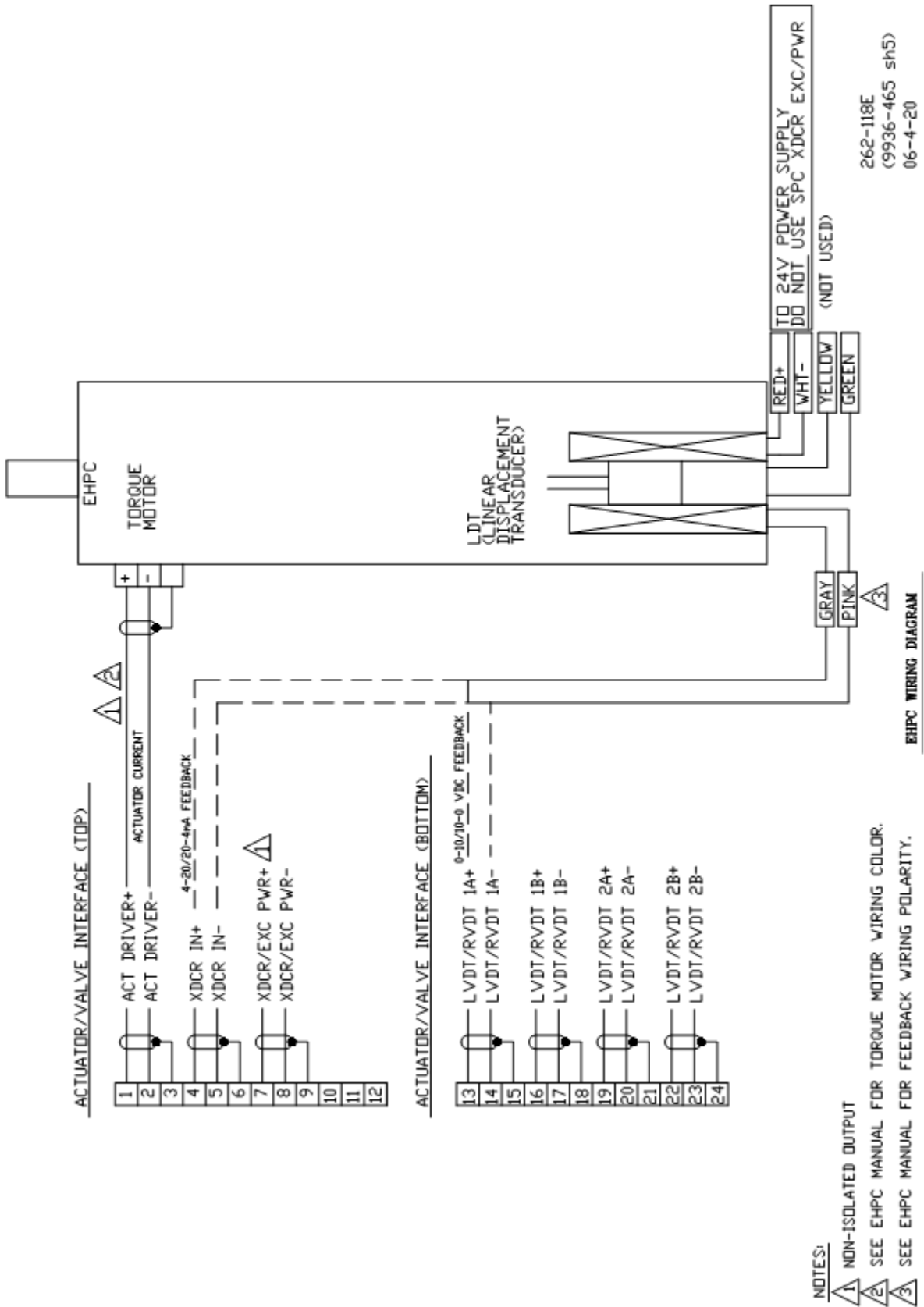
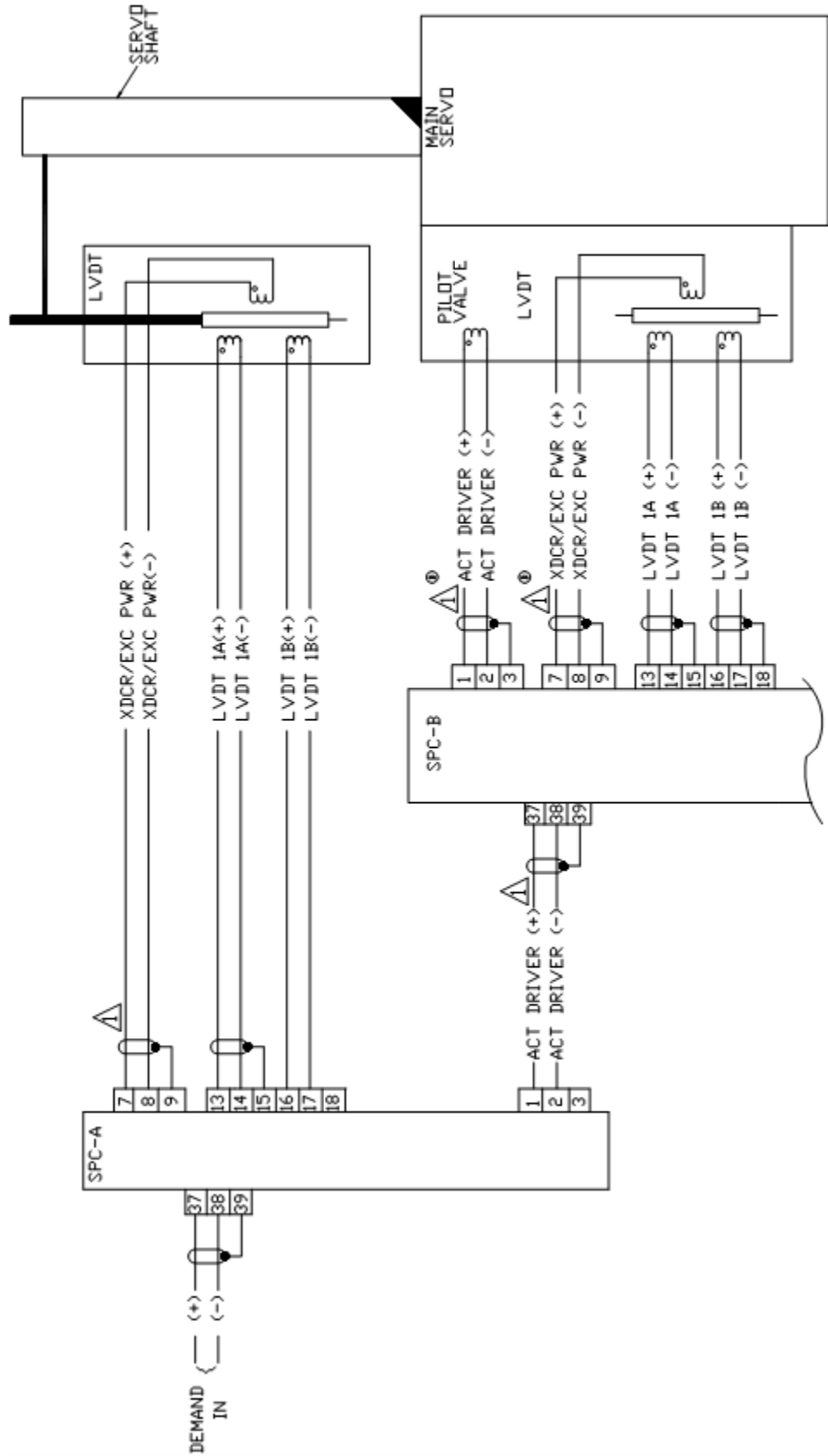


Figure 2-4e. SPC Wiring Diagram



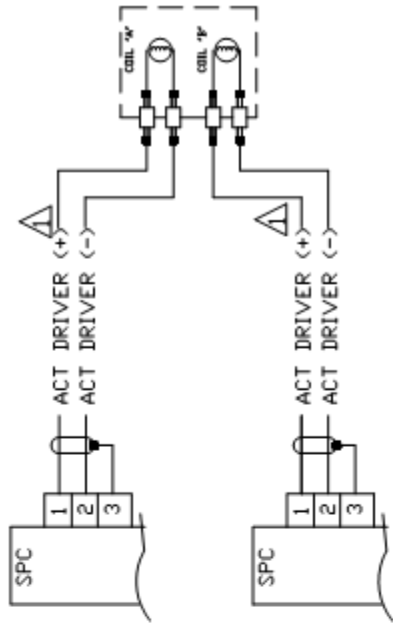
262-118F  
(9936-465 sh6)  
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GE OIL GEAR SERVO APPLICATION

NOTES:  
▲ NON-ISOLATED OUTPUT

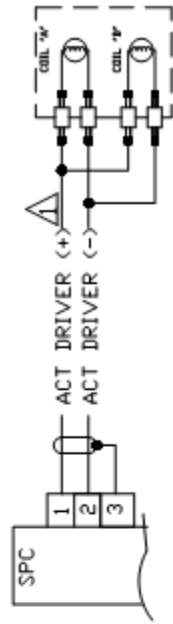
Figure 2-4f. SPC Wiring Diagram

OPTIONAL DUAL COIL WIRING\*



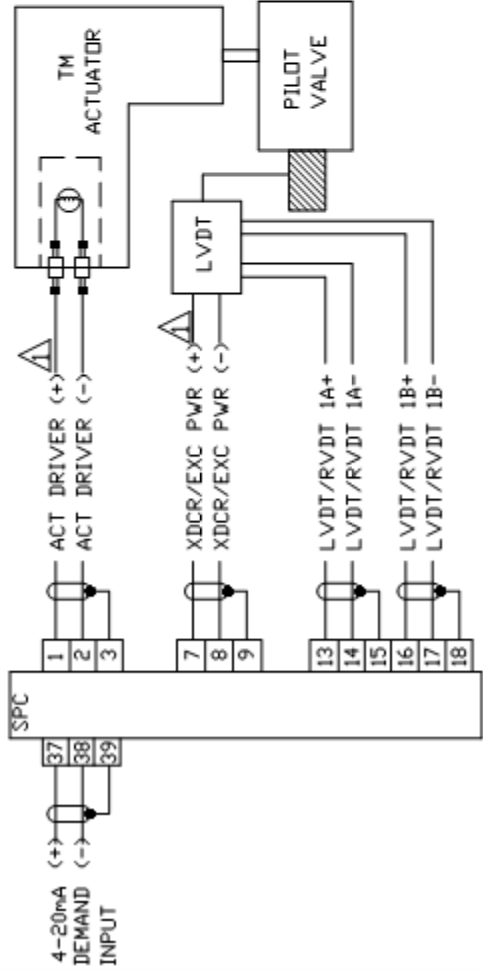
\*ONLY ONE SPC CAN BE ACTIVE AT A TIME IN THIS CONFIGURATION.

OPTIONAL DUAL COIL WIRING



262-118G  
(9936-465 sh7)  
06-4-20

SINGLE COIL WIRING - INTEGRATING SERVO APPLICATION



NOTES:  
△ NON-ISOLATED OUTPUT

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

Figure 2-4g. SPC Wiring Diagram

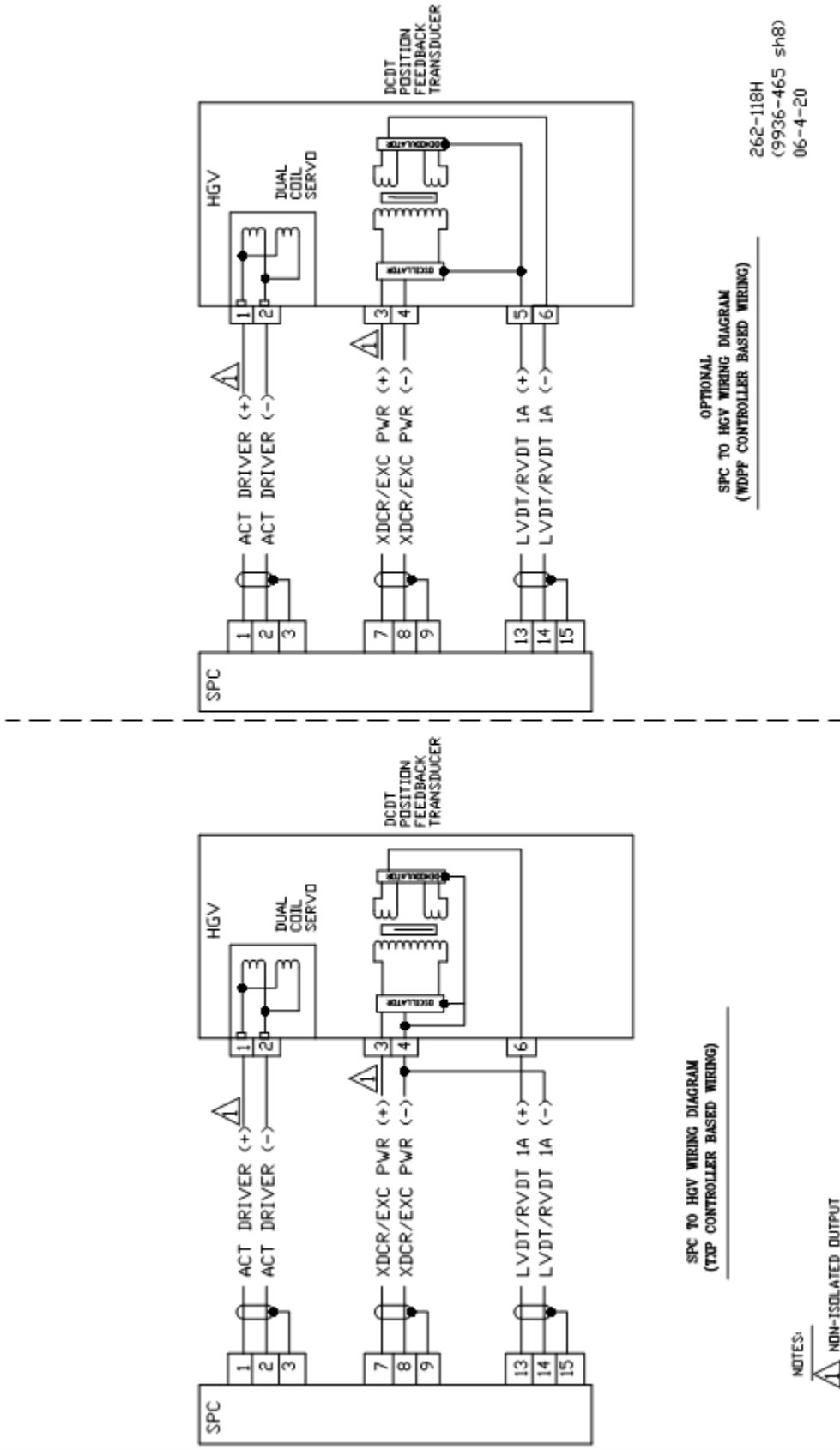


Figure 2-4h. SPC Wiring Diagram

## Chapter 3. SPC Specifications

### System Accuracy

Using DeviceNet	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).

### 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 $\Omega$
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 $\Omega$ min
Input Filter	10 ms lag
Resolution	14 bits
Linearity	0.1 % of full scale
Temperature Sensitivity	150 ppm/°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 °C
Temperature Sensitivity	150 ppm/°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 $\mu$ A
Isolation Voltage	500 V (rms)
Maximum Delay	1 ms

**DeviceNet**

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:

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:	$1/(\text{full scale current, in Amps})$ ohms, where full scale current is the driver current range displayed on the service tool. For example, if the driver current range is $\pm 100\ \text{mA}$ , the short threshold is $(1/0.100) = 10\ \Omega$ .
Exciter Voltage Tolerance:	$\pm 0.2\ \text{V (rms)}$
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.

## Environmental Specifications

Temperature Range:	$(-40\ \text{to}\ +70)\ ^\circ\text{C}$
Shock:	30 G, 11 ms half sine pulse
Vibration (random):	0.7 G, (5 to 2000) Hz
Humidity:	95 % condensing

## 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 $\text{NO}_2$ , $\text{CO}_2$ , $\text{SO}_2$ , and $\text{H}_2\text{S}$ 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 DeviceNet 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.



**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](http://www.woodward.com/software). Select software product “SPC Tools”. Follow the installation instructions given on that page.

## IMPORTANT

SPC model 8200-226 requires SPC Service Tool version 1.3 or later to function correctly.

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 your 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 DeviceNet bus, 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 DeviceNet port. The Module Status LED provides information about the general operating status of the SPC.

### 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

### 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.

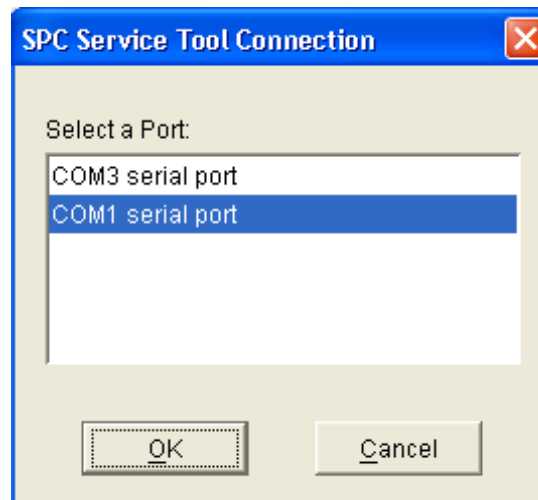


Figure 4-1. Selecting Communication Port

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.

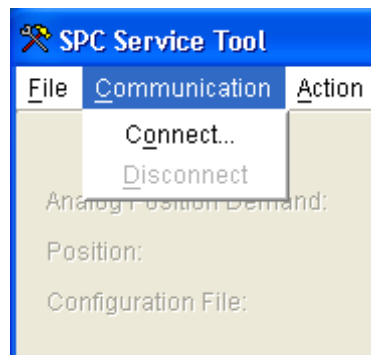


Figure 4-2. Connecting to the SPC

## WARNING

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.

## 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.

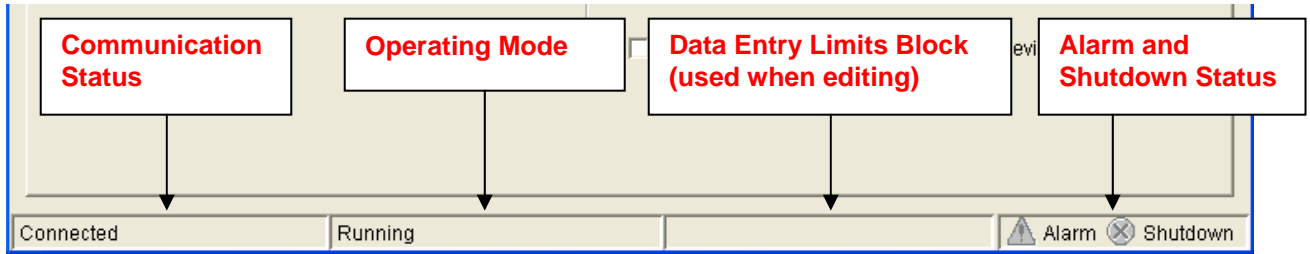


Figure 4-3. Service Tool Status Bar

### 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 DeviceNet Port

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

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

The servo controller proportional and integral gains can be configured to be adjustable over the DeviceNet 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 DeviceNet bus by checking the **Calibration will be performed through DeviceNet** checkbox in the Overview 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.

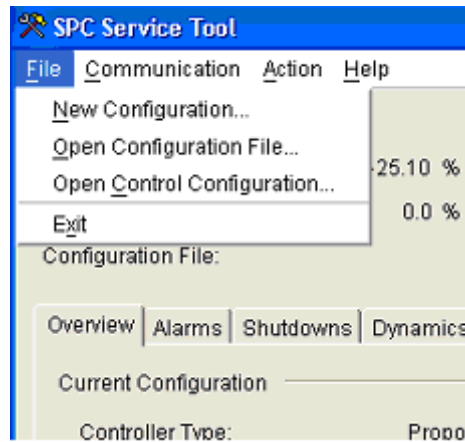


Figure 4-4. Selecting Configuration Options

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.

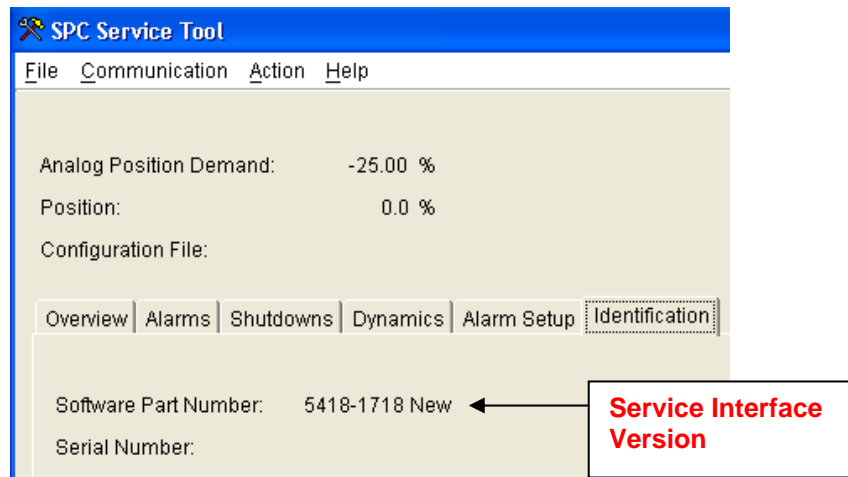


Figure 4-5. Determining Service Interface Version

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.

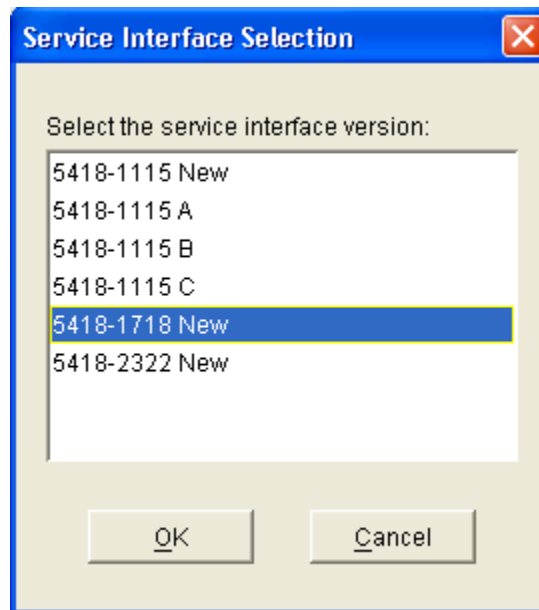


Figure 4-6. Selecting Service Interface Version

#### 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 DeviceNet. 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 DeviceNet

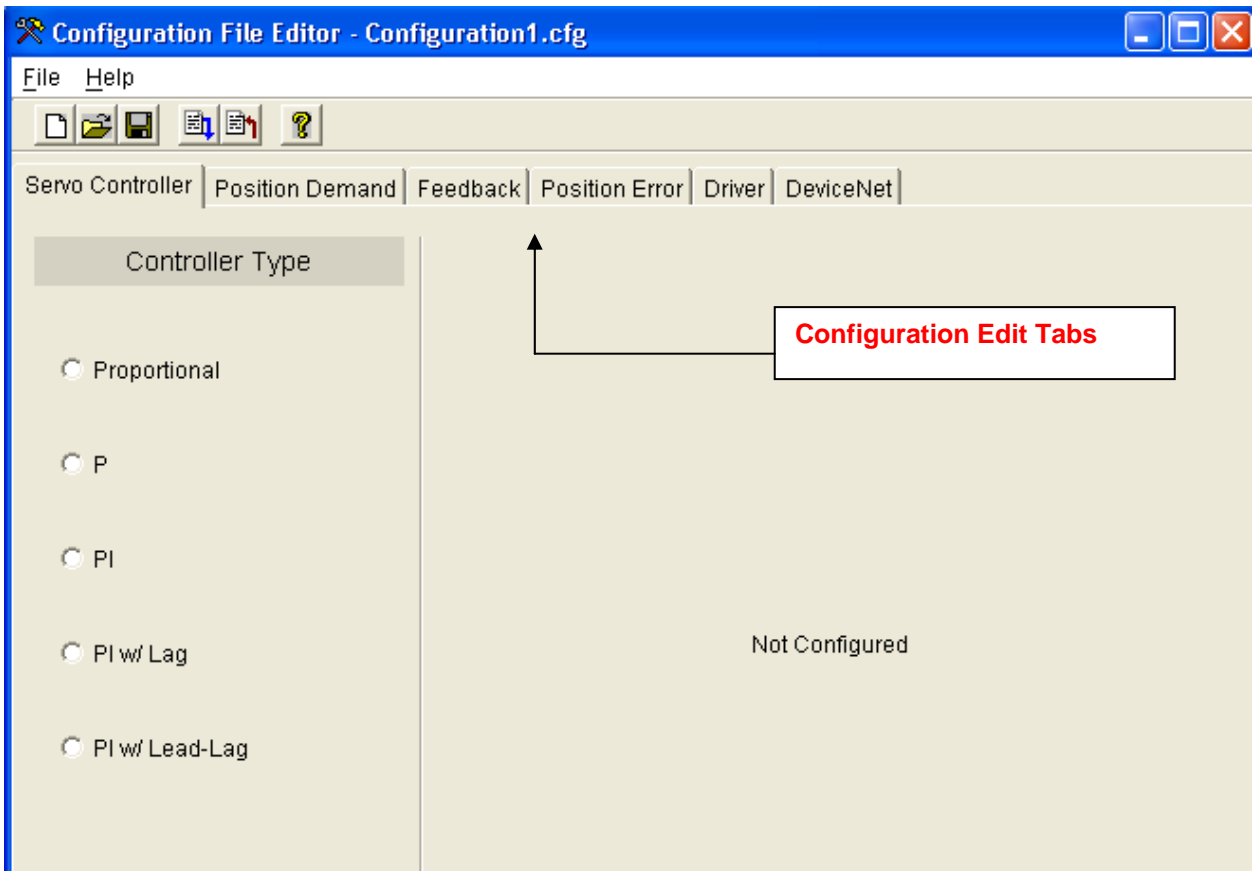


Figure 4-7. Configuration Editing Tabs

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.

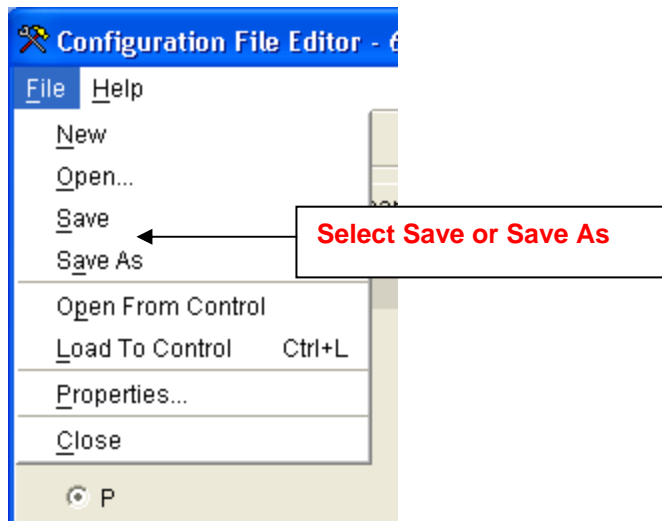


Figure 4-8. Saving the Configuration File

## 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.

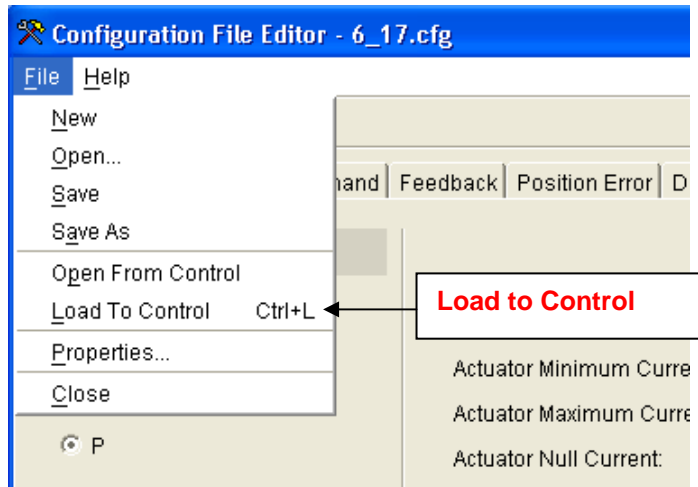


Figure 4-9. Loading Configuration File to the Control

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.

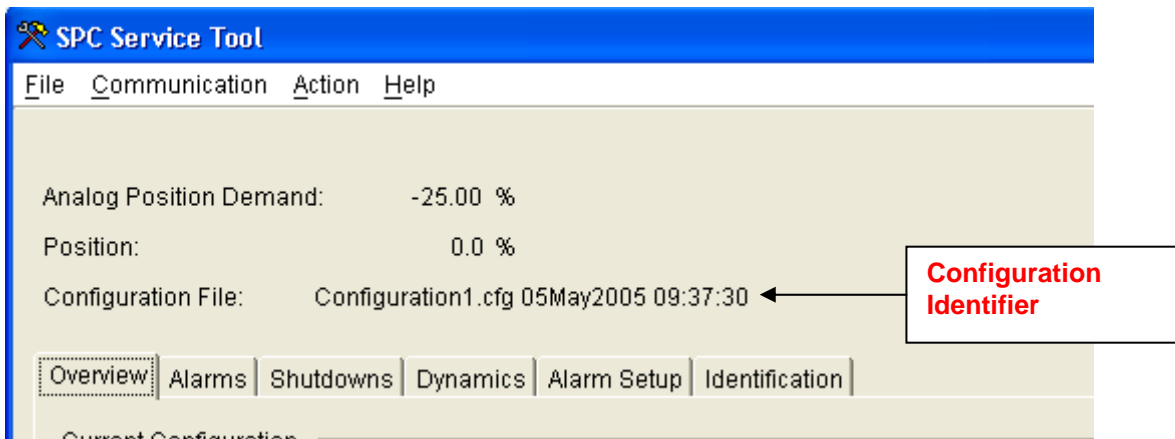


Figure 4-10. Identifying the Configuration File in the Control

## 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.

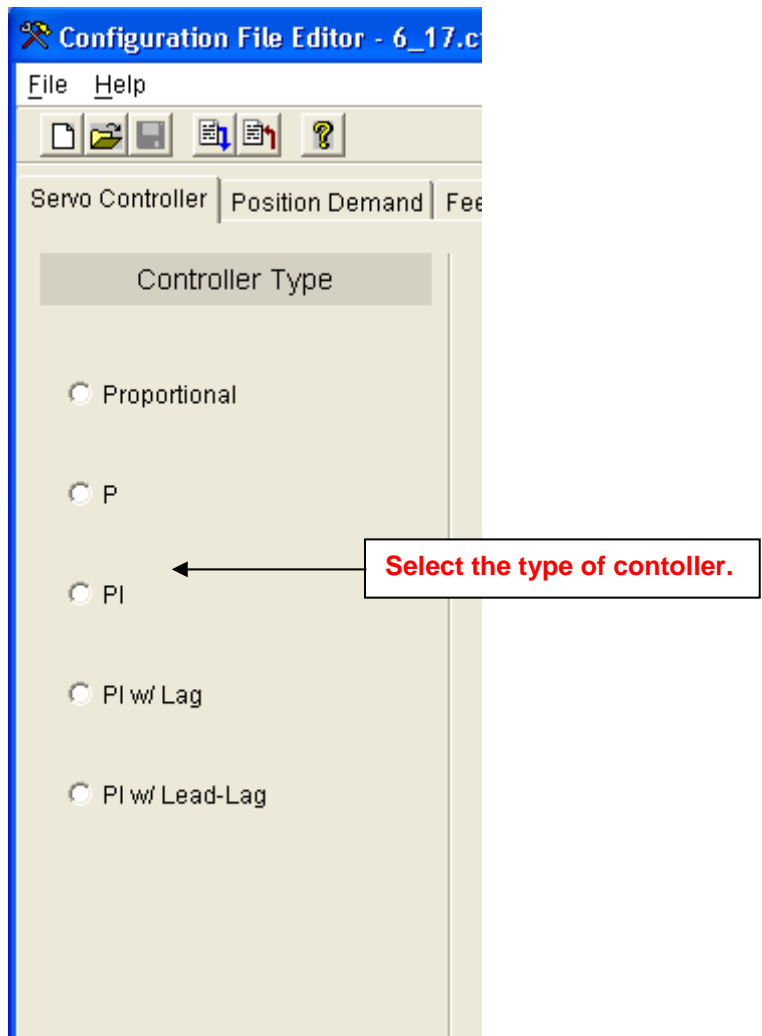


Figure 4-11. Selecting Type of Control

**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)

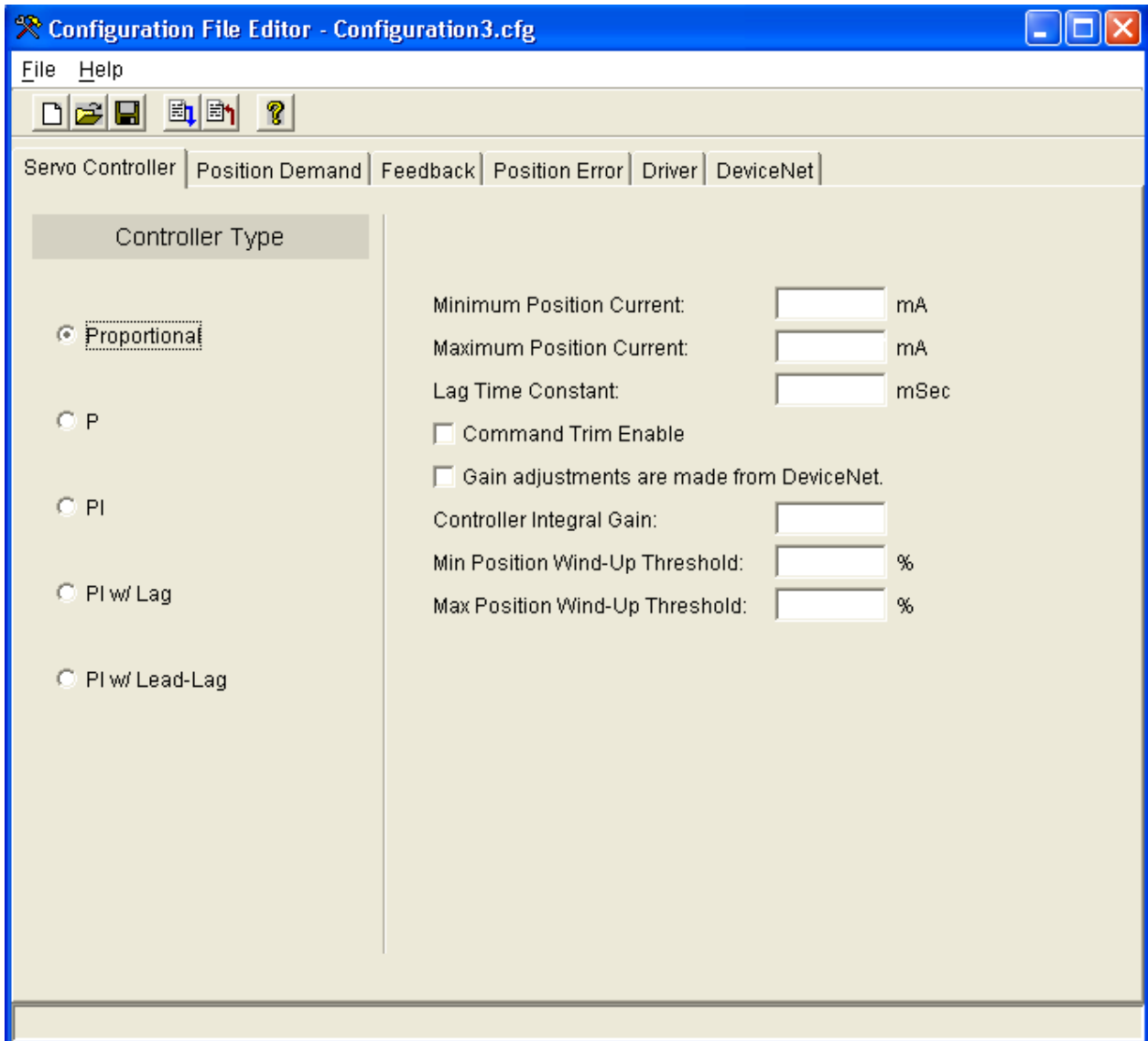


Figure 4-12. Proportional-Control Configuration Settings

**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 check-box**

When checked, the Controller Integral Gain is updated over the DeviceNet bus and cannot be modified by the service tool. When not checked, 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 %

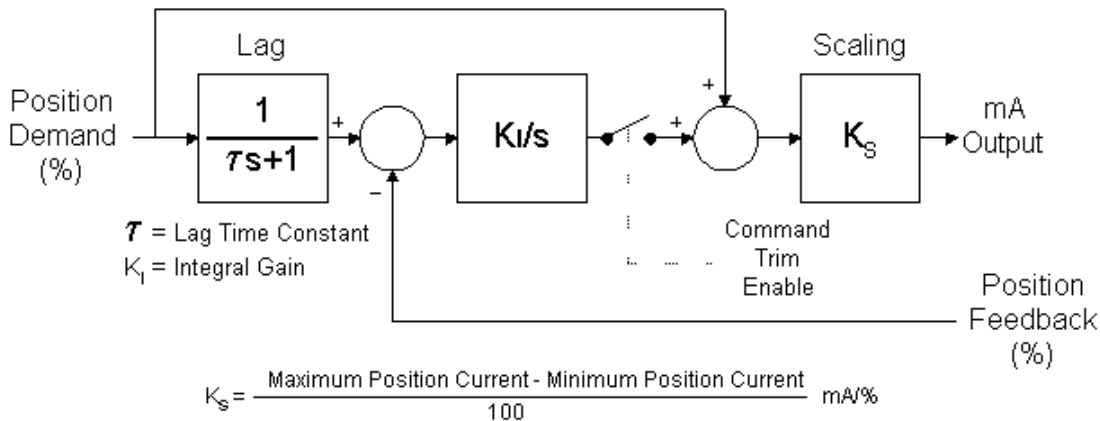


Figure 4-13. Proportional Control Structure

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 ± 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 Ki/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. Ref. Manual 83402 *PID Control* for additional information on tuning the control.

## Configuring and Adjusting a P Control

(Figures 4-14 and 4-15)

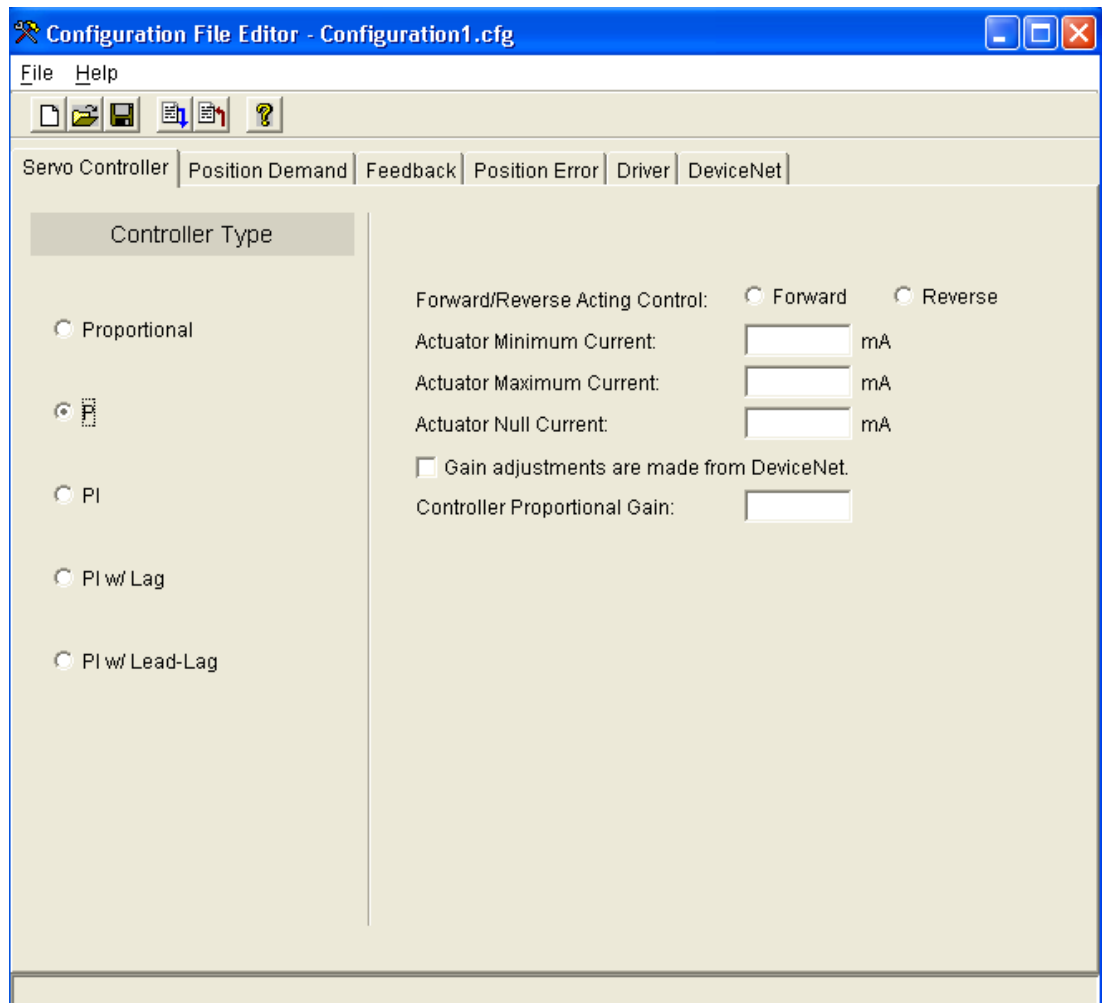


Figure 4-14. P-Control Configuration Settings

**P**—The P Controller provides the best stability. This control is the simplest controller, is very robust and works well for systems that 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.

#### 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 check-box

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

#### Controller Proportional Gain

Sets the proportional gain of the P control.

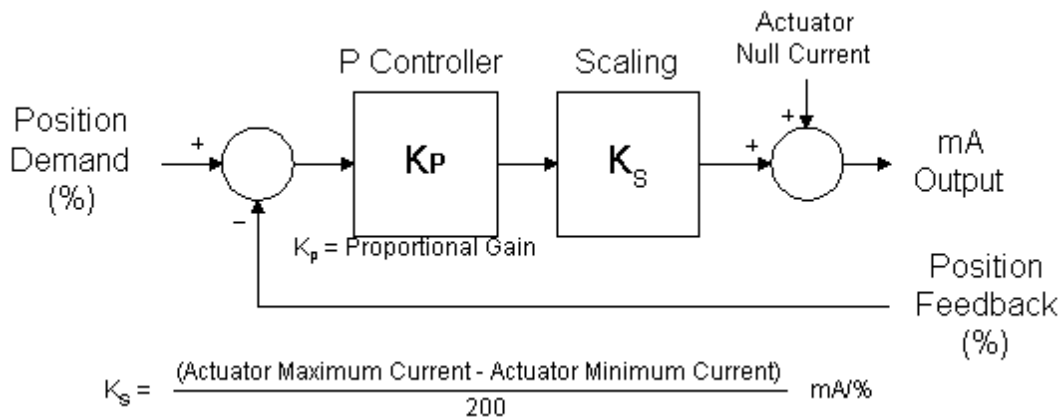


Figure 4-15. P Control Structure

Tuning can be accomplished by increasing the Proportional Gain until the actuator just starts to oscillate, then reducing the Proportional Gain by a factor of 2.

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. Ref. Manual 83402 *PID Control* for additional information on tuning the control.

## Configuring and Adjusting a PI Control

(Figures 4-16 and 4-17)

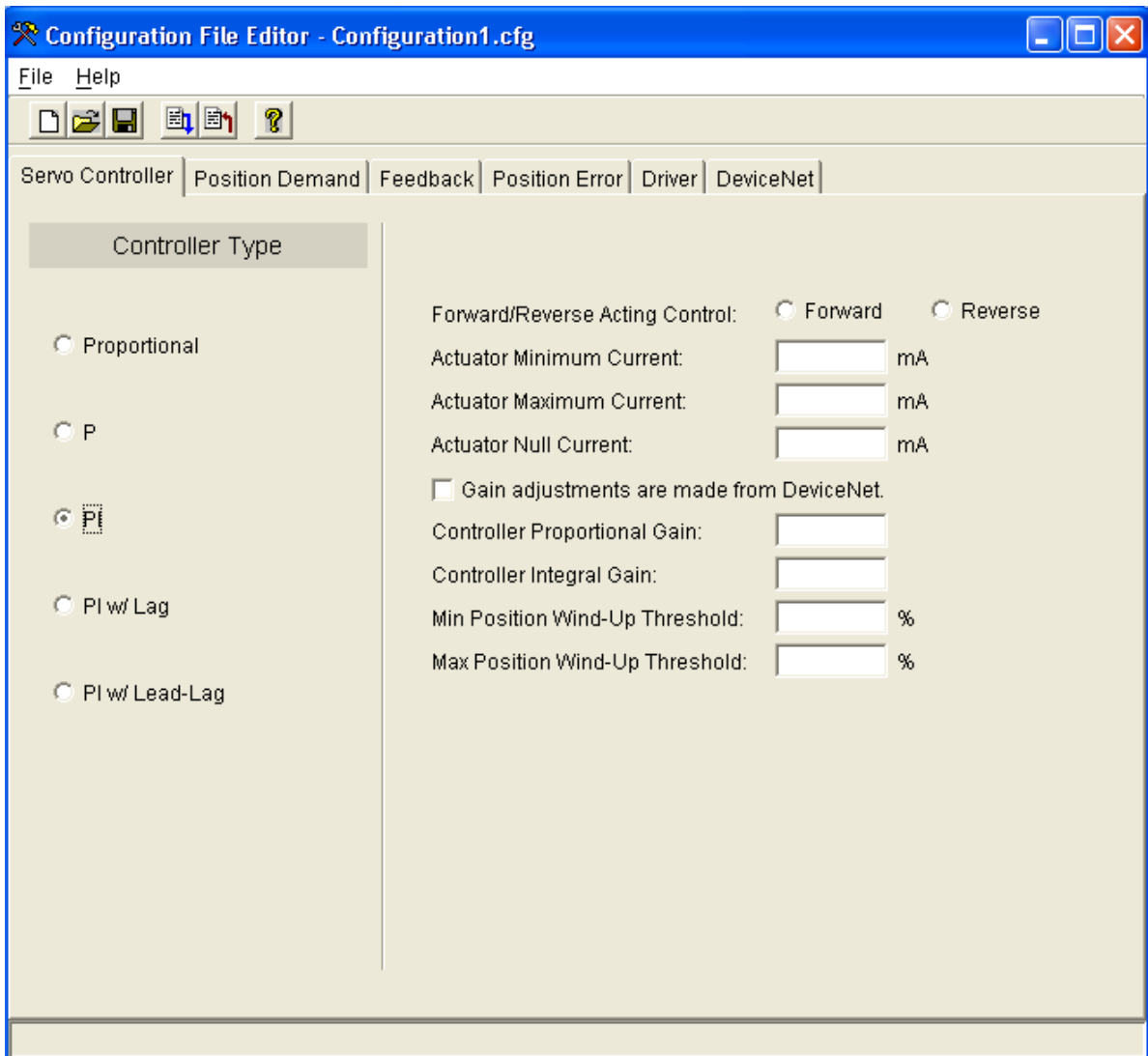


Figure 4-16. PI-Control Configuration Settings

**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 check-box**

When checked, the Controller Integral Gain is updated over the DeviceNet bus and cannot be modified by the service tool. When not checked, 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 %

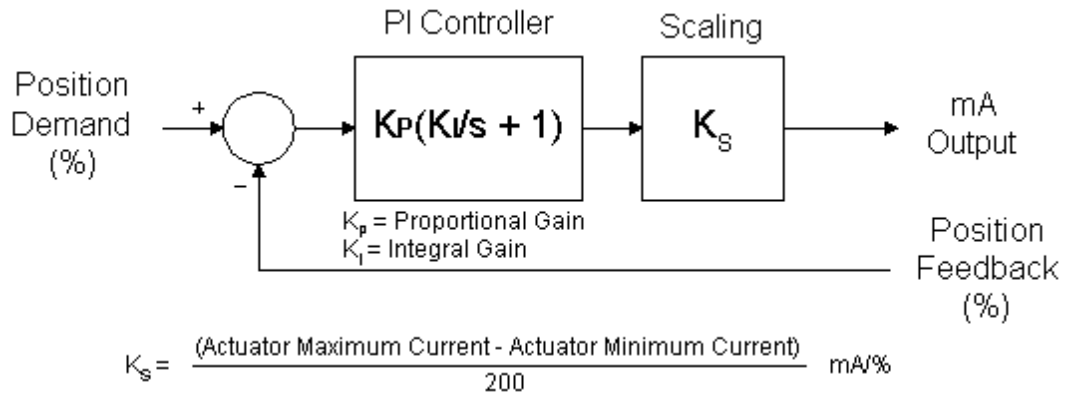


Figure 4-17. PI Control Structure

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. Ref. 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)

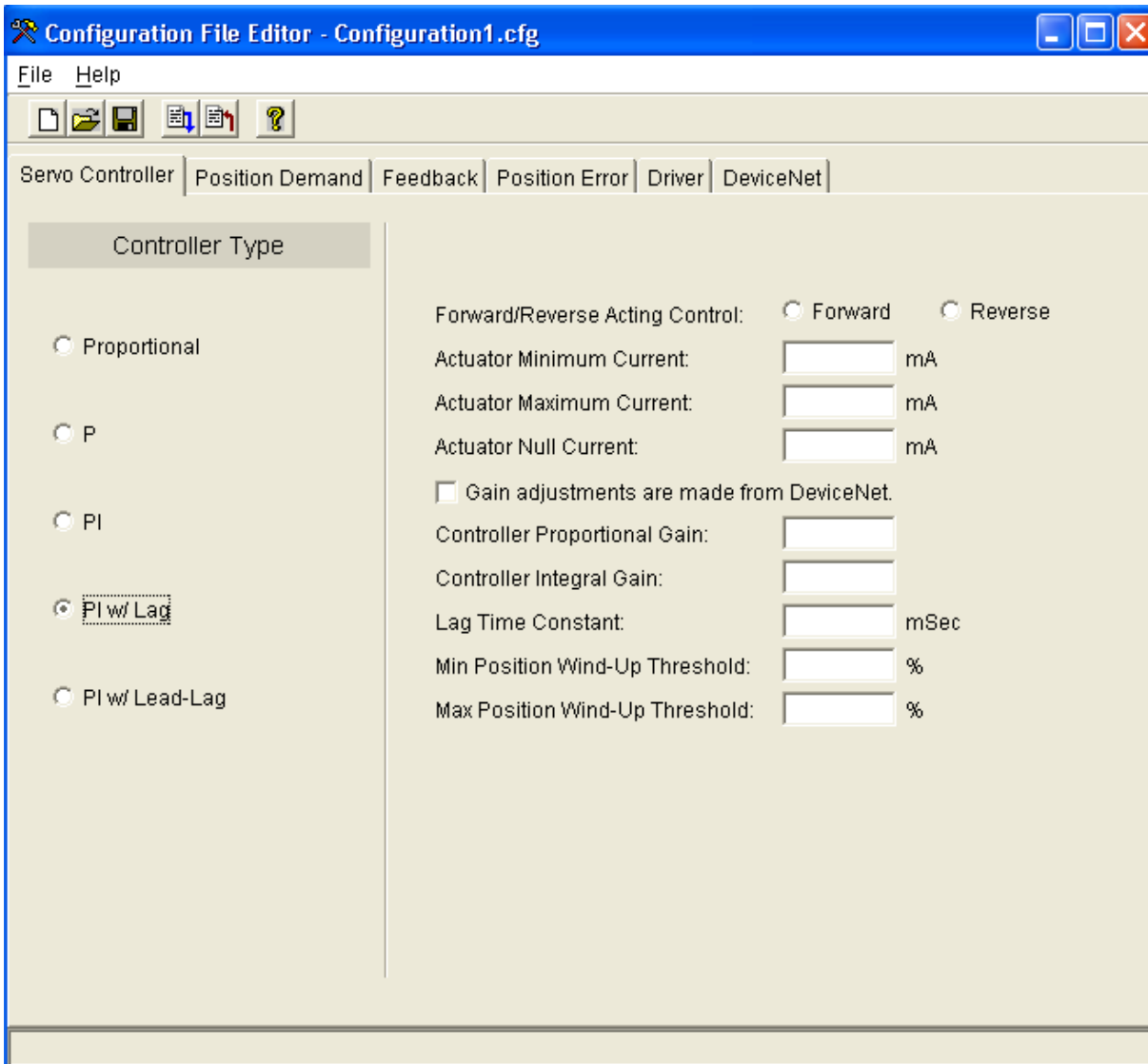


Figure 4-18. PI with Lag-Control Configuration Settings

**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 check-box**

When checked, the Controller Integral Gain is updated over the DeviceNet bus and cannot be modified by the service tool. When not checked, 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 %

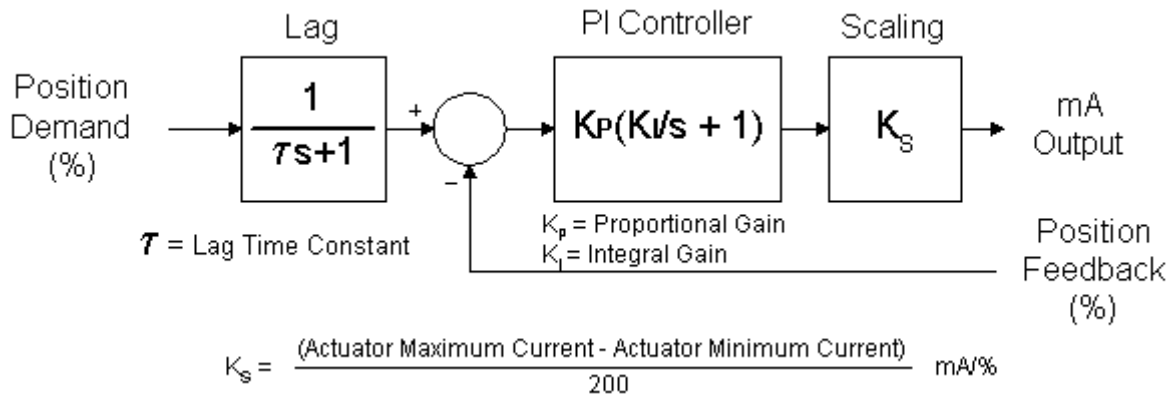


Figure 4-19. PI w/Lag Control Structure

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 Kosc 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. Ref. 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)

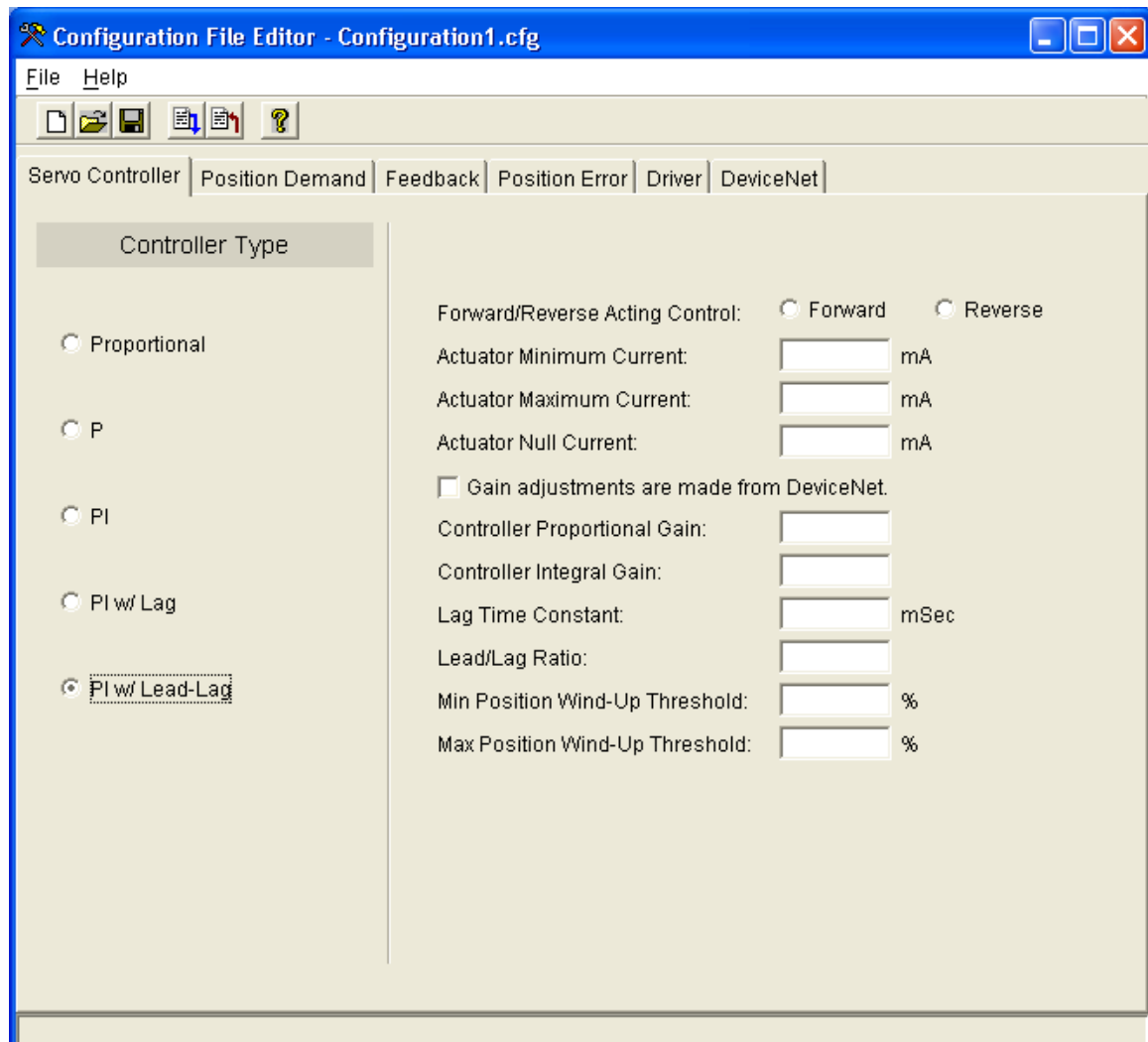


Figure 4-20. PI with Lead-Lag Control Configuration Settings

**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 check-box**

When checked, the Controller Integral Gain is updated over the DeviceNet bus and cannot be modified by the service tool. When not checked, 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 %

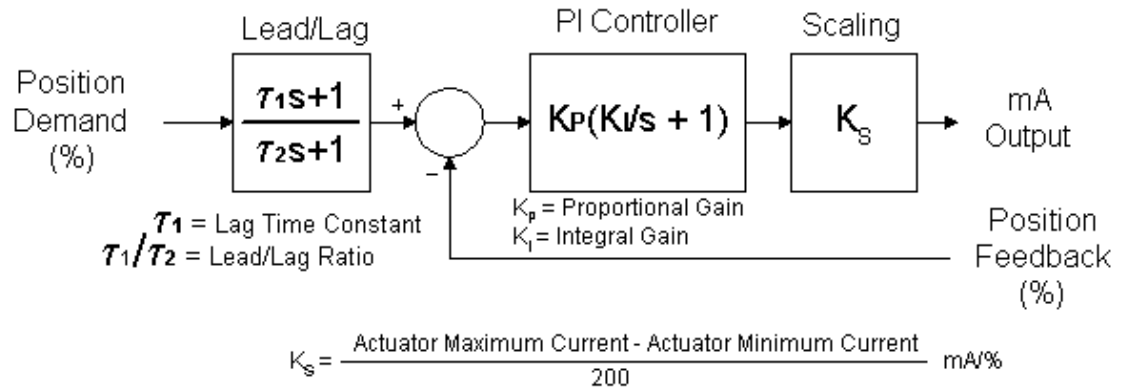


Figure 4-21. PI w/Lead-Lag Structure

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/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. Ref. 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.

### DeviceNet Only

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

### DeviceNet Primary

- The SPC position demand is received via the DeviceNet 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 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

### DeviceNet Only

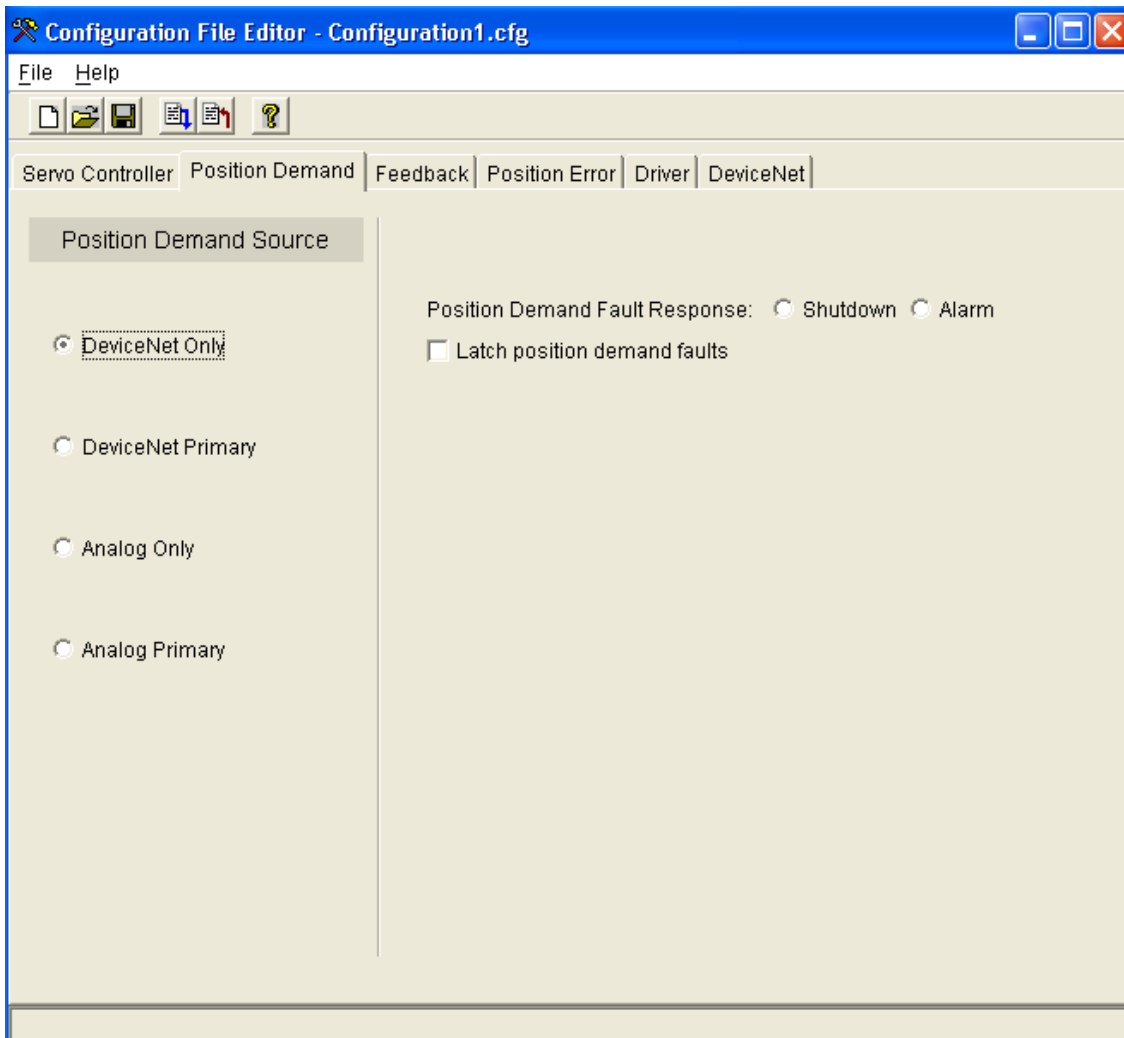


Figure 4-22. Position Demand DeviceNet Only

**DeviceNet Only**—The SPC position demand is received on the DeviceNet 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.

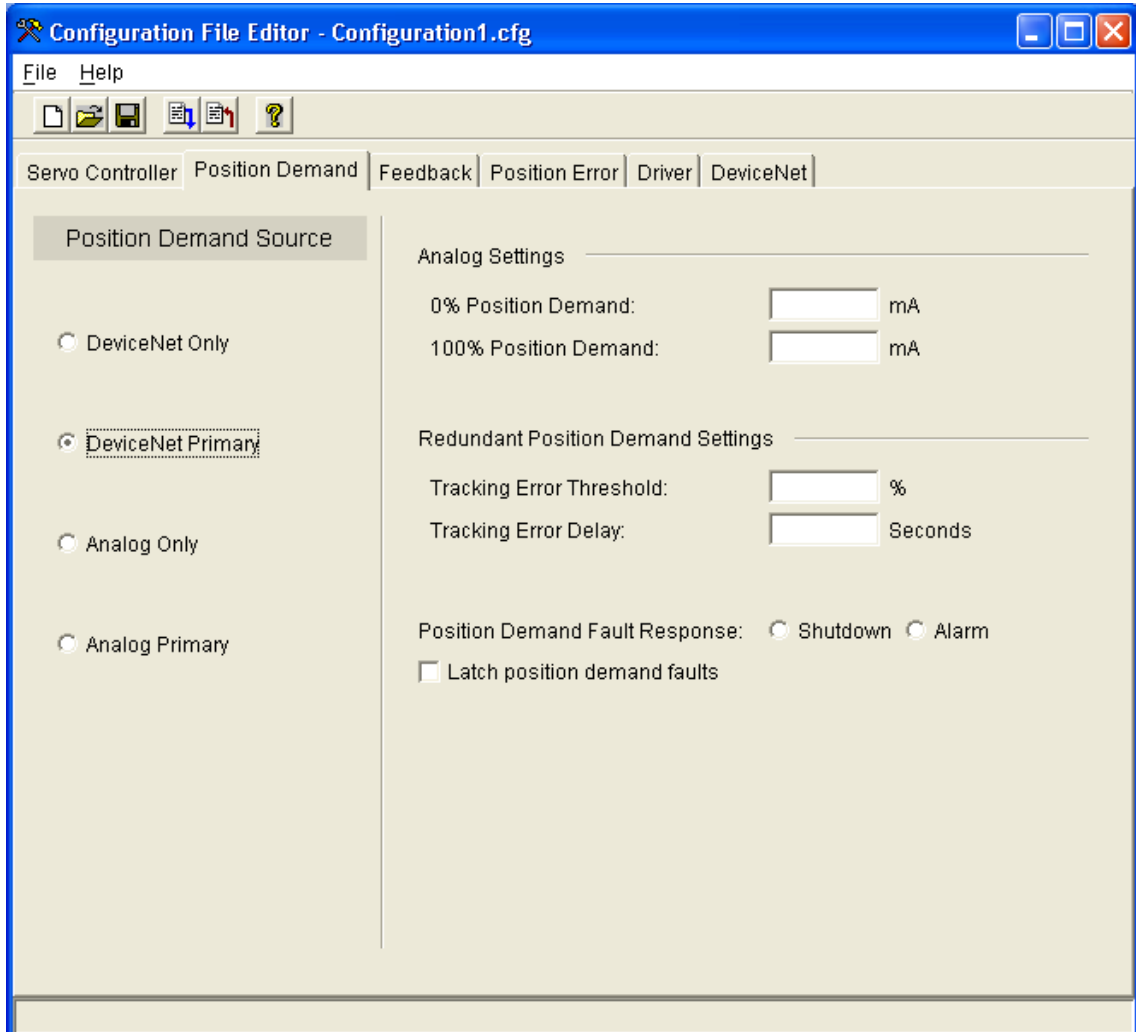
**DeviceNet Primary**

Figure 4-23. Position Demand DeviceNet Primary

**DeviceNet Primary**—The SPC position demand is received on the DeviceNet 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.

## 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

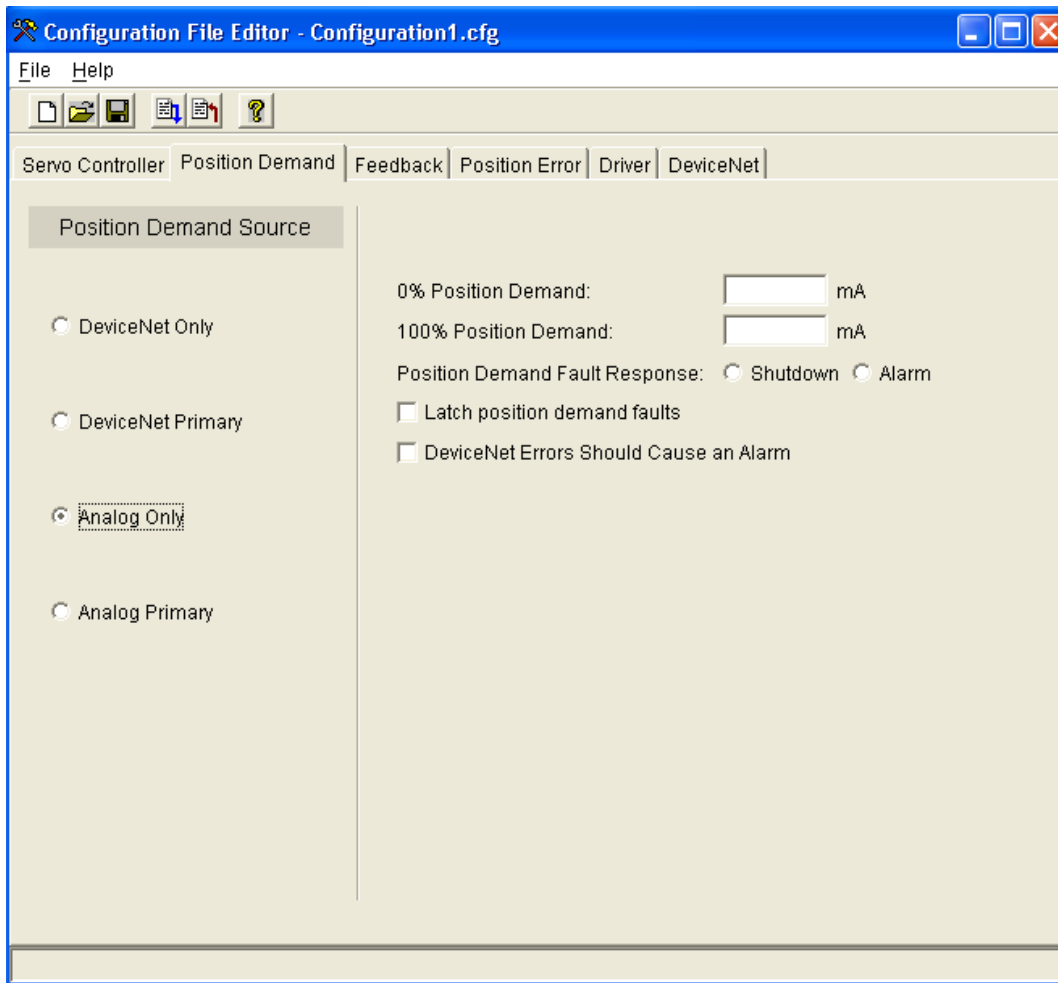


Figure 4-24. Position Demand Analog Only

**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.

**DeviceNet Errors Should Cause an Alarm check-box**

Check this box if DeviceNet Errors should signal an alarm.

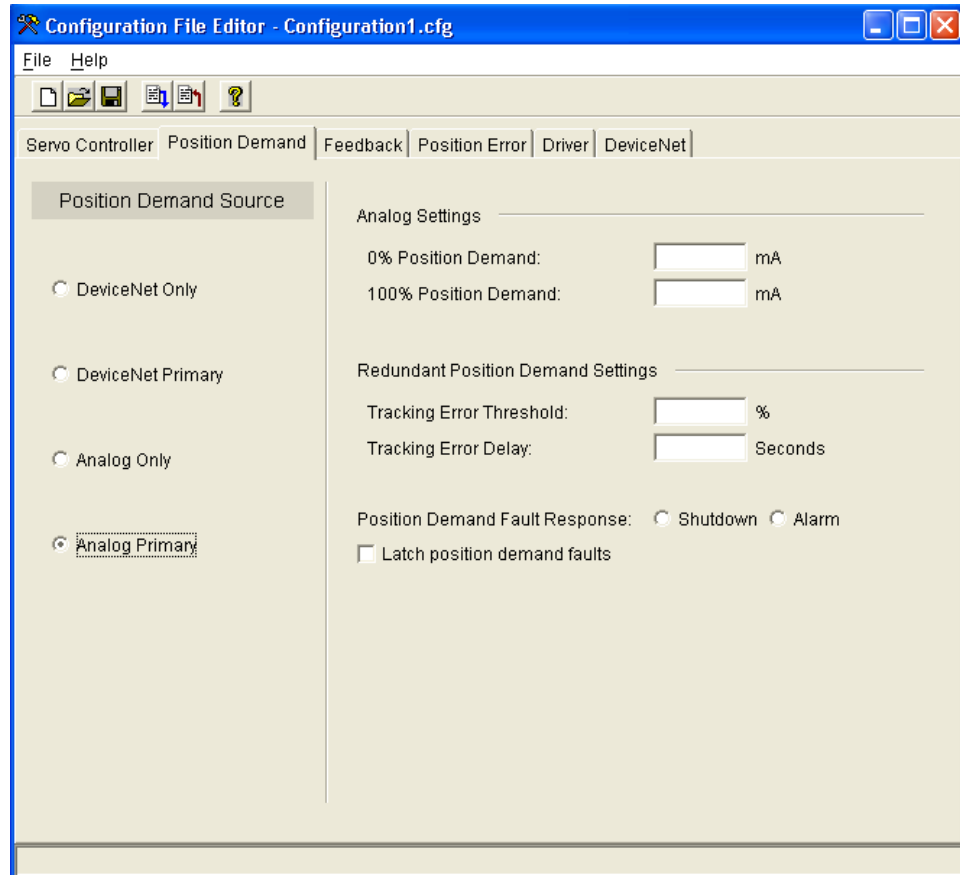
**Analog Primary**

Figure 4-25. Position Demand Analog Primary

**Analog Primary**—The SPC position demand is received on the Analog Demand Input and uses the DeviceNet 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 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

**(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.



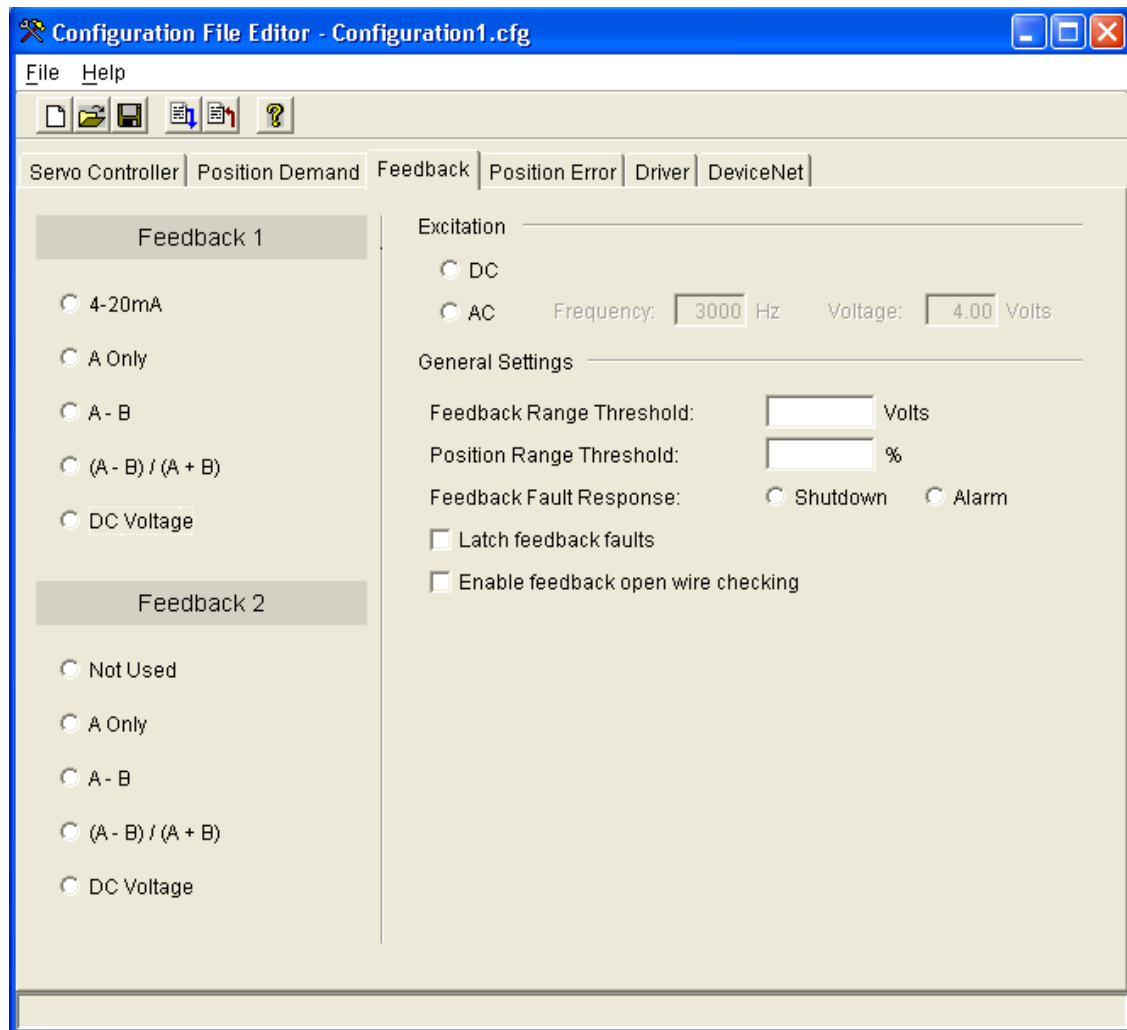


Figure 4-26. Position Feedback Configuration

### (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, the device manufacturer’s documentation should be consulted 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.

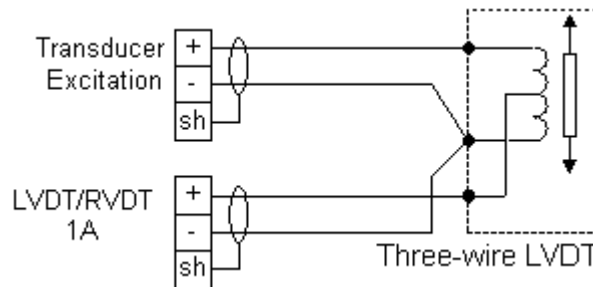


Figure 4-27. 3-wire Device

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 un-checked to avoid nuisance Feedback Open Faults.

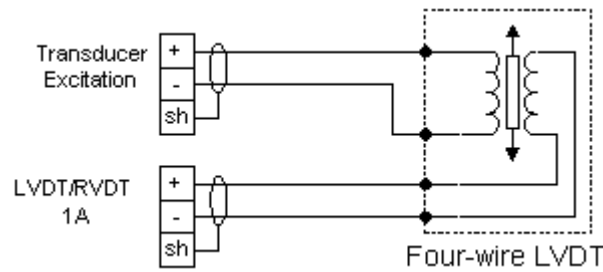


Figure 4-28. 4-wire Device

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.

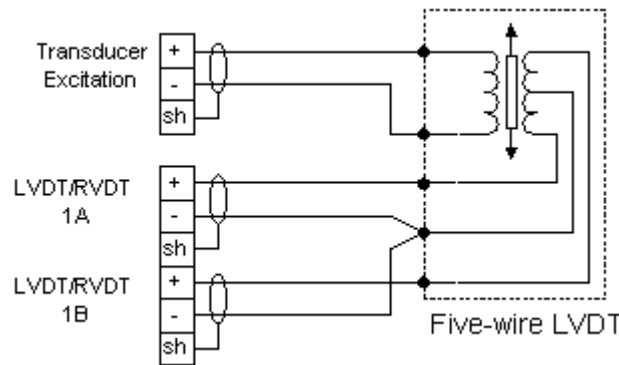


Figure 4-29. 5-wire Device

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:

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

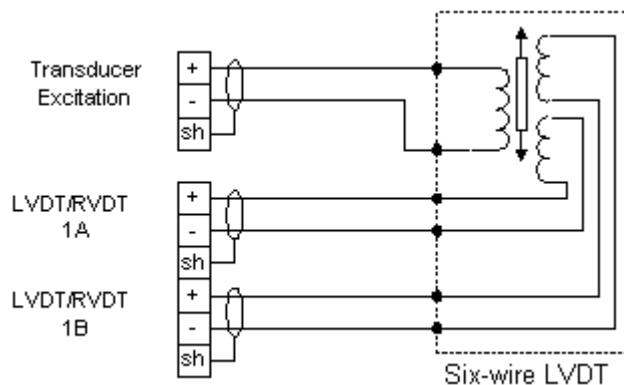


Figure 4-30. 6-wire Device

For the SPC, “+” and “-” designations are arbitrary, and polarity or phase markings on the device can be ignored. 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:

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

## (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.

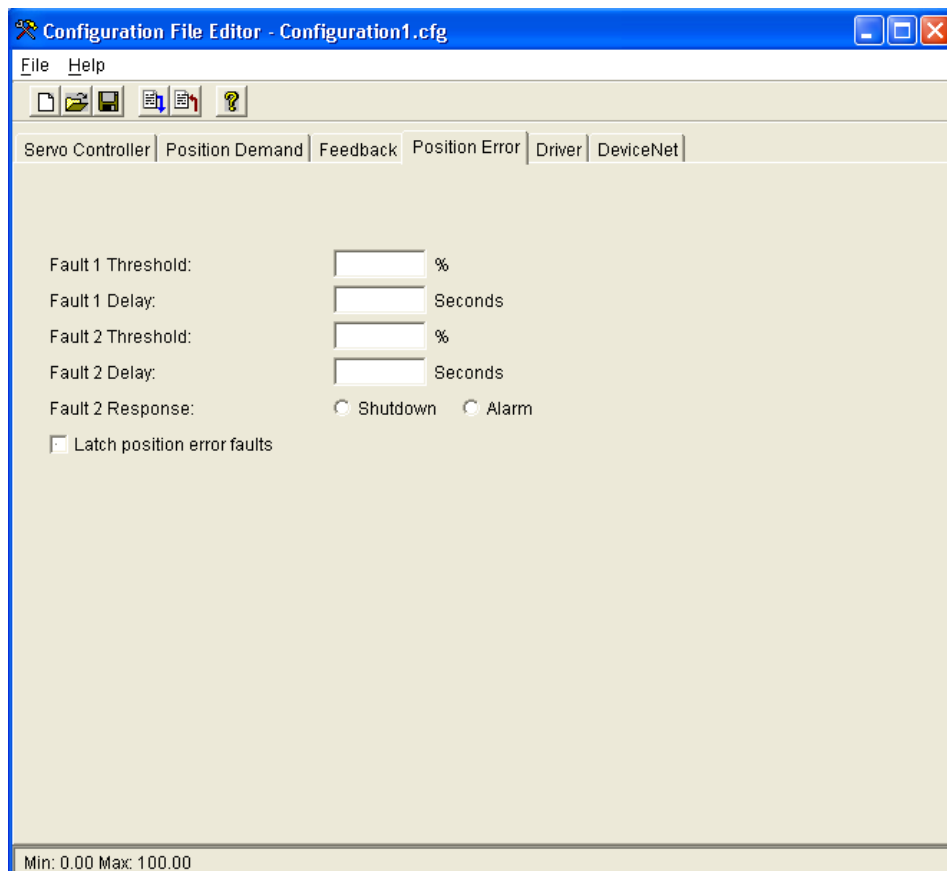


Figure 4-31. Position Error Settings

**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.

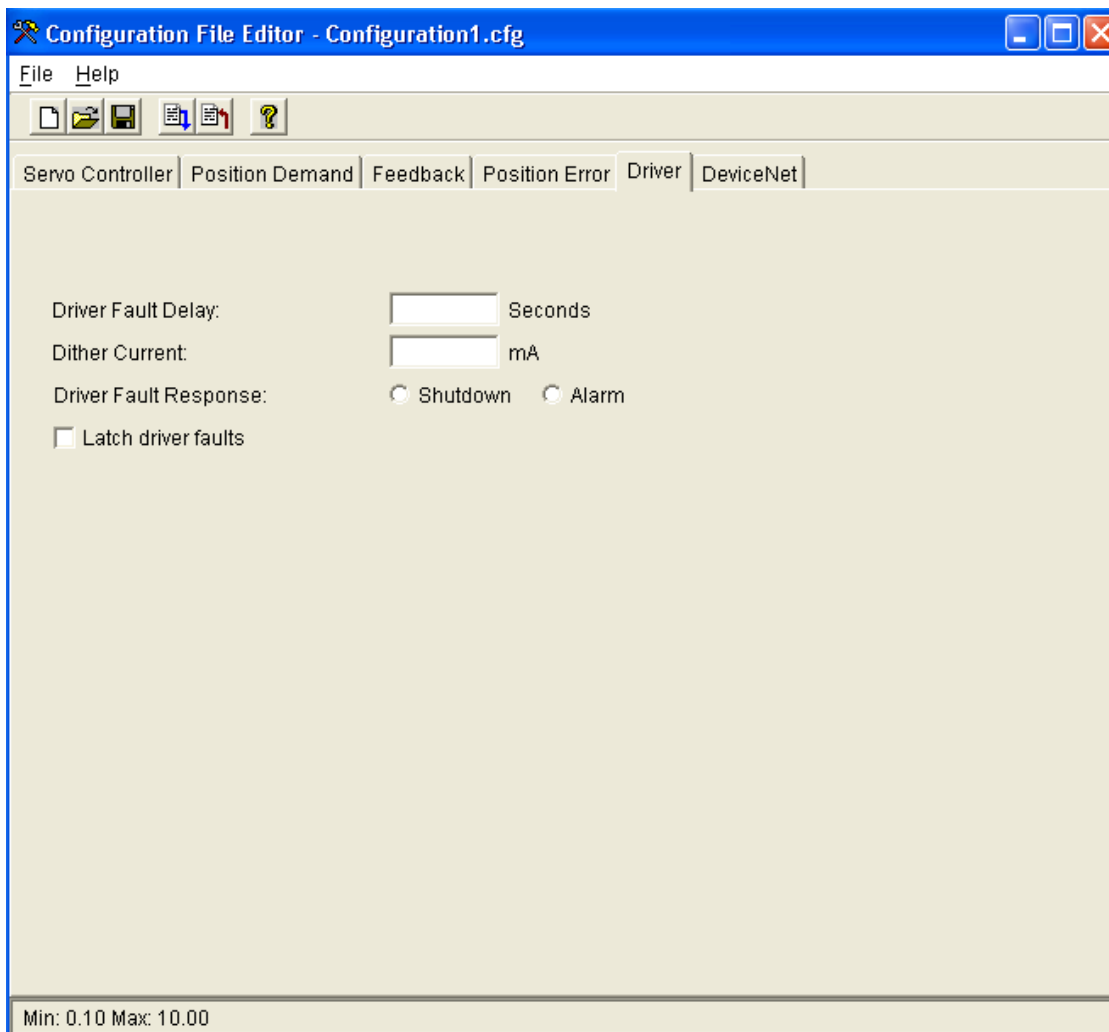


Figure 4-32. Driver Configuration

## 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

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

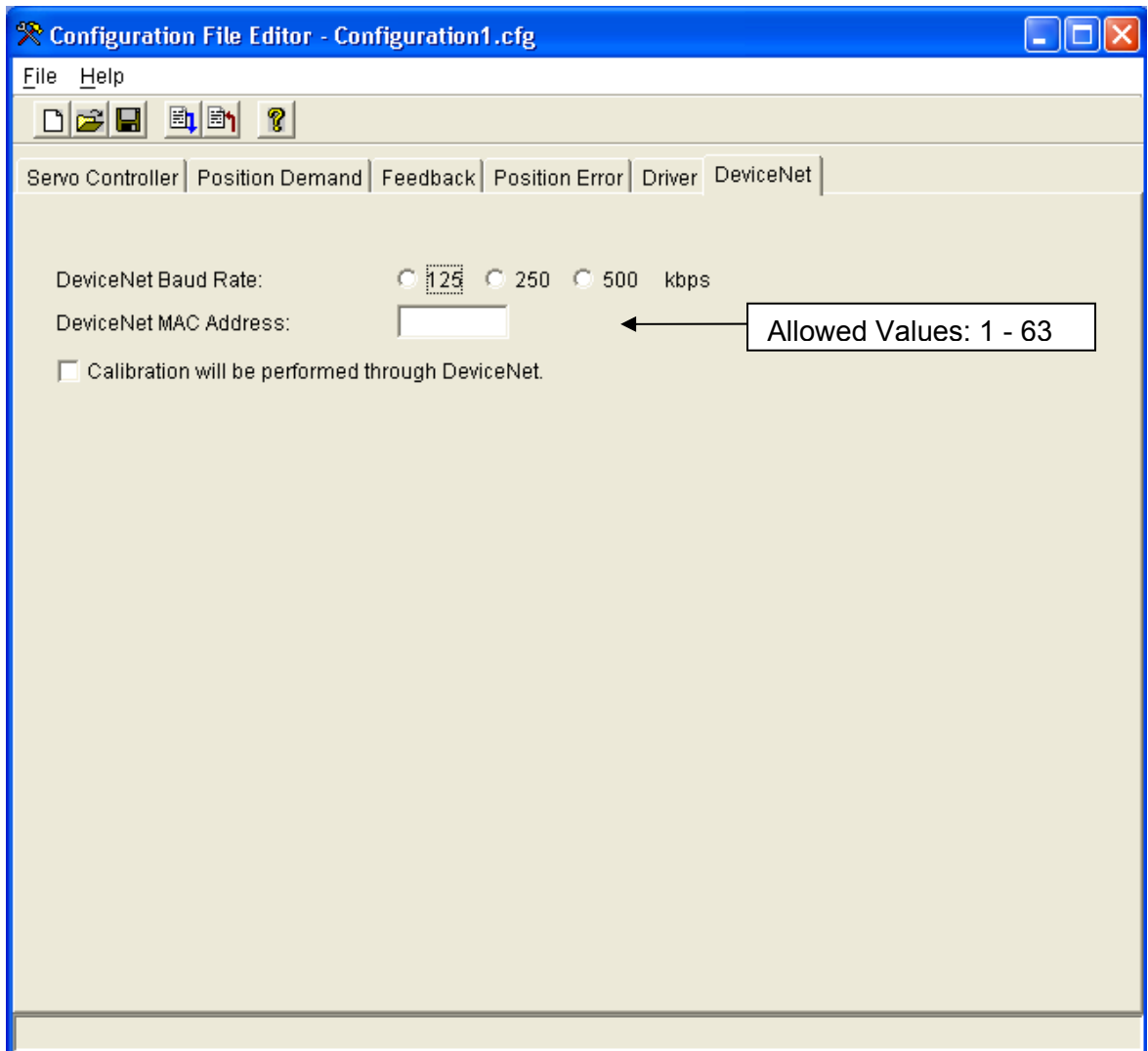


Figure 4-33. DeviceNet Configuration

**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.

## 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 DeviceNet bus. The SPC service tool guides the user through the calibration procedure. Calibration through the DeviceNet 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 DeviceNet 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** 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 5 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.



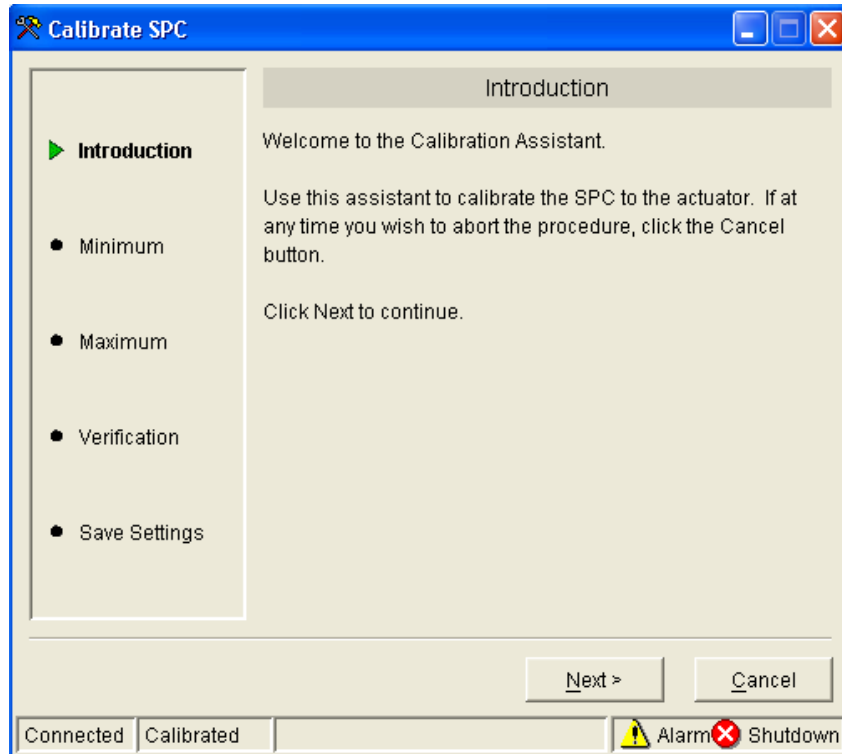


Figure 4-34. Introduction

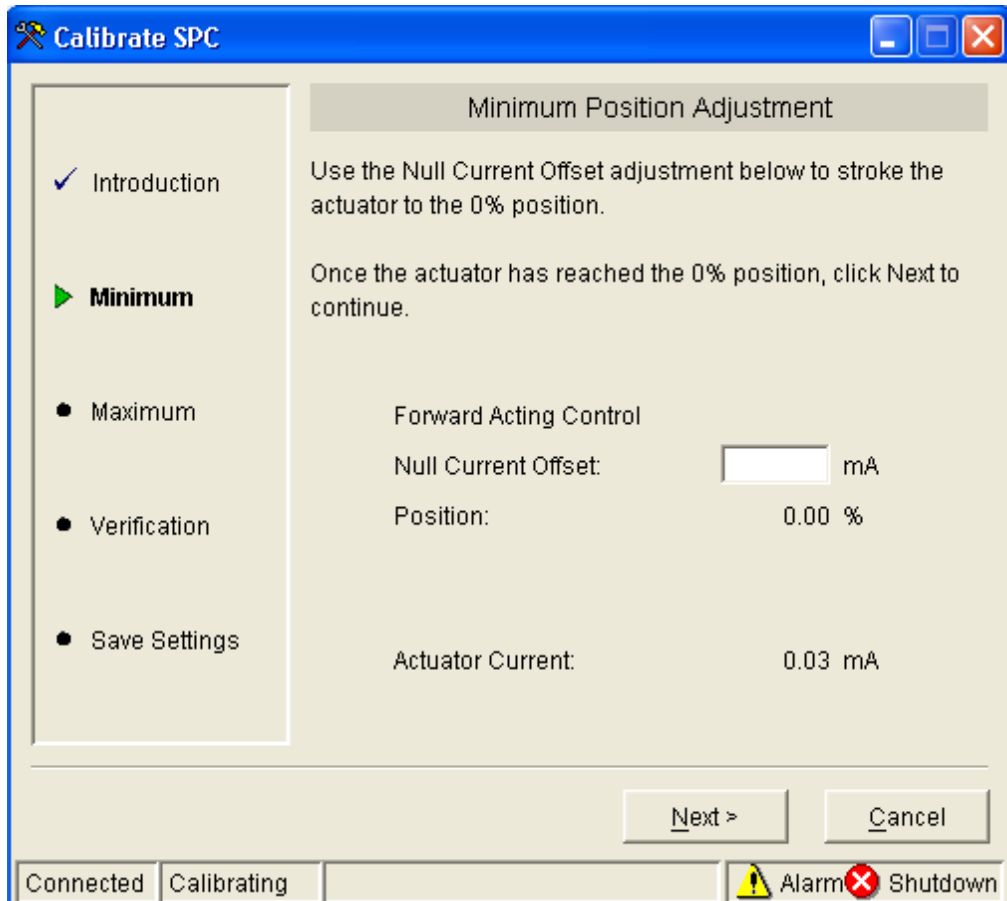


Figure 4-35. Minimum Position Adjustment

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.

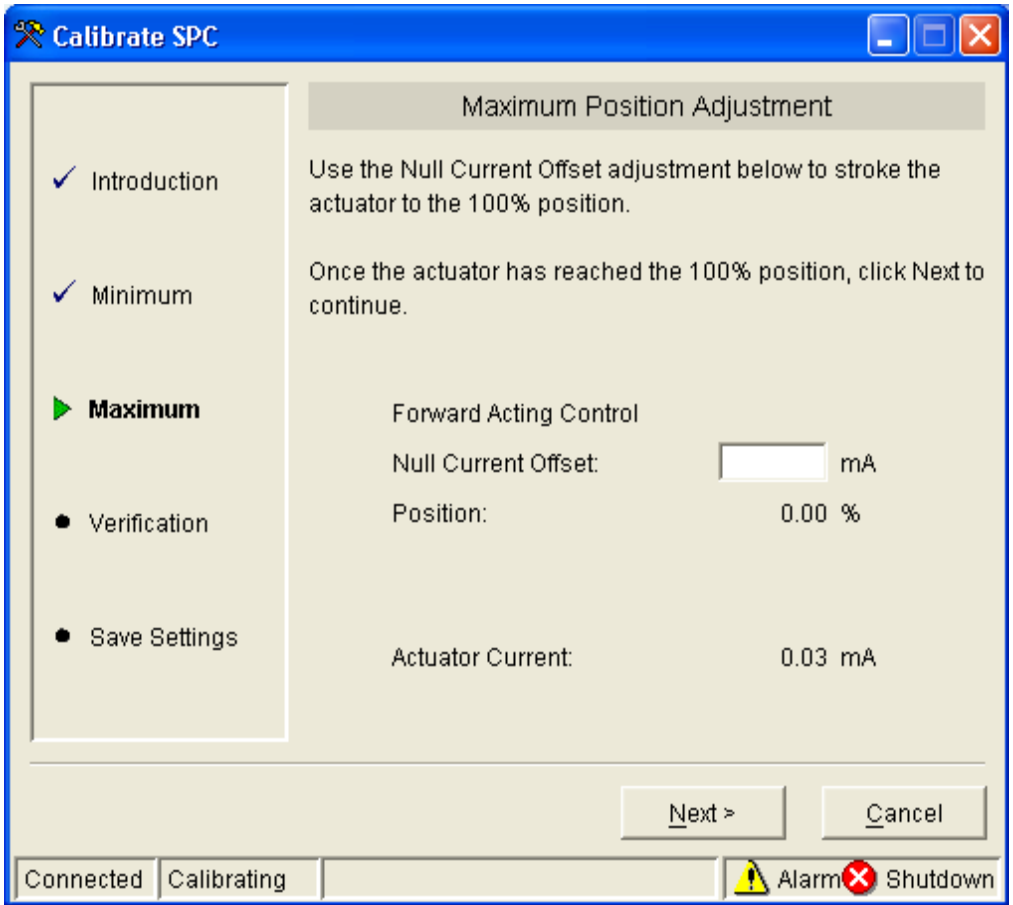


Figure 4-36. Maximum Position Adjustment

#### 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.

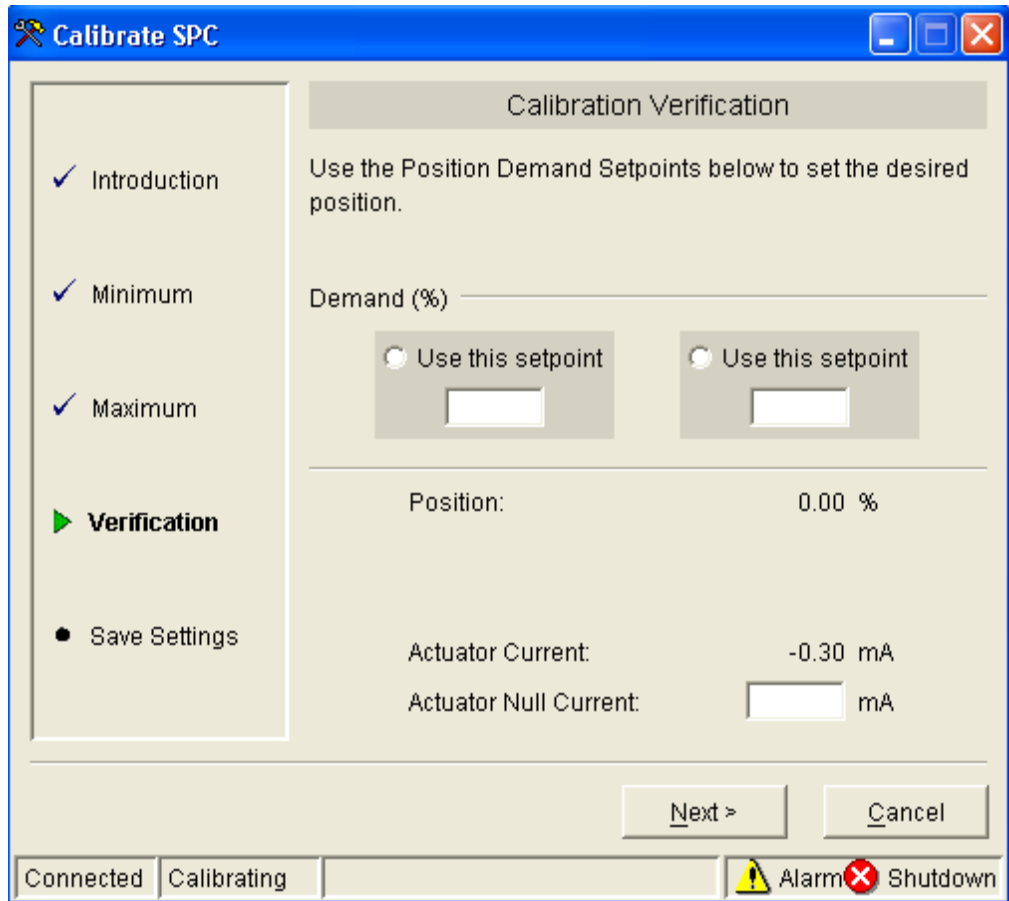


Figure 4-37. Calibration Verification

5. Save Settings

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

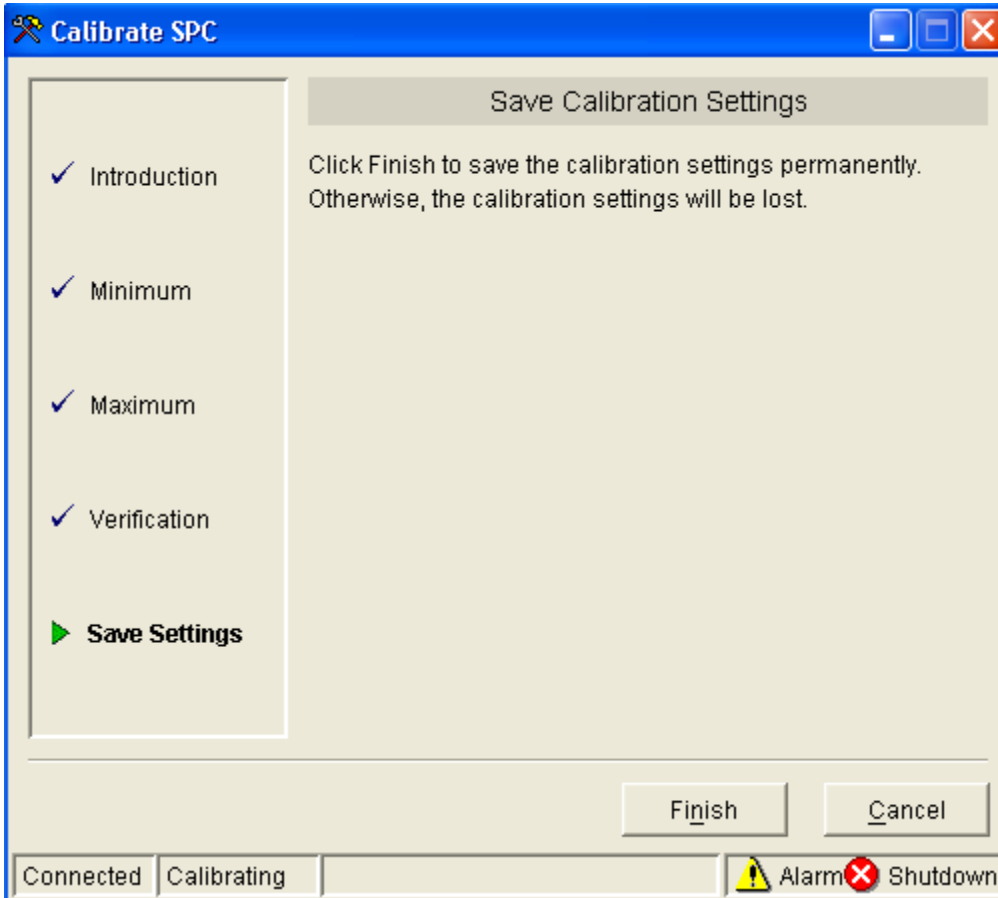


Figure 4-38. Saving the Calibration Settings

<b>IMPORTANT</b>	<p>The SPC remains in the calibration mode until told to run by selecting <i>Action</i>, then selecting <i>Run</i> form the SPC Service Tool menu.</p>
------------------	--



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 is shut 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 is shut 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**. When this box is checked, calibration can only be performed through DeviceNet. 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.

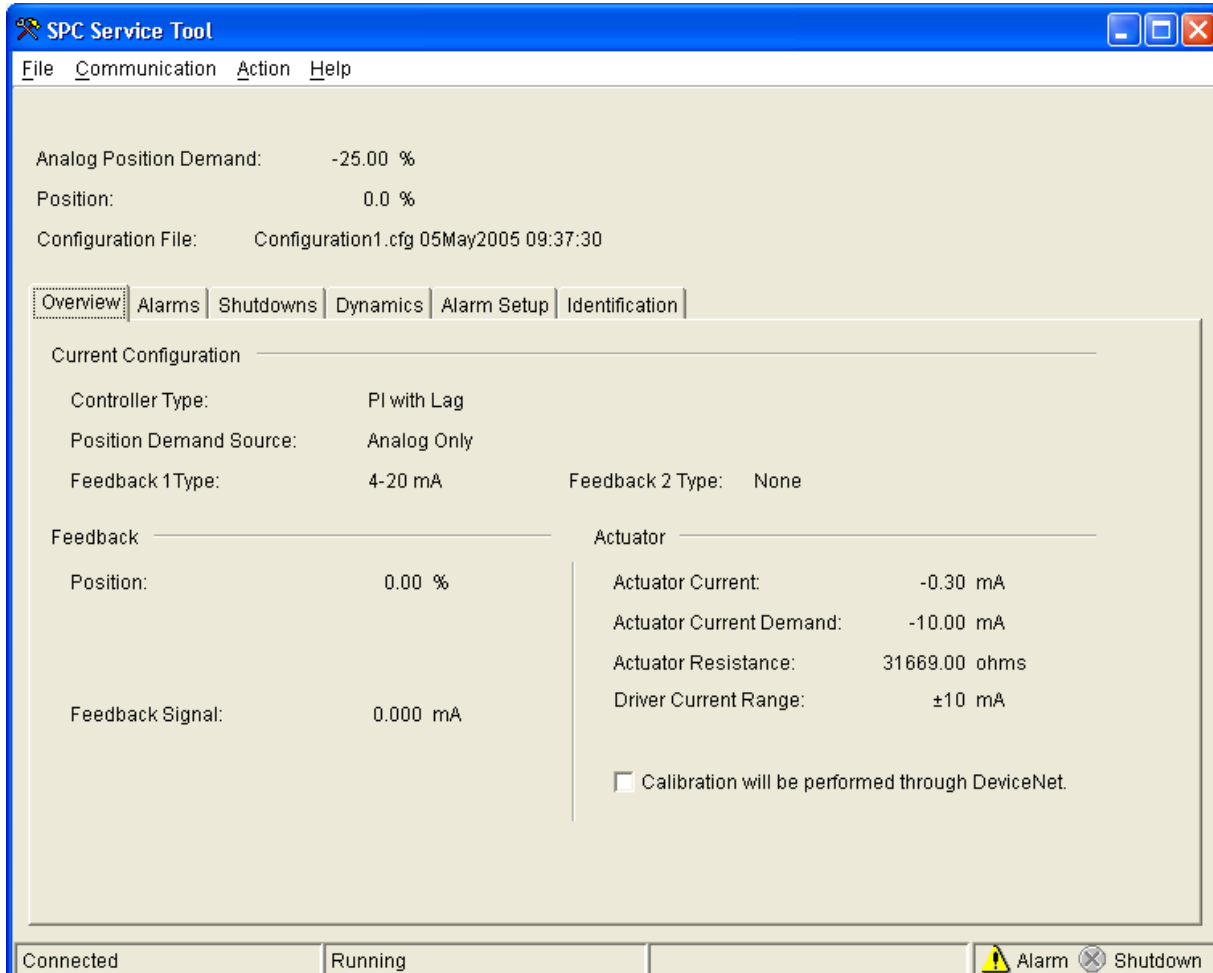


Figure 4-40. SPC Service Tool Overview Tab

### 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 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.

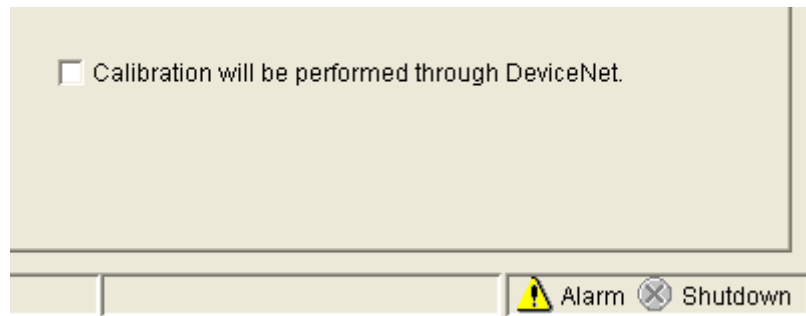


Figure 4-41. Calibration will be performed through DeviceNet

The Overview page includes a check box labeled **Calibration will be performed through DeviceNet**. When this box is checked, calibration can only be performed through DeviceNet. 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.

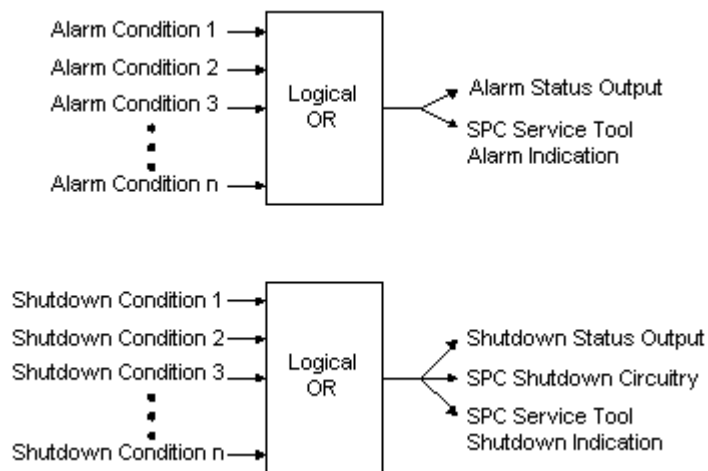




Figure 4-42. Alarm Structure



## 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 can be found at the end of this chapter.

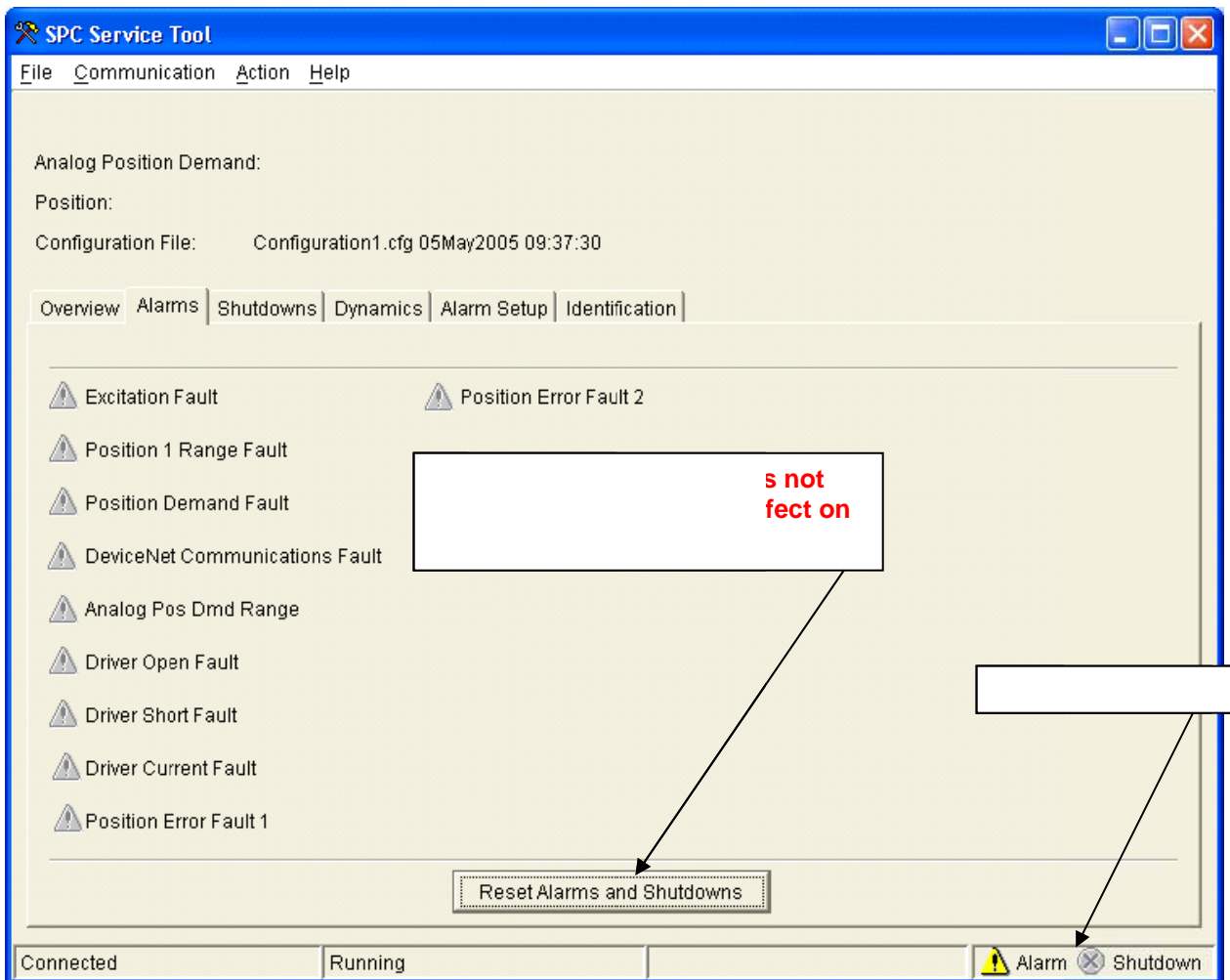


Figure 4-43. Alarms

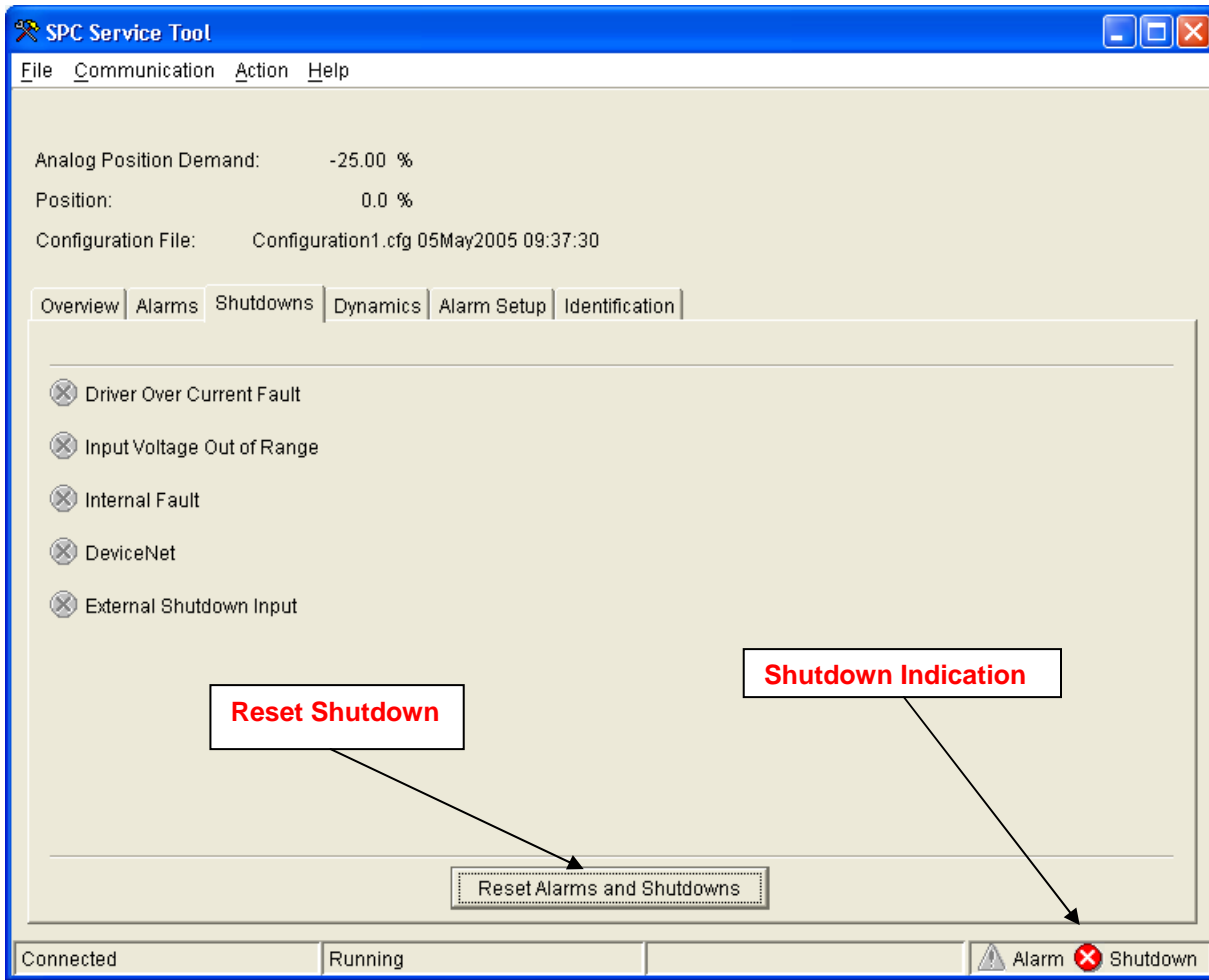


Figure 4-44. Driver Fault Error Shutdown

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.

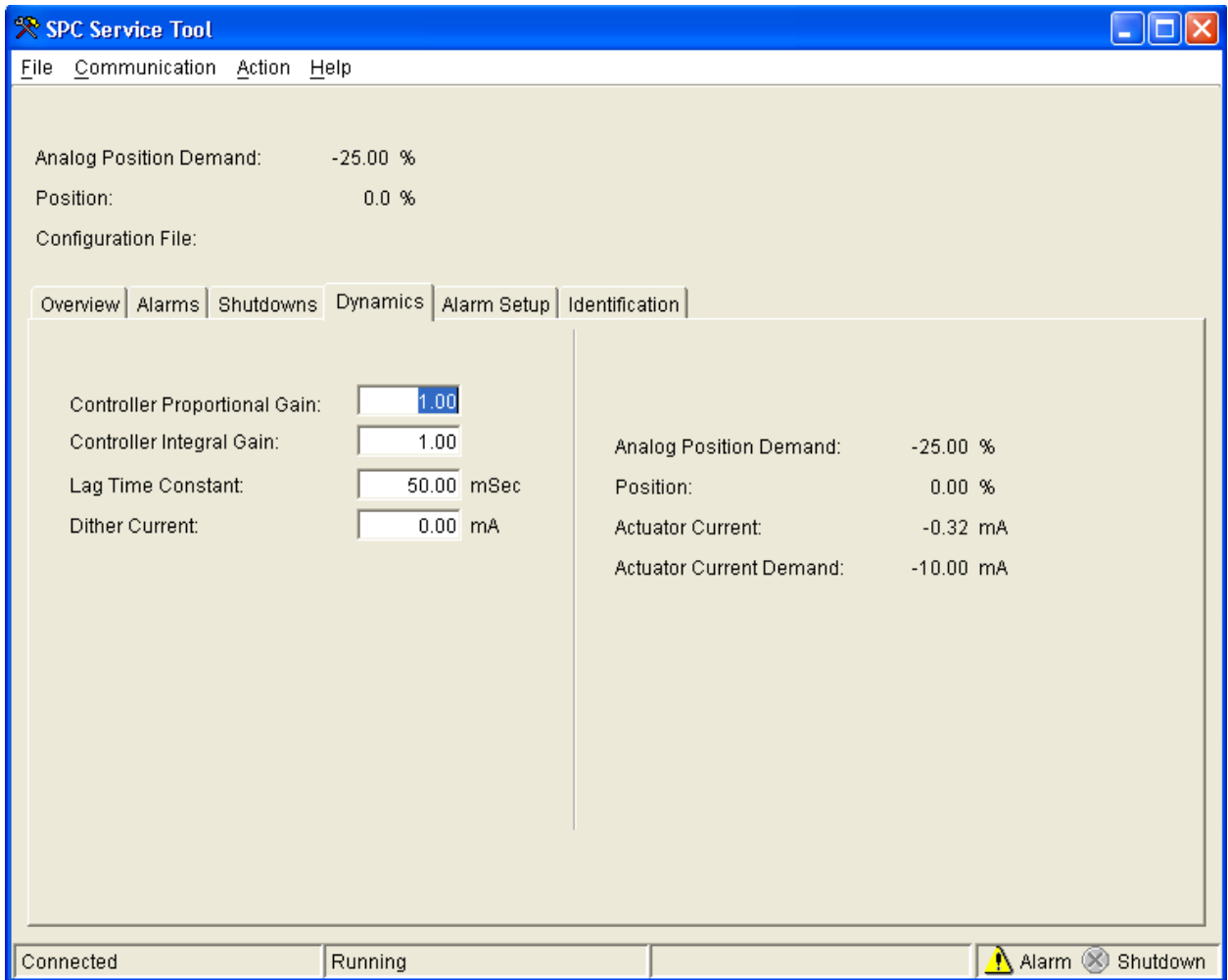


Figure 4-45. Dynamic Settings

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.

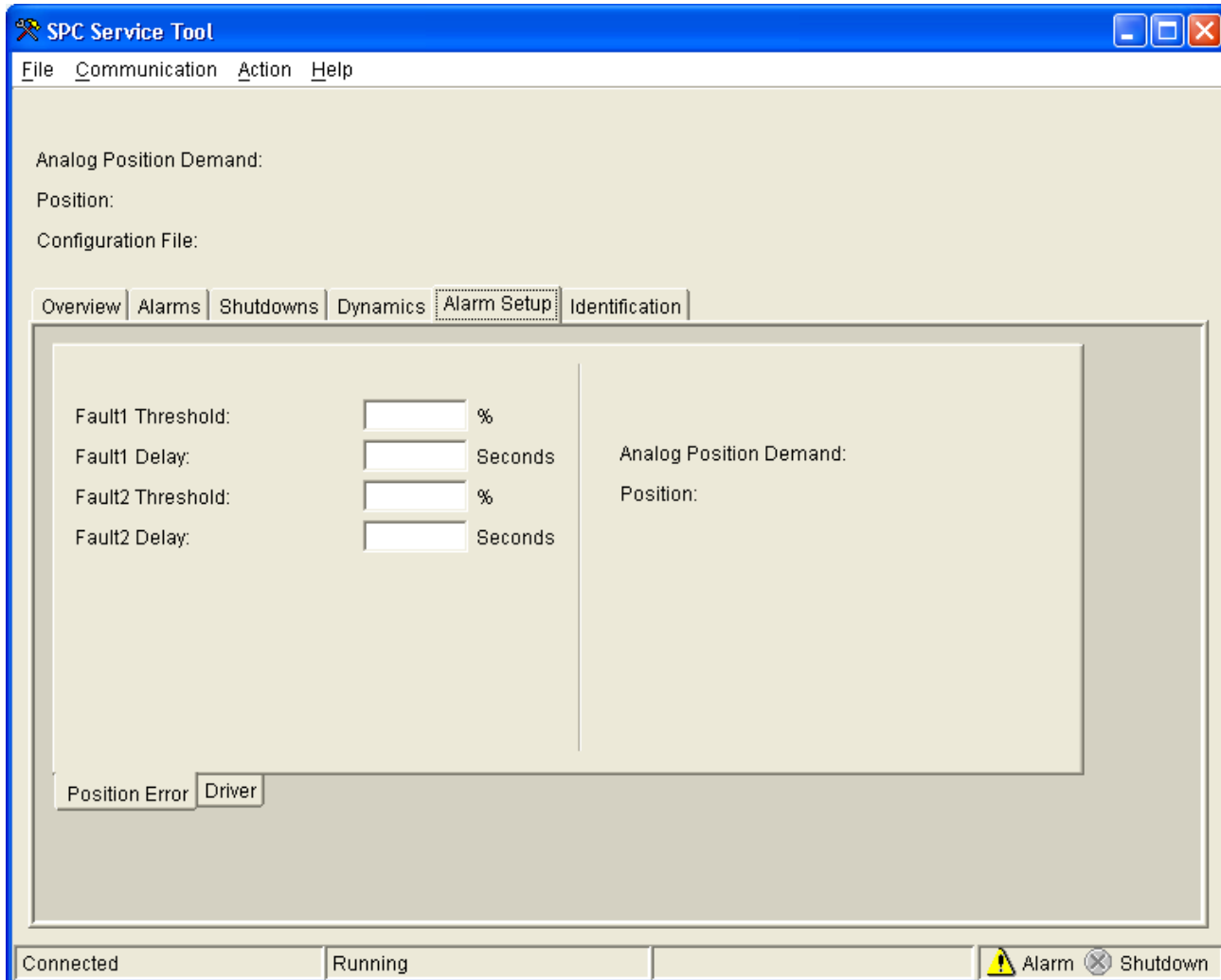


Figure 4-46. Position Error Alarms

### **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

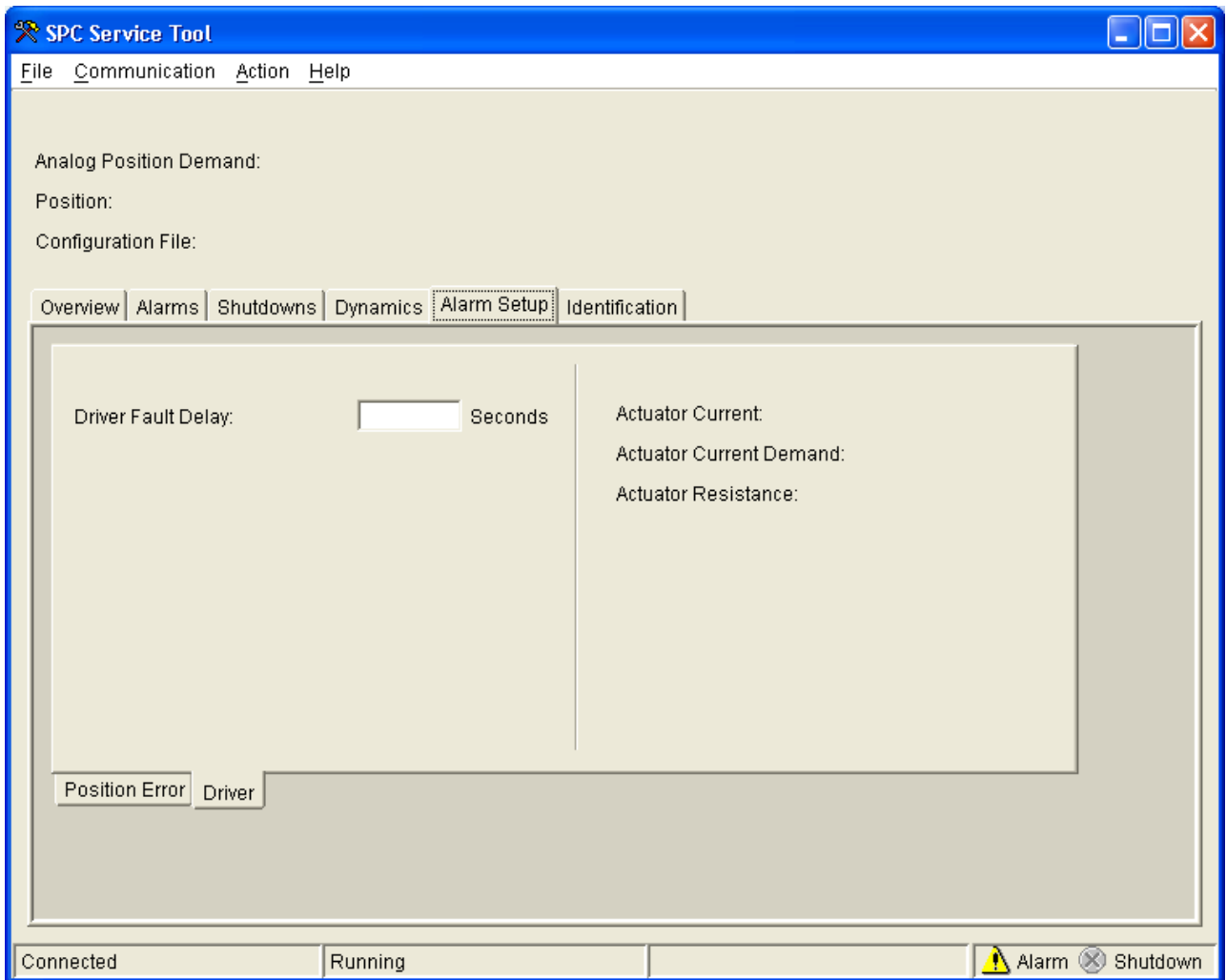


Figure 4-47. Driver Fault Error Alarms

## 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

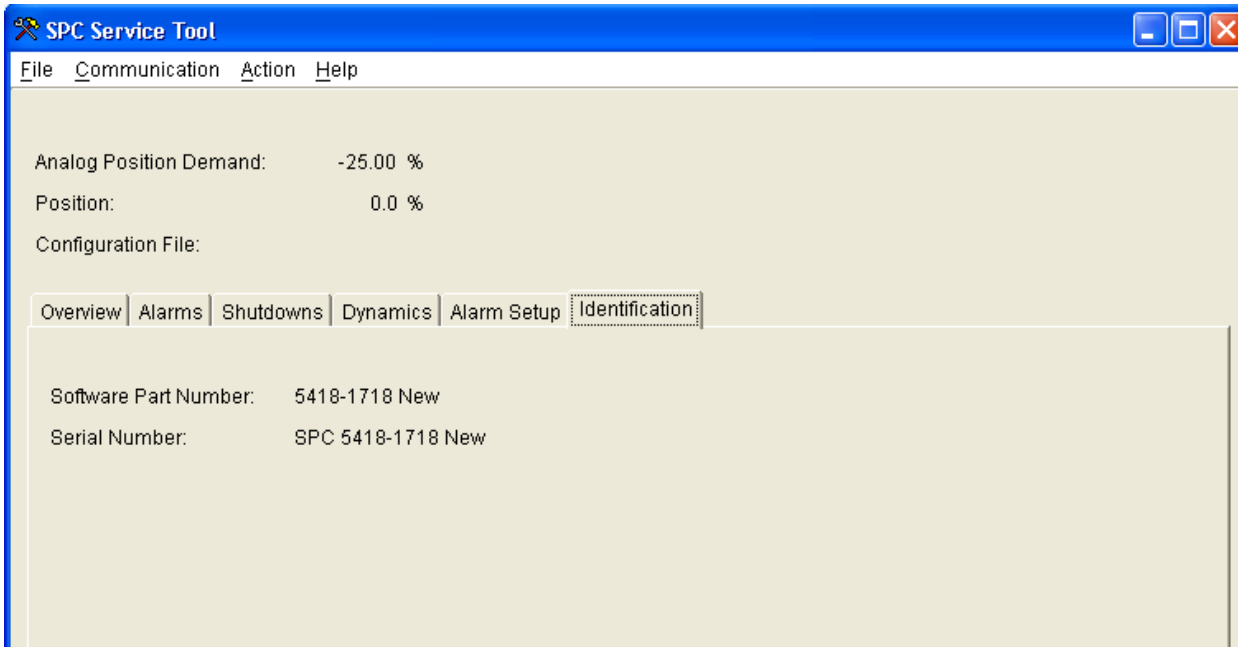


Figure 4-48. SPC Service Tool Identification Tab

## Manually Stroking the Actuator

To enter the manual stroke mode, select **Action** from the SPC Service Tool menu, 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.**

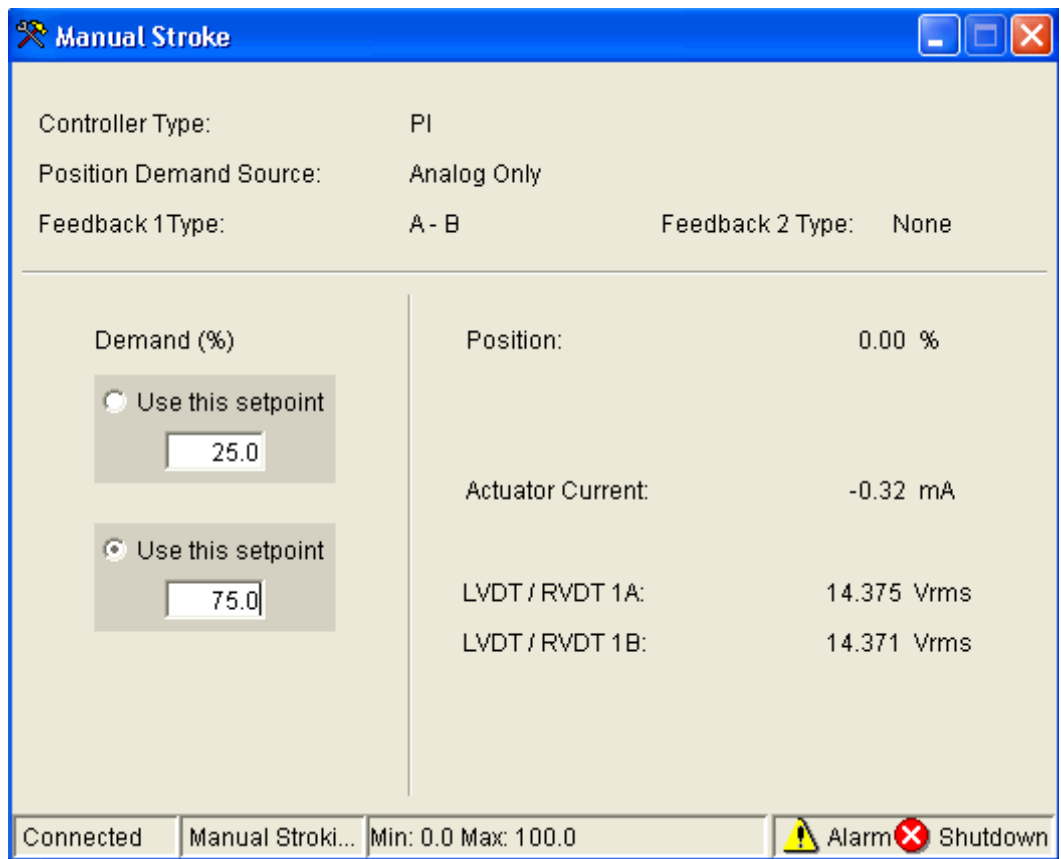





































Figure 4-50. SPC Service Tool Manual Stroking

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

	<b>Shutdown</b>		<b>Alarm</b>
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		

	<b>Alarms Only</b>
	<b>Shutdown Only</b>
	<b>Both: Alarm &amp; ShtDwn</b>

**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.

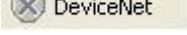
**Analog Position Dmd Out of Range**

- 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



**DeviceNet Communication Fault**

- The DeviceNet Communication Fault goes true when any of the following conditions exists:
  - o 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.
  - o The configured MAC ID is the same as the MAC ID of another device already established on the bus.
  - o There is a problem with the CAN bus which is preventing the SPC from communicating.
  - o 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 2A 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 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 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. Service Options

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

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

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

## Woodward Factory Servicing 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/support](http://www.woodward.com/support).

### How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

#### Electrical Power Systems

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

#### Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Stuttgart	+49 (711) 78954-0
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

#### Turbine Systems

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

You can also contact the Woodward Customer Service Department or consult our worldwide directory ([www.woodward.com/support/directory.cfm](http://www.woodward.com/support/directory.cfm)) for the name of your nearest Woodward distributor or service facility.

### Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Your Name \_\_\_\_\_

Site Location \_\_\_\_\_

Phone Number \_\_\_\_\_

Fax Number \_\_\_\_\_

---

Engine/Turbine Model Number \_\_\_\_\_

Manufacturer \_\_\_\_\_

Number of Cylinders (if applicable) \_\_\_\_\_

Type of Fuel (gas, gaseous, steam, etc) \_\_\_\_\_

Rating \_\_\_\_\_

Application \_\_\_\_\_

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**Control/Governor #1**

Woodward Part Number & Rev. Letter \_\_\_\_\_

Control Description or Governor Type \_\_\_\_\_

Serial Number \_\_\_\_\_

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**Control/Governor #2**

Woodward Part Number & Rev. Letter \_\_\_\_\_

Control Description or Governor Type \_\_\_\_\_

Serial Number \_\_\_\_\_

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**Control/Governor #3**

Woodward Part Number & Rev. Letter \_\_\_\_\_

Control Description or Governor Type \_\_\_\_\_

Serial Number \_\_\_\_\_

*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
		1								Alarm Reset	ALM_RST
		2								Feedback Difference Override	FBDIFF_OVR
		3								Position Error Override	POSERR_OVR
		4								Command Trip Enable	CT_ENABLE
	5								Reserved		
	6								Reserved		
	7								Index	Internal (INDEX_OUT)	
	4		REAL			0	500		0	Reserved	KP (Proportional Gain)
SLOW TO SPC			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		BOOL					30	Reserved	CAL_MODE_E (Enable Calibration)
		1								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	FLDDBUS_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 V2A	FDBK_V_2B
		REAL				mA		36	Measured Actuator Current	MA_OUT
		UINT				OHMS		40	Actuator Ohms	ACT_OHMS
		UINT						42	Calibration Status	SPC_CAL_ST
		UINT						44	Operation Status	OP_STATUS
		UINT						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 2 Fault	POS_RNG_1
	15								Position Range 1 Fault	POS_RNG_2
	0							50	Feedback 2 Range Fault	FB_RNG_1
	1								Feedback 1 Range Fault	FB_RNG_2
	2								Feedback 2 Open Fault	FB_OPEN_1
	3								Feedback 1 Open Fault	FB_OPEN_2
	4								Feedback 2 Fault	
	5								Feedback 1 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 DeviceNet GAP™ Block Help Menu

### FB\_SPC

#### BLOCK DESCRIPTION:

The FB\_SPC block is used to communicate between an Atlas and an SPC. The link between the two devices is DeviceNet with a PC104 DeviceNet module required on the Atlas.

### Input Fields

#### DEMAND:

Position Demand Input. The allowed range is –10 % to 110 %.

#### SD:

Shutdown. When true, causes the SPC to shut down. The SPC will remain shut down as long as this input is true.

#### ALM\_RST:

Alarm Reset. Resets alarms and shutdowns.

#### CT\_ENABLE:

Command Trim Enable: When true, the proportional control attempts to match the position feedback to the position demand. This input is ignored if the SPC has not been configured as a proportional controller.

Command Trim is disabled by the SPC if there is no valid feedback signal.

### IMPORTANT

If communications are lost, this input will default to false.

#### POSSERR\_OVR:

Position Error Override: While true, prevents Position Error Fault 1 and Position Error Fault 2 from causing an alarm or shutdown. The SPC forces this input false if the DeviceNet link has failed.

#### FBDIFF\_OVR:

Feedback Tracking Override: While true, prevents Feedback Tracking Fault 1 and Feedback Tracking Fault 2 from causing an alarm or shutdown.

The SPC forces this input false if the DeviceNet link has failed.

#### KP:

Proportional Gain: Sets the proportional gain of the controller when the SPC has been configured to allow controller gain adjustments via DeviceNet.

#### KI:

Integral Gain: Sets the integral gain of the controller when the SPC has been configured to allow controller gain adjustments via DeviceNet.

**NULL\_I:**

Actuator Null Current (mA): This value should match the actual actuator null current.

This input is used if the SPC is configured for controller types P, PI, PI w/lag, or PI w/lead-lag, and ignored otherwise. It is limited to stay within the configured current range.

This input is ignored if the SPC is not configured to Enable Remote Field Calibration.

**NULL\_I\_OFF:**

Null Current Offset (mA): Is added to the Actuator Null Current value to allow the operator to stroke the actuator during the open-loop portion of the field calibration procedure. Its value is limited so that the sum of the Null Current and Null Current Offset inputs will stay within the configured current range.

This input is used if the SPC is configured for controller types P, PI, PI w/lag, or PI w/lead-lag, and ignored otherwise.

This input is ignored if the SPC is not configured to Enable Remote Field Calibration.

**MA\_MIN\_POS:**

Min Position Current (mA): Determines the actuator current at 0 % position demand for the proportional controller. This input is only adjustable during the field calibration procedure.

This input is used if the SPC is configured for controller type Proportional, and is ignored otherwise.

This input is ignored if the SPC is not configured to Enable Remote Field Calibration.

**MA\_MAX\_POS:**

Min Position Current (mA): Determines the actuator current at 100 % position demand for the proportional controller. This input is only adjustable during the field calibration procedure.

This input is used if the SPC is configured for controller type Proportional, and is ignored otherwise.

This input is ignored if the SPC is not configured to Enable Remote Field Calibration.

**CAL\_MODE\_E:**

Enables the SPC Calibration. See the calibration procedure in Special Instructions below.

**AT\_MIN\_POS:**

A transition from FALSE to TRUE will cause the SPC to record the present position as the 0 % position point. See the calibration procedure in Special Instructions below.

**AT\_MAX\_POS:**

A transition from FALSE to TRUE will cause the SPC to record the present position as the 100 % position point. See the calibration procedure in Special Instructions below.

**SAVE\_CAL:**

A transition from FALSE to TRUE will cause the SPC to save calibration values. It will remain in this state until CAL\_MODE\_E goes FALSE. See the calibration procedure in Special Instructions below.

**E\_M\_STROKE:**

Enable Manual Stroke mode: Enables the SPC to enter the manual stroke mode where an operator can stroke the actuator using MANUAL\_IN as the position demand.

The SPC must be shut down to enable manual stroking, it is ignored otherwise.

CAL\_MODE\_E, AT\_MIN\_POS, AT\_MAX\_POS, & SAVE\_CAL must be set to FALSE and remain FALSE before E\_M\_STROKE is set to TRUE.

This input is ignored if the SPC is not configured to Enable Remote Field Calibration.

**MANUAL\_IN:**

Manual Position Demand Input ( %): Determines the position demand during the "verify calibration" step of the field calibration procedure and during manual stroke mode.

**NTWK\_RATIO:**

Network Scan Time / Rate Group Ratio: This value is set to the ratio of the DeviceNet network scan time and the rate group that the SPC block belongs to. If it is set to too small a value, some of the data communicated over the bus could be lost. It should be set to  $\text{trunc}[(\text{network scan time})/(\text{rate group})] + 1$ . "Trunc" indicates that the fractional part of the result should be dropped. For example, if the worst-case network scan time is 12 ms and the SPC block rate group is 10 ms, NTWK\_RATIO should be set to  $\text{trunc}(12/10) + 1 = \text{trunc}(1.2) + 1 = 1 + 1 = 2$ . The slow index values will be updated every time this value decrements to zero. It will decrement once every rate group execution. If this number is too small, the slow index values will be updated before they are sent out on the network and data will be over-written and lost. If this number is too big, the slow index data will be sent too slowly. In either case, the slave will report an error in the slow indexed data and set D\_RATE\_FLT to TRUE.

## Output Fields

**CAL\_STAT\_R:**

Field calibration sequence request.

0 = No Request/Exit Calibration, 1 = Set Minimum Position, 2 = Set Maximum Position, 3 = Verify Calibration, 4 = Save Calibration, 5 = Manual Stroke.

SPC:

An output to read the Fieldbus demand that comes into the block. SPC = DEMAND.

**POS\_RDBK:**

Position Feedback (%): The position feedback that is used by the servo controller. If position transducer 2 is not used, Position Feedback equals Position Feedback 1. If redundant transducers are used, Position Feedback is equal to Position Feedback 1, Position Feedback 2, or the average of the two, depending on the status of the two position feedback channels.

**CURRENT\_DMD:**

Actuator Current Demand (mA): The actuator current demand value.

**ANALOG\_DMD:**

Analog Position Demand (%): The position demand being received from the analog position demand input.

**FLDBUS\_DMD:**

DeviceNet Position Demand (%): The position demand being received from the DeviceNet position demand input.

**POSN\_DMD:**

Position Demand (%): The position demand presently used by the controller, and is equal to either the analog or the fieldbus position demand.

**ACTIVE\_DMD:**

Active Position Demand (T/F): The position demand presently used by the controller, TRUE = Fieldbus & FALSE = Analog.

**POS\_RDBK\_1:**

Position Feedback 1 (%): The position indicated by position transducer 1.

**POS\_RDBK\_2:**

Position Feedback 2 (%): The position indicated by position transducer 2.

**FDBK\_V\_1A:**

LVDT/RVDT 1 Coil A Voltage (V rms): Voltage on coil "A" of RVDT or LVDT 1.

**FDBK\_V\_1B:**

LVDT/RVDT 1 Coil B Voltage (V rms): Voltage on coil "B" of RVDT or LVDT 1.

**FDBK\_V\_2A:**

LVDT/RVDT 2 Coil A Voltage (V rms): Voltage on coil "A" of RVDT or LVDT 2.

**FDBK\_V\_2B:**

LVDT/RVDT 2 Coil B Voltage (V rms): Voltage on coil "B" of RVDT or LVDT 2.

**MA\_OUT:**

Actuator Current (mA): The actuator current measured by the SPC. This value is not updated when the SPC is not actively positioning the actuator.

**ACT\_OHMS:**

Actuator Resistance (Ohms): The actuator resistance measured by the SPC. 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.

**FB\_RNG\_1:**

Feedback 1 Range Fault: 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.

SPC Service Tool Annunciation: *Alarm-Feedback 1 Range Fault*

**FB\_RNG\_2:**

Feedback 2 Range Fault: 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.

SPC Service Tool Annunciation: *Alarm-Feedback 2 Range Fault*

**FB\_OPEN\_1:**

Feedback 1 Open Fault: The SPC has detected an open wire in the position feedback 1 transducer circuit.

SPC Service Tool Annunciation: *Alarm-Feedback 1 Open Fault*

**FB\_OPEN\_2:**

Feedback 2 Open Fault: The SPC has detected an open wire in the position feedback 2 transducer circuit.

SPC Service Tool Annunciation: *Alarm-Feedback 2 Open Fault*

**DRV\_OVRCT:**

Driver Over current Fault: The actual driver current exceeds the commanded driver current by more than 20 % of the full-scale current.

SPC Service Tool Annunciation: *SD-Driver Over Current Fault*

**FB\_FLT\_SD:**

Feedback Fault: Feedback alarms have occurred which indicate 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.

SPC Service Tool Annunciation: *Shutdown-Feedback Fault*

**FB\_DIF\_ALM:**

Feedback Tracking Fault 1: The difference between Position 1 and Position 2 exceeds the Tracking Fault 1 Threshold for longer than the Tracking Fault 1 Delay time.

SPC Service Tool Annunciation: *Alarm-Feedback Tracking Fault 1*

**FB\_DIF\_SD:**

Feedback Tracking Fault 2: The difference between Position 1 and Position 2 exceeds the Tracking Fault 2 Threshold for longer than the Tracking Fault 2 Delay time.

**SPC Service Tool Annunciation:**

When configured as an alarm: *Alarm-Feedback Tracking Fault 2*

When configured as a shutdown: *SD- Feedback Tracking Fault 2*

**POS\_ERR\_AL:**

Position Error Fault 1: The difference between Position Demand and Position Feedback exceeds the position error Fault 1 Threshold for longer than the Fault 1 Delay time.

SPC Service Tool Annunciation: *Alarm-Position Error Fault 1*



**POS\_ERR\_SD:**

Position Error Fault 2: The difference between Position Demand and Position Feedback exceeds the position error Fault 2 Threshold for longer than the Fault 2 Delay time.

**SPC Service Tool Annunciation:**

When configured as an alarm: *Alarm-Position Error Fault #2*

When configured as a shutdown: *SD-Position Error Fault #2*

**DRV\_FLT:**

Driver Fault: One or more SPC driver faults are active.

**DEMAND\_SD:**

Position Demand Fault: Position demand alarms have occurred which indicate 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 Communication Fault.

SPC Service Tool Annunciation: *Shutdown-Position Demand*

**SPC\_AL:**

One or more SPC alarms are active.

SPC Service Tool Annunciation: *Alarm indicator on*

**SPC\_SD:**

One or more SPC shutdowns are active.

SPC Service Tool Annunciation: *Shutdown indicator on*

**SPC\_CAL\_ST:**

Field Calibration State: The Calibration State of the SPC as follows:

0 = Has not been Calibrated

1 = Waiting for the indication that the actuator is at minimum position

2 = Waiting for the indication that the actuator is at maximum position

3 = Calibration may be verified using the manual position demand input.

4 = Manual Stroke mode has been enabled

5 = Calibration has been Completed

**CAL\_CMPLT:**

Field Calibration Status: The field calibration status of the SPC as follows:

0 = not calibrated

1 = calibrated

**OP\_STATUS:**

SPC Operational Mode: The current operational mode of the SPC:

1-Configure Mode

2-Run Mode

3-Field Configure Calibration Mode

0-PowerUp Mode -- This mode should not be visible to the User

4-Factory Configuration Mode -- This mode should not be visible to the User

**POS\_RNG\_1:**

Position 1 Range Fault: Position 1 is less than (0 % - Position Range Threshold) or greater than (100 % + Position Range Threshold).

SPC Service Tool Annunciation: *Alarm-Position 1 Range Fault*

**POS\_RNG\_2:**

Position 2 Range Fault: Position 2 is less than (0 % - Position Range Threshold) or greater than (100 % + Position Range Threshold).

SPC Service Tool Annunciation: *Alarm-Position 2 Range Fault*

**EXC\_FLT:**

Excitation Fault: The excitation voltage is not within 0.2 V (rms) of the configured value.

SPC Service Tool Annunciation: *Alarm-Excitation Fault*

**DRV\_OPEN:**

Driver Open Fault: The SPC has detected an open actuator coil.

SPC Service Tool Annunciation:

When configured as an alarm: *Alarm-Driver Open Fault*

When configured as a shutdown: *SD- Driver Open Fault*

**DRV\_SHORT:**

Driver Short Fault: The SPC has detected a shorted actuator coil. There must be sufficient current demand to the actuator for a short to be detected.

SPC Service Tool Annunciation:

When configured as an alarm: *Alarm-Driver Short Fault*

When configured as a shutdown: *SD- Driver Short Fault*

**CURR\_FLT:**

Driver Current Fault: The actual driver current does not match the commanded driver current within 15 % of the full-scale current.

SPC Service Tool Annunciation:

When configured as an alarm: *Alarm-Driver Current Fault*

When configured as a shutdown: *SD- Driver Current Fault*

**AN\_DMD\_AL:**

Analog Demand Fault: The (4 to 20) mA analog position demand current is below 1 mA or above 24 mA.

SPC Service Tool Annunciation: *Analog Pos Dmd Range*

**FB\_DMD\_AL:**

DeviceNet Position Demand Fault: The position demand value is not being received on the DeviceNet bus.

SPC Service Tool Annunciation: *None*

**IN\_V\_ERR:**

Input Voltage Out Of Range Fault: The SPC input voltage is below 17 V (dc) or above 33 V (dc).

SPC Service Tool Annunciation: *SD-Input Voltage Out Of Range*

**DMD\_TRK\_AL:**

Position Demand Tracking Fault: The difference between Analog Position Demand and DeviceNet Position Demand exceeds the Tracking Fault Threshold for longer than the Tracking Fault Delay time.

SPC Service Tool Annunciation: *Alarm-Position Demand Tracking*

**INTERN\_FLT:**

Internal Fault: 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.

SPC Service Tool Annunciation: *SD-Internal Fault*

**FB\_SD:**

DeviceNet Shutdown: A shutdown command is being received over the DeviceNet bus.

SPC Service Tool Annunciation: *SD-DeviceNet*

**EXTERN\_SD:**

External Shutdown Input: The external shutdown contact input is open.

SPC Service Tool Annunciation: *SD-External Shutdown Input*

**DCOMM\_FLT:**

DeviceNet Slow Data Communication Fault: A DeviceNet communication fault has occurred where the Slow Indexed Data has not been sent to the slave fast enough. The most common cause of this is the NTWK\_RATIO being too high or the RG\_LOOPS value being too low.

**D\_RATE\_FLT:**

DeviceNet Data Rate Fault: The SPC has detected that it is not receiving all the required DeviceNet data. The most likely cause of this fault is the NTWK\_RATIO value being set too small.

**Proprietary FIELDS:**

The following fields are proprietary and are intended to be used in development or for troubleshooting:

INDEX\_OUT Temporary storage of the Index number to be sent

INDX\_VAL\_O Temporary storage of the Index data value to be sent

INDX\_VAL\_I Temporary storage of the Index data value received from the slave

INDEX\_LAST Temporary storage of the last Index received from the slave

INDEX\_TMR Number of Rate Groups left to execute before an Index update

RG\_LOOPS Slow Data must be completely sent before this number of Rate Groups have executed. If not, D\_RATE\_FLT = TRUE

LOOPED Slow Data has completed it's loop and has been sent

INDEX\_CNTR Temporary storage for counter used in RG\_LOOPS

INDEX\_GOOD Temporary storage for variable stating the input index has been received in the correct order.

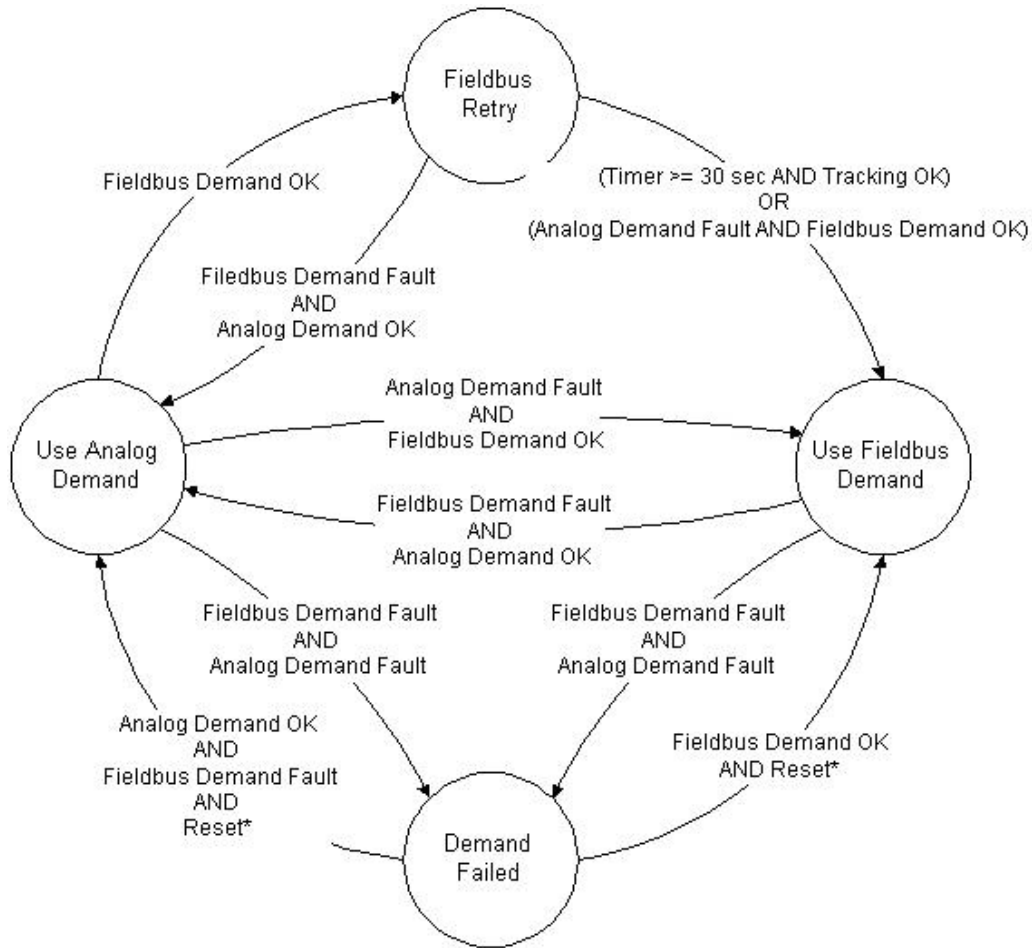
READX\_FLT The read from the X word on the Applicom Module has failed

WRITE\_FLT Any write to the Applicom Module has failed

## Special Instructions

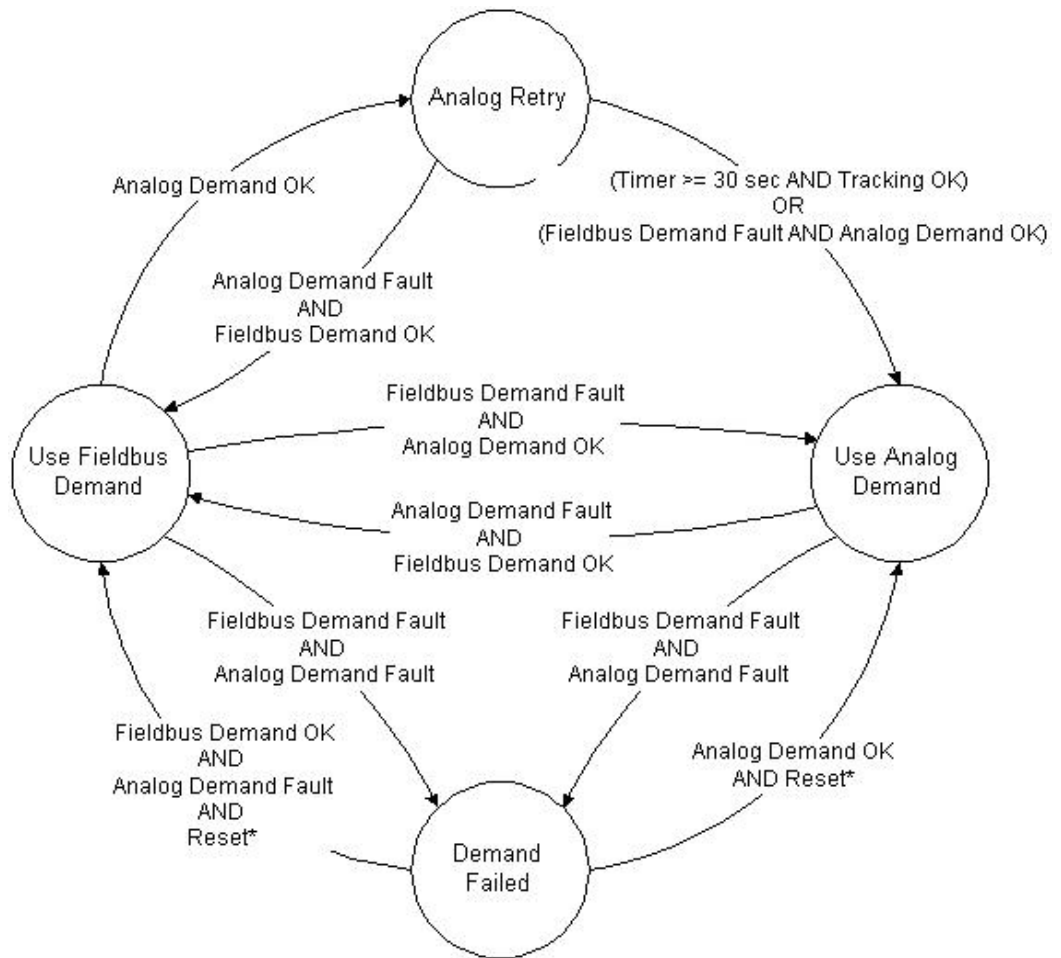
### DEMAND FAILOVER LOGIC:

The following diagrams describe the SPC demand failover between Analog and Fieldbus Demand.



\*Reset not required if configured as non-latching

Figure C-1. State Diagram of Fieldbus being the Primary Demand Signal



\*Reset not required if configured as non-latching

Figure C-2. State Diagram of Analog being the Primary Demand Signal

## Calibration Procedure

The following is the procedure for calibrating the SPC from an Atlas control using the FB\_SPC block.

### **IMPORTANT**

The SPC must be configured for Calibration through DeviceNet and the unit must be shutdown.

#### STEP #1

All Calibration blocks should be set to false and the SPC\_CAL\_ST should be reading a 0 or a 5, and CAL\_STATUS should be reading a 0.

```

CAL_MODE_E: FALSE
AT_MIN_POS: FALSE
AT_MAX_POS: FALSE
SAVE_CAL: FALSE
E_M_STROKE: FALSE
SPC_CAL_ST: 0,5,5
CAL_STATUS: 0
  
```

**STEP #2**

Enable calibration mode by turning CAL\_MODE\_E to TRUE. SPC\_CAL\_ST and CAL\_STATUS should be reading a 1 now.

CAL\_MODE\_E: TRUE  
AT\_MIN\_POS: FALSE  
AT\_MAX\_POS: FALSE  
SAVE\_CAL: FALSE  
E\_M\_STROKE: FALSE  
SPC\_CAL\_ST: 1  
CAL\_STATUS: 1

**STEP #3**

Force the SPC valve to the minimum position by tuning the following values.

Integrating Valve

NULL\_I:

NULL\_I\_OFF:

Proportional Valve

AT\_MIN\_POS:

AT\_MAX\_POS:

**STEP #4**

Tune AT\_MIN\_POS value TRUE and then back to FALSE. SPC\_CAL\_ST and CAL\_STATUS should be reading a 2 now. The value must be returned to a FALSE condition before the next step may proceed.

**STEP #5**

Force the SPC valve to the maximum position by tuning the same values as in step #3. After the valve is at maximum position, tune AT\_MAX\_POS value TRUE and then back to FALSE. SPC\_CAL\_ST and CAL\_STATUS should be reading a 3 now. The value must be returned to a FALSE condition before the next step may proceed.

**STEP #6**

Calibration can now be verified by adjusting the MANUAL\_IN variable to position the valve.

**STEP #7**

Once the calibration is verified, tune the SAVE\_CAL variable to TRUE. SPC\_CAL\_ST and CAL\_STATUS should be reading a 5 now.

**STEP #8**

Tune the SAVE\_CAL variable to FALSE to complete the Calibration.

**STEP #9**

Tune CAL\_MODE\_E to FALSE to put the SPC back into RUN\_MODE.  
MANUAL STROKING:

## Manual Stroking Procedure

The following is the procedure for manually stroking the SPC from an Atlas control using the FB\_SPC block:

**IMPORTANT**

The SPC must be configured for Calibration through DeviceNet, and the unit must be shut down.

**STEP #1**

All Calibration blocks should be set to false and the SPC\_CAL\_ST should be reading a 0 or 5, or 5, and CAL\_STATUS should be reading a 0.

CAL\_MODE\_E: FALSE  
AT\_MIN\_POS: FALSE  
AT\_MAX\_POS: FALSE  
SAVE\_CAL: FALSE  
E\_M\_STROKE: FALSE  
SPC\_CAL\_ST: 0,5,5  
CAL\_STATUS: 0

**STEP #2**

Enable calibration mode by turning CAL\_MODE\_E to TRUE. SPC\_CAL\_ST should be reading a 4 now, and CAL\_STATUS should be reading a 5 now. This represents the Manual Stroke.

CAL\_MODE\_E: FALSE  
AT\_MIN\_POS: FALSE  
AT\_MAX\_POS: FALSE  
SAVE\_CAL: FALSE  
E\_M\_STROKE: TRUE  
SPC\_CAL\_ST: 4  
CAL\_STATUS: 5

**STEP #3**

The valve is now in Manual Stroke and can be manipulated with the MANUAL\_IN variable. Changing this variable will change the demand to the SPC valve.

**STEP #4**

Tuning the E\_M\_STROKE to FALSE will put the SPC back into RUN\_MODE.

## Appendix D.

# 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.



## DECLARATION OF CONFORMITY

According to EN 45014

**Manufacturer's Name:** WOODWARD GOVERNOR COMPANY (WGC)  
Industrial Controls Group

**Manufacturer's Address:** 1000 E. Drake Rd.  
Fort Collins, CO, USA, 80525

**Model Name(s)/Number(s):** Servo Position Controller

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

94/9/EC of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.

**Applicable Standards:** EN61000-6-4, (2007): EMC Part 6-4: Generic Standards – Emissions for Industrial Environments.  
EN61000-6-2, (2005): EMC Part 6-2: Generic Standards – Immunity for Industrial Environments.

EN50021:1999 Electrical Apparatus for Potentially Explosive Atmospheres –Type of Protection 'n'

**3<sup>rd</sup> Party Certification:** LCIE 01 ATEX 6076 to Standard EN50021

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

### MANUFACTURER

  
\_\_\_\_\_  
**Signature**

Suhail Horan  
\_\_\_\_\_  
**Full Name**

**Position**

Quality Manager  
\_\_\_\_\_  
**Position**

**Place**

WGC, Fort Collins, CO, USA  
\_\_\_\_\_  
**Place**

**Date**

01-MAR-2010  
\_\_\_\_\_  
**Date**

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