



Installation and Operation Manual



SPC Servo Position Controller

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

Manual 26236 (Revision H)

WARNING—DANGER OF DEATH OR PERSONAL INJURY



WARNING—FOLLOW INSTRUCTIONS

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.



WARNING—OUT-OF-DATE PUBLICATION

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If your publication is not there, please contact your customer service representative to get the latest copy.



WARNING—OVERSPEED PROTECTION

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

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



WARNING—PROPER USE

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

CAUTION—POSSIBLE DAMAGE TO EQUIPMENT OR PROPERTY



CAUTION—BATTERY CHARGING

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.



CAUTION—ELECTROSTATIC DISCHARGE

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

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

IMPORTANT DEFINITIONS

- A **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
- A **CAUTION** indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment or property.
- A **NOTE** provides other helpful information that does not fall under the warning or caution categories.

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: Declared to 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility.

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

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.



WARNING—EXPLOSION HAZARD

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

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



AVERTISSEMENT—RISQUE D'EXPLOSION

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

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



CAUTION—ELECTROSTATIC DISCHARGE

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, 4–20 mA, or both. A software program running on a Personal Computer (PC) allows the user to easily configure and calibrate the SPC.

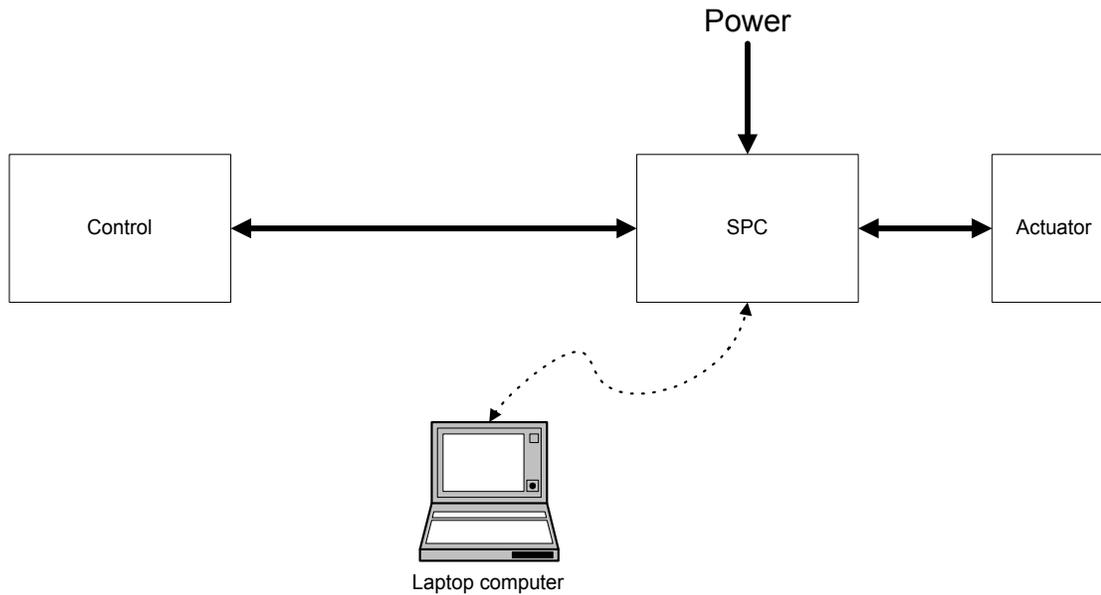


Figure 1-1. SPC Connections

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

**NOTE**

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.

**CAUTION—BATTERY**

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—INGRESS PROTECTION**

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.

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.

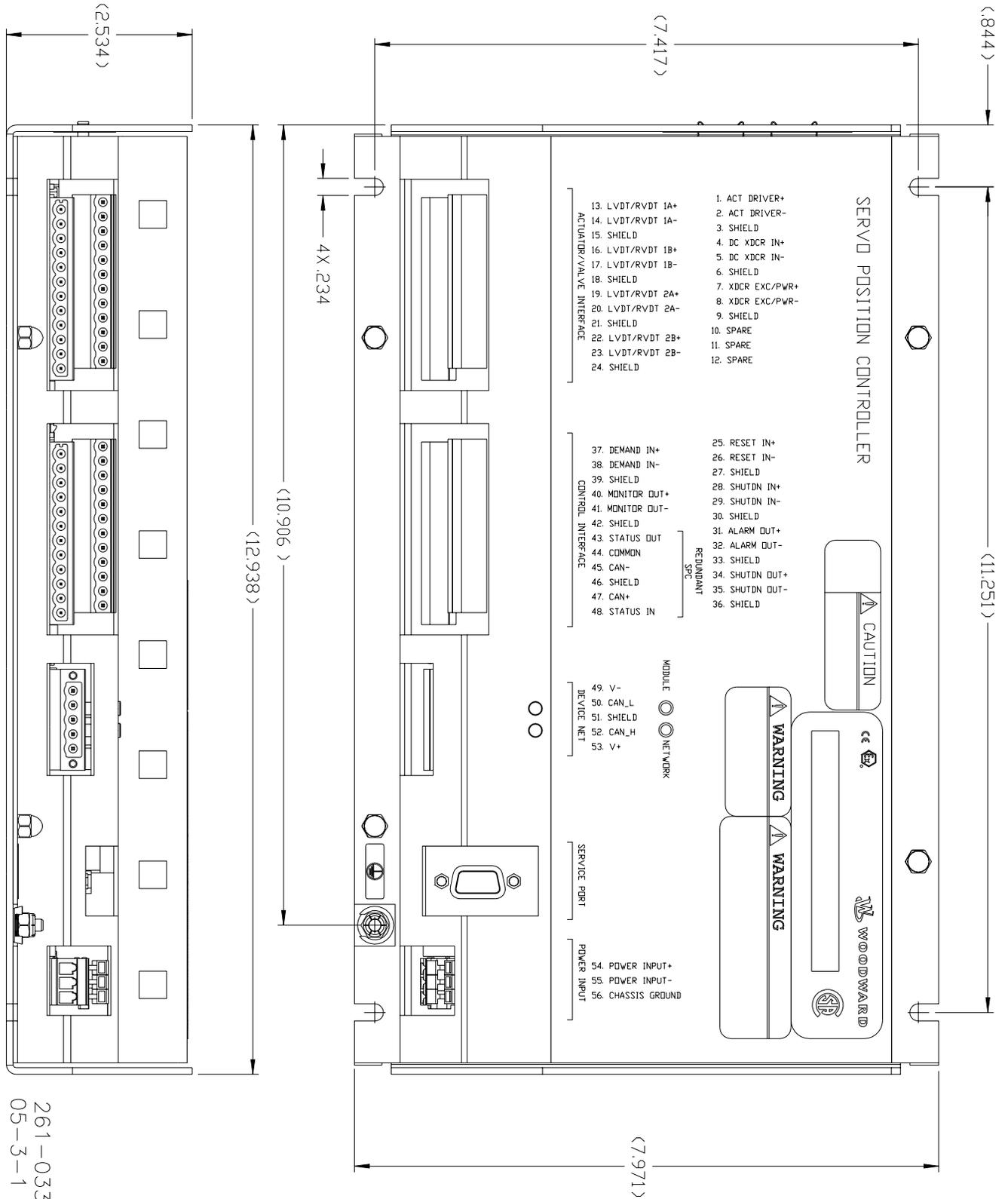


Figure 2-1. SPC Outline Drawing

261-033
05-3-1

**NOTE**

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 0.08–4 mm² (26–12 AWG). The recommended strip length is 8 mm (0.3 inches)

**NOTE**

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 2-3 for the wiring diagram.

Actuator Driver Output

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

DC Transducer Input

If a 4–20 mA position transducer is used for feedback, connect shielded twisted-pair cable from transducer to DC XD CR IN+(4) and DC XD CR 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 XD CR EXC/PWR+(7) and XD CR 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 Vdc (120 mA max) for the transducer power. Connect a shielded twisted-pair cable from the transducer power input to XD CR EXC/PWR+(7) and XD CR 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).

**NOTE**

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.

**NOTE**

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 2-2.

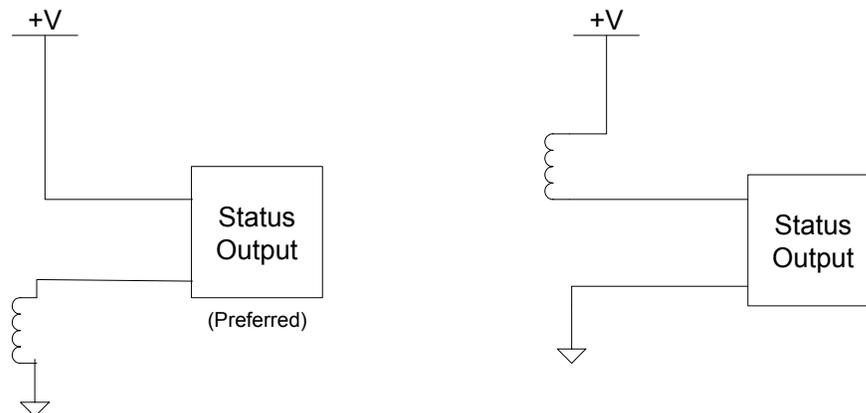


Figure 2-2. Status Relay Driver Output Wiring

Position Demand Input

Connect a shielded twisted-pair cable from the system controller 4–20 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 4–20 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, 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 18–32 Vdc 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 ft) with a total capacitance of less than 2500 pF.

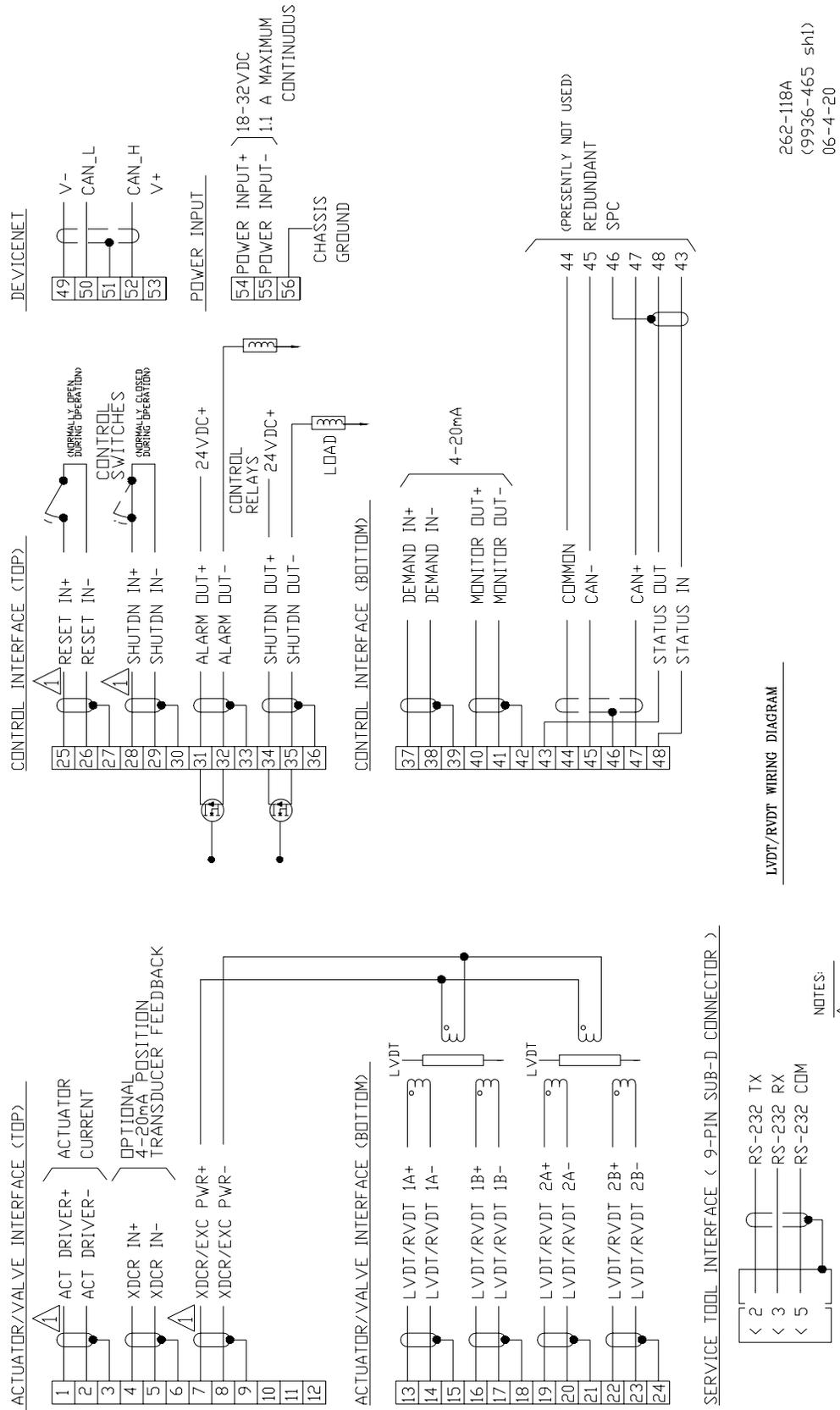


Figure 2-3a. SPC Wiring Diagram

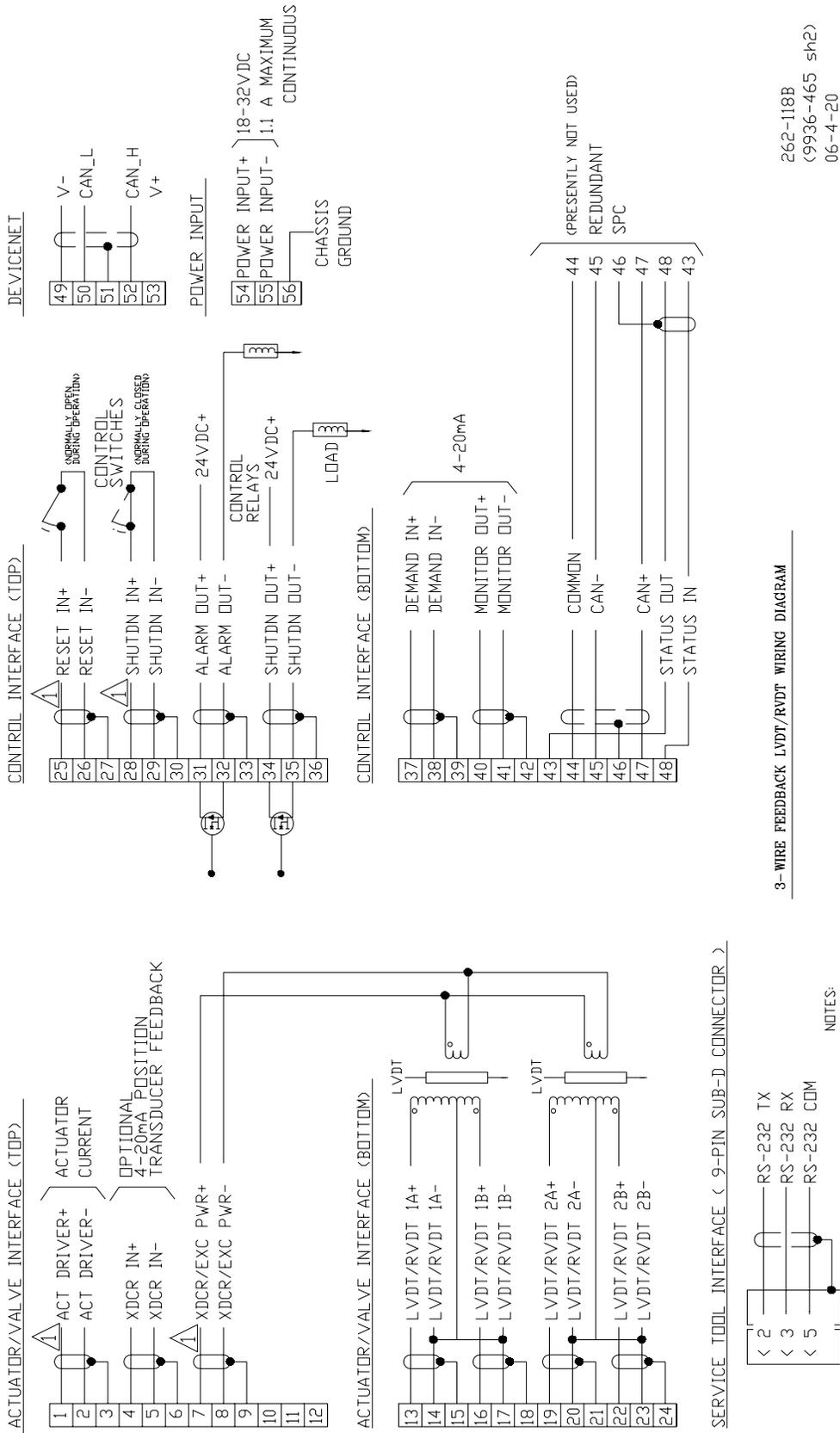


Figure 2-3b. SPC Wiring Diagram

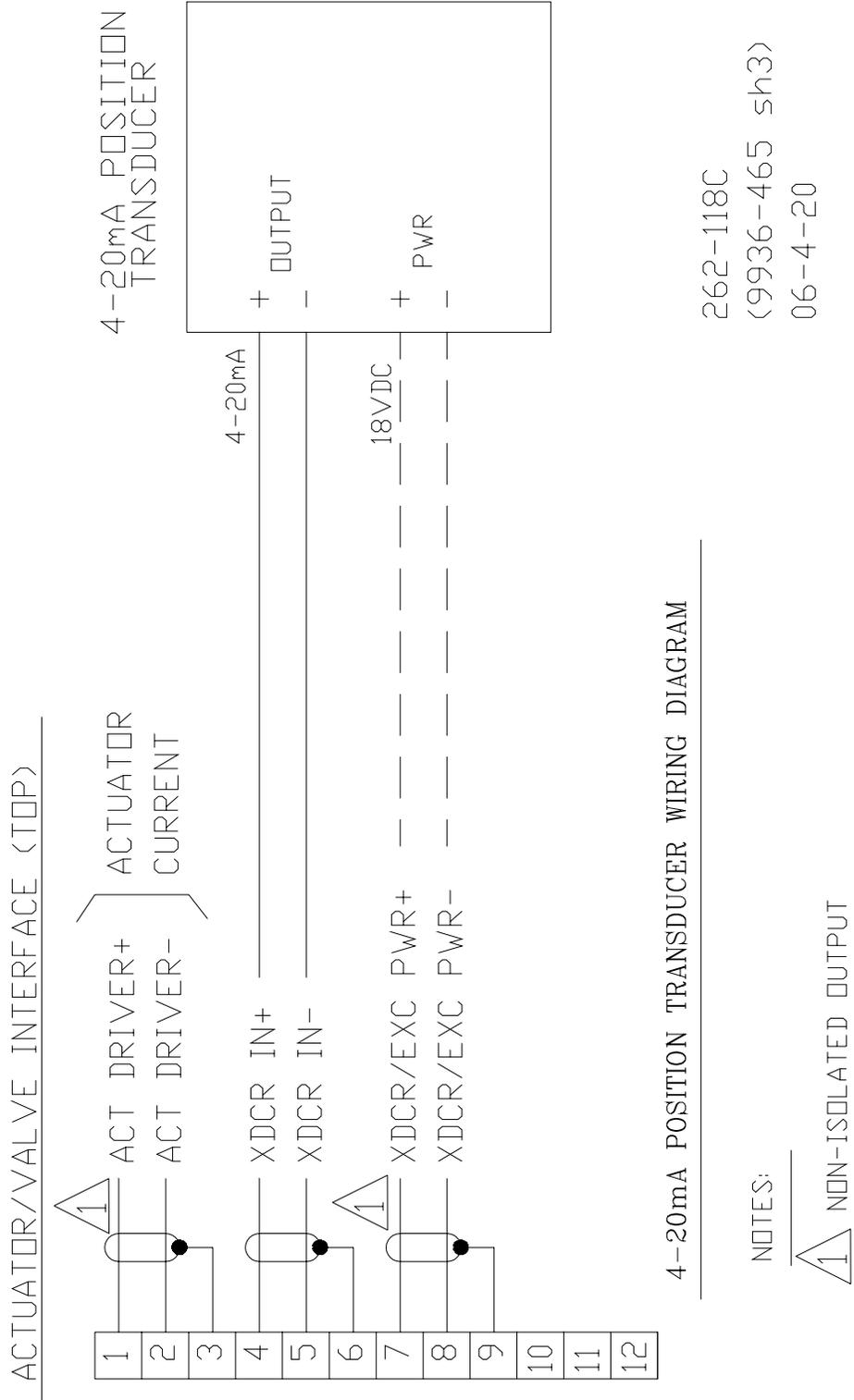
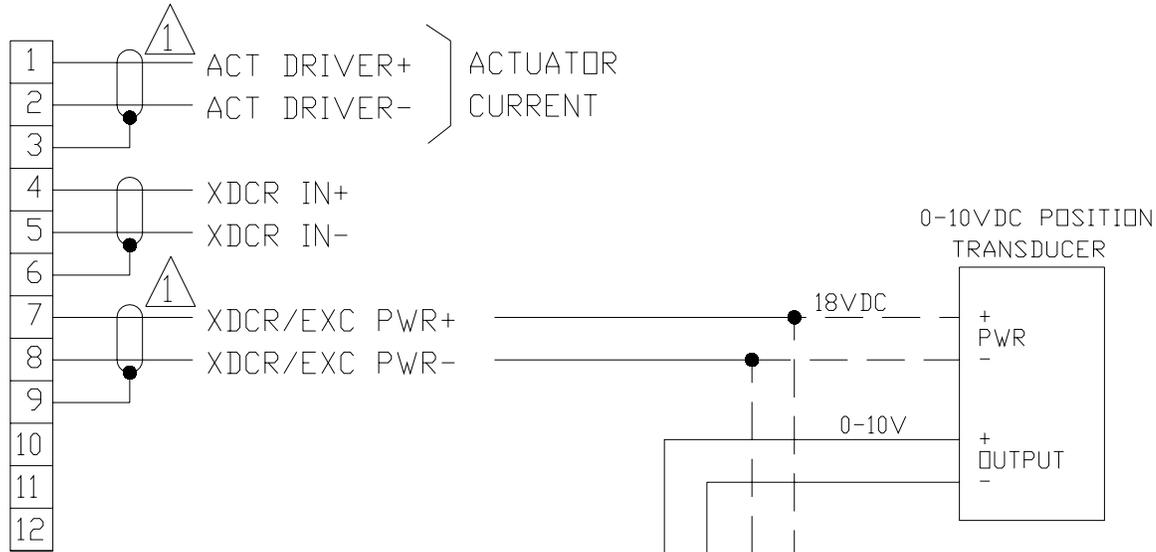
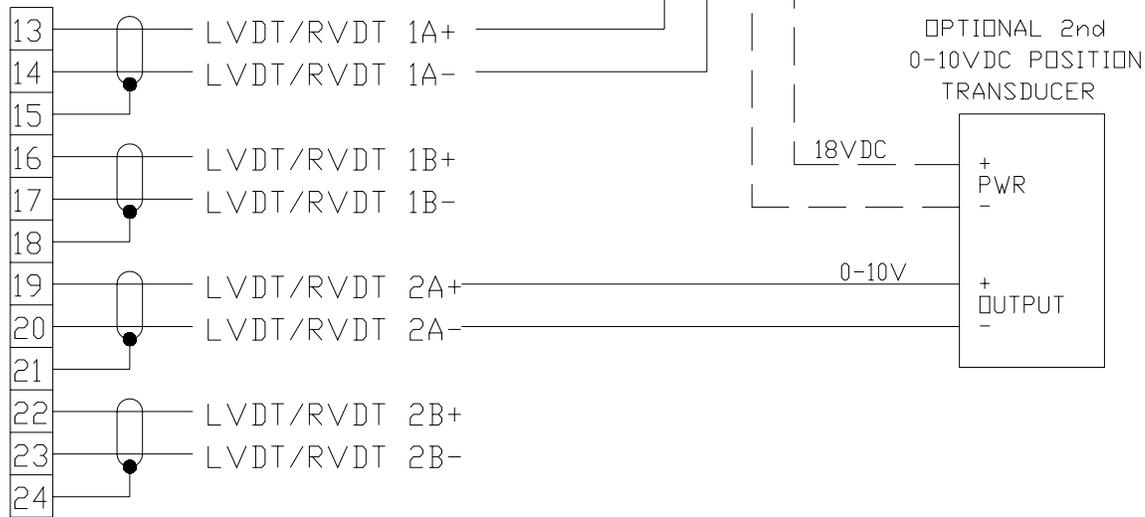


Figure 2-3c. SPC Wiring Diagram

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 2-3d. SPC Wiring Diagram

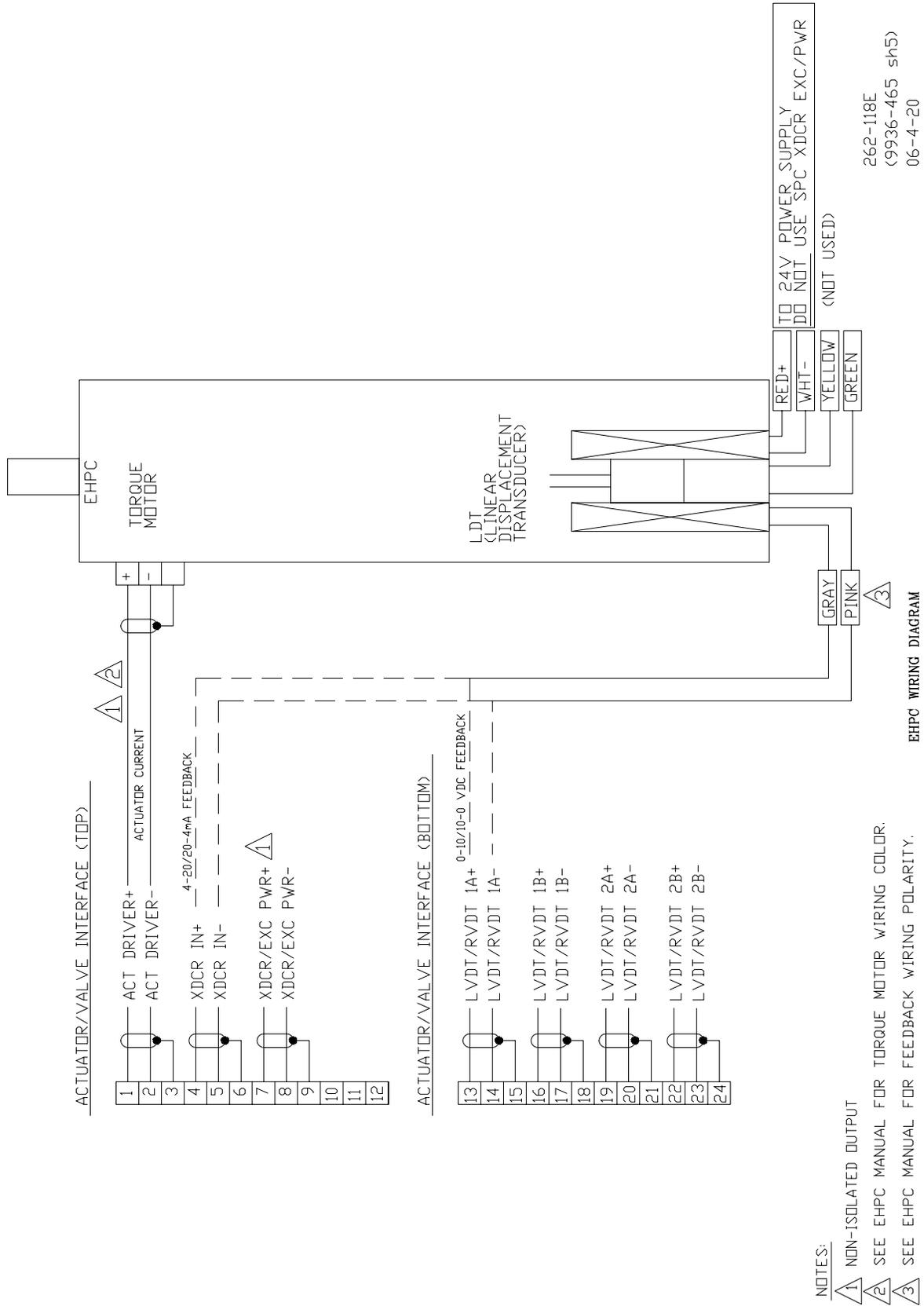
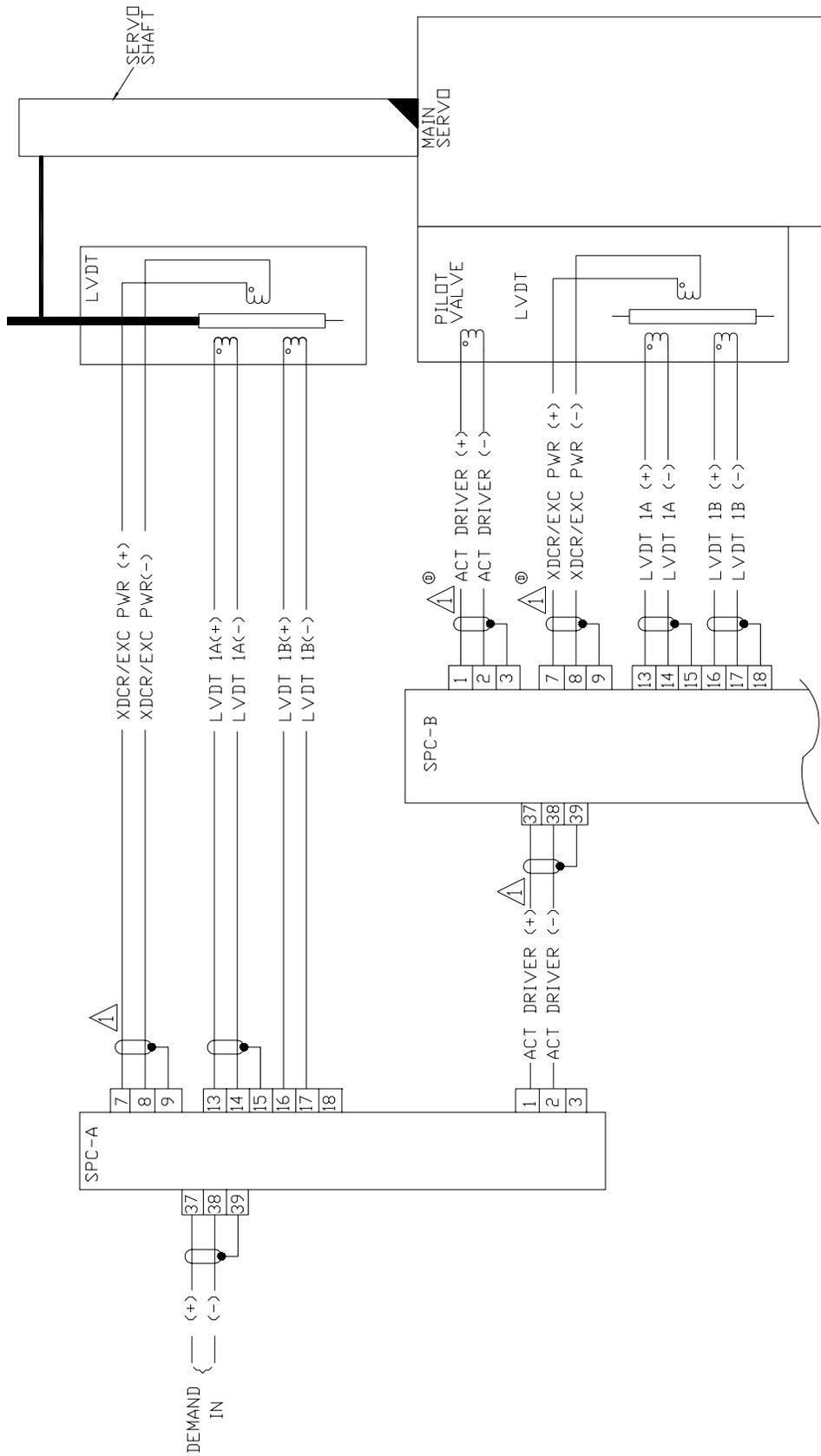


Figure 2-3e. SPC Wiring Diagram



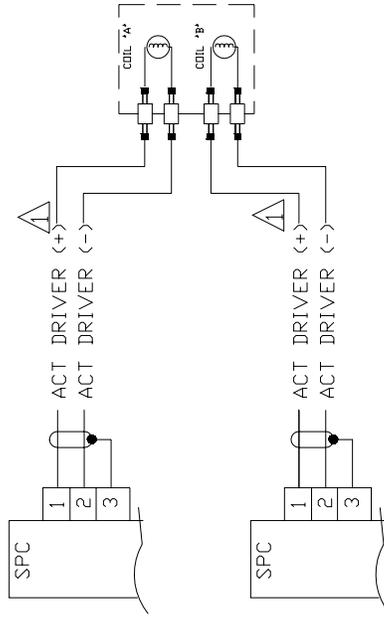
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GE OIL GEAR SERVO APPLICATION

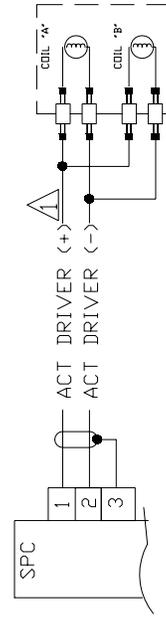
NOTES:
 ▲ NON-ISOLATED OUTPUT

Figure 2-3f. SPC Wiring Diagram

OPTIONAL DUAL COIL WIRING*

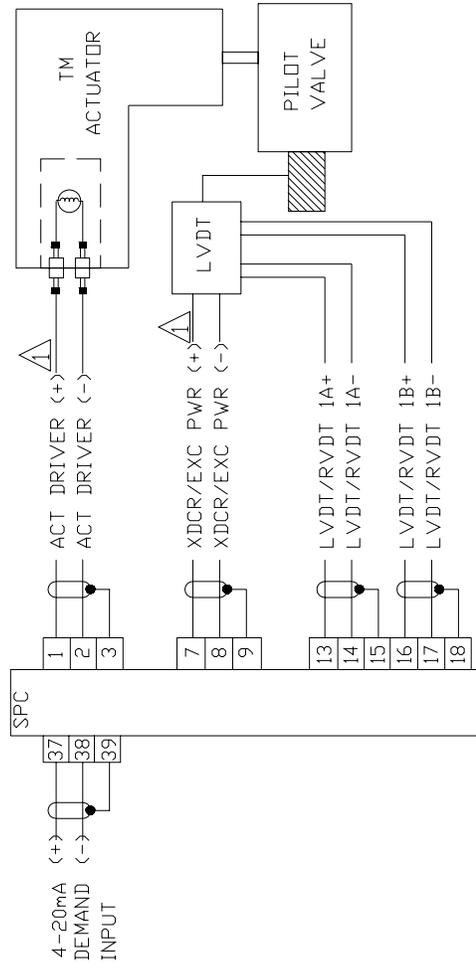


OPTIONAL DUAL COIL WIRING



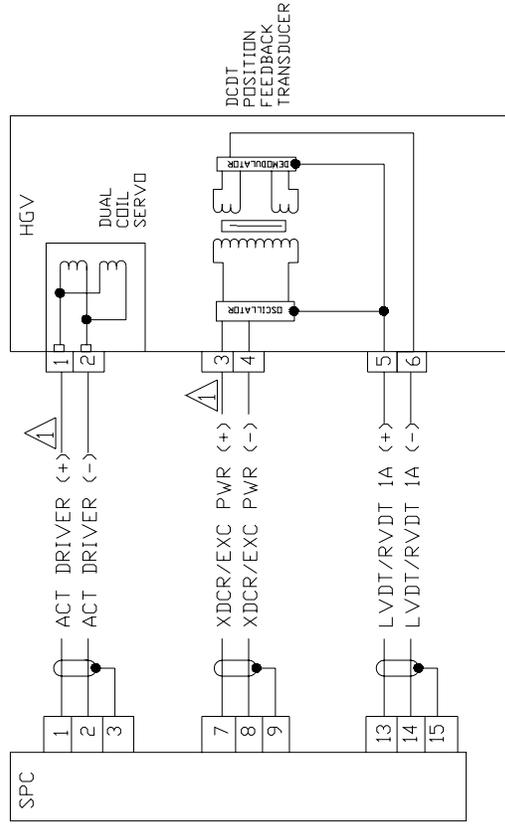
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(9936-465 sh7)
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SINGLE COIL WIRING - INTEGRATING SERVO APPLICATION



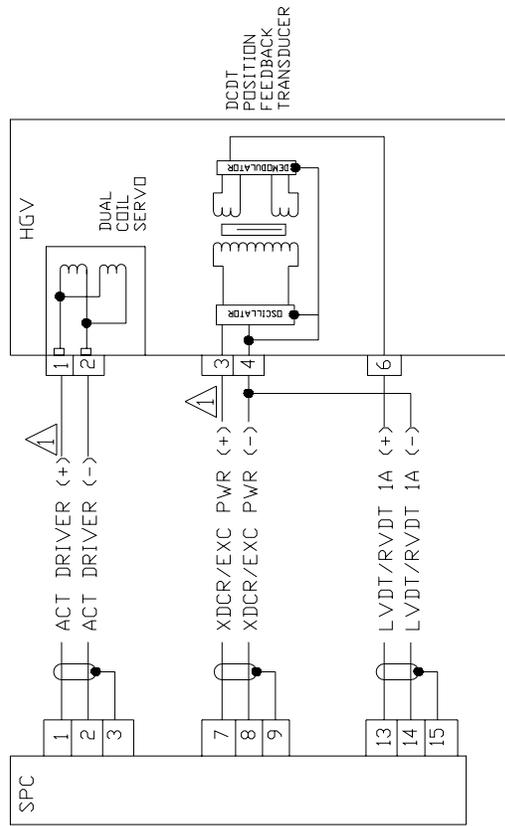
NOTES:
NON-ISOLATED OUTPUT
SPC TO TM-25LP/TM-200LP WIRING

Figure 2-3g. SPC Wiring Diagram



OPTIONAL
SPC TO HGV WIRING DIAGRAM
(WDPF CONTROLLER BASED WIRING)

262-118H
(9936-465 sh8)
06-4-20



SPC TO HGV WIRING DIAGRAM
(TYP CONTROLLER BASED WIRING)

NOTES:

NON-ISOLATED OUTPUT

Figure 2-3h. SPC Wiring Diagram

Chapter 3. SPC Specifications

System Accuracy

Using DeviceNet	0.25% of full scale @ 25 °C, TC < 150 ppm/°C
Using 4–20 mA Input	0.25% of full scale @ 25 °C, TC < 300 ppm/°C



NOTE

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

Electrical Specifications

Power Input

Nominal Voltage	24 Vdc
Maximum Voltage Range	18–32 Vdc
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	0–10%, 25% duty cycle @ 25 Hz
Load Resistance Range	see Diagnostics section below

Analog Demand and DC Transducer Inputs

Nominal Range	4–20 mA
Operating Range	2–22 mA
Fault Detection	Current < 1 mA or > 23 mA
Common Mode Input Voltage	200 Vdc
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	4–20 mA
Operating Range	0–25 mA
Isolation Voltage	500 Vrms
Maximum Load	500 Ω
Output Filter	3 ms lag
Resolution	12 bits
Linearity	0.2% of full scale
Temperature Sensitivity	300 ppm/°C

LVDT/RVDT/DC Voltage Input

Maximum AC Voltage	10 Vrms
DC Voltage Range	0–12 Vdc
Common Mode Input Voltage	200 Vdc
Common Mode Rejection	–60 dB @ 60 Hz
Input Impedance	100 k Ω min
Input Filter	10 ms lag
Resolution	14 bits
Linearity	0.1% of full scale
Temperature Sensitivity	150 ppm/°C

Transducer Exciter Output

Voltage Range	4–10 Vrms
Frequency Range	1–5 kHz
Maximum Load	120 mA
Resolution	0.1 Vrms
Accuracy	0.2% of full scale @ 25 °C
Temperature Sensitivity	150 ppm/°C

Transducer Power Output

Nominal Voltage	18 Vdc \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 Vdc
Maximum Current	500 mA
Maximum Voltage Drop	1V @ 500 mA
Maximum Leakage	10 μ A
Isolation Voltage	500 Vrms
Maximum Delay	1 ms

DeviceNet

Node Isolation	500 Vrms
Node Power	self-powered

Service Port

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

Diagnostics

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 ± 100 mA, the short threshold is $(1/0.100) = 10 \Omega$.
Exciter Voltage Tolerance System Diagnostics	± 0.2 Vrms 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 to $+70$ °C
Shock	30g, 11 ms half sine pulse
Vibration (random)	0.7 g, 5–2000 Hz
Humidity	95% condensing

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.



WARNING—TRAINED PERSONNEL

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

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

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



NOTE

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.

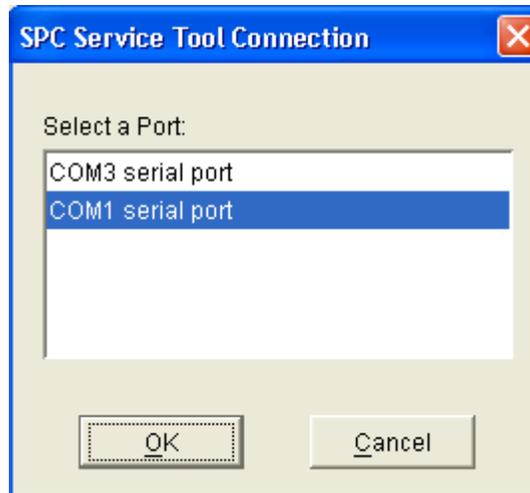


Figure 4-1. Selecting Communication Port

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.

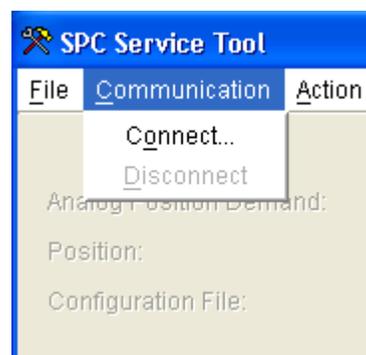


Figure 4-2. Connecting to the SPC



WARNING—SERIAL CABLE

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.

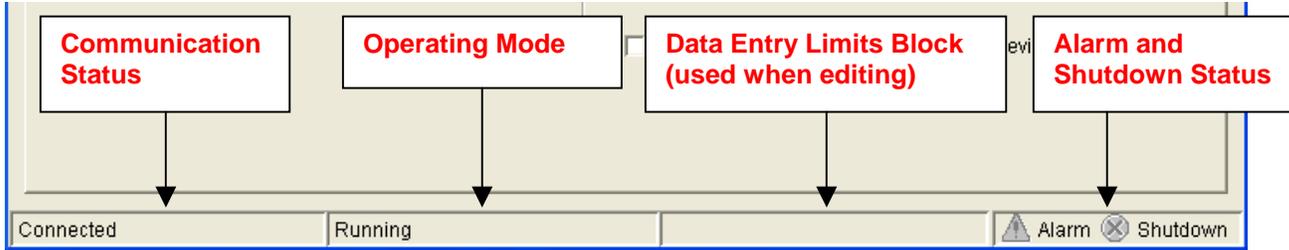


Figure 4-3. Service Tool Status Bar

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.

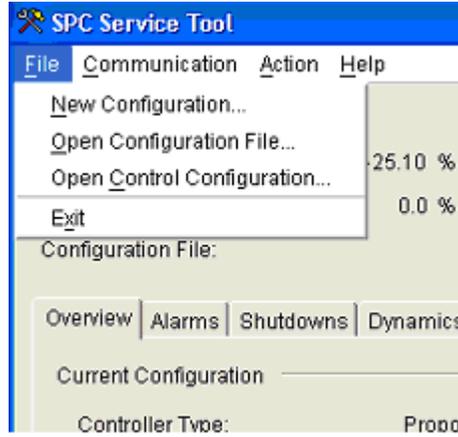


Figure 4-4. Selecting Configuration Options

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.

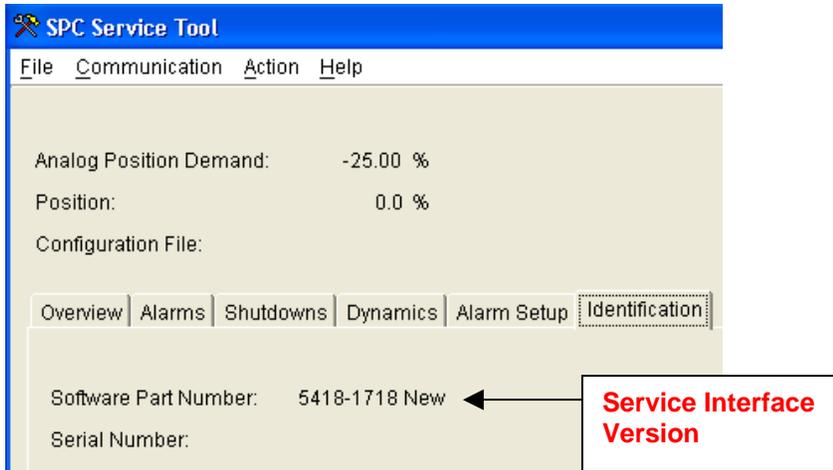


Figure 4-5. Determining Service Interface Version

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.

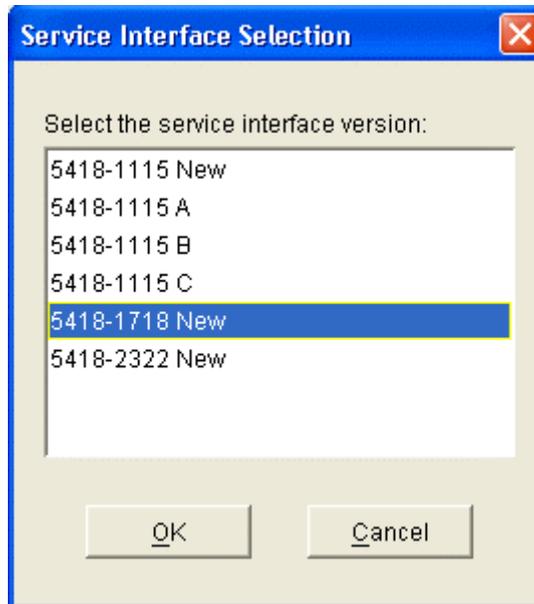


Figure 4-6. Selecting Service Interface Version

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

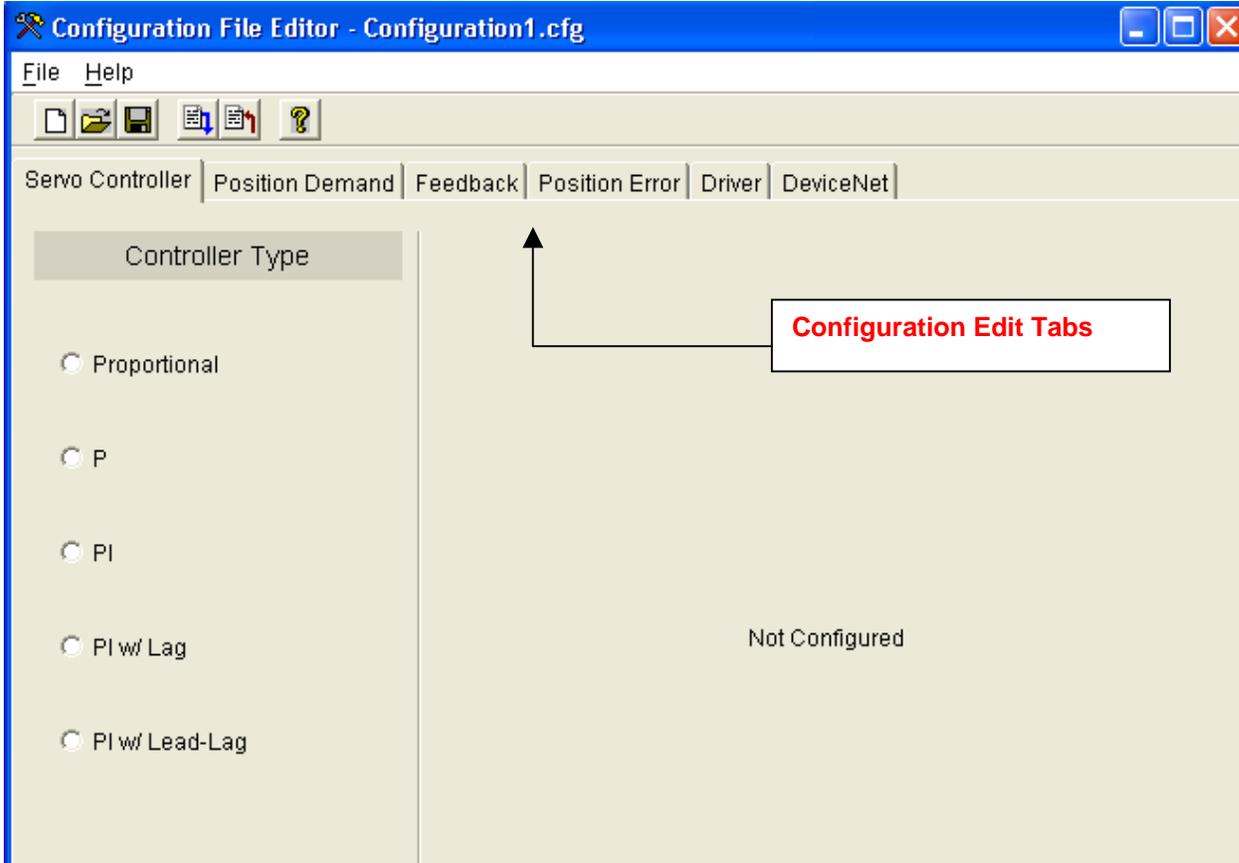


Figure 4-7. Configuration Editing Tabs

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.

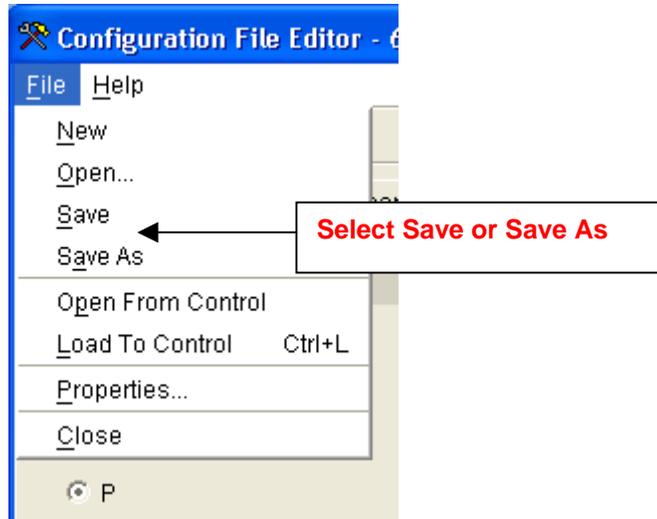


Figure 4-8. Saving the Configuration File

Loading the Configuration File to the SPC



CAUTION—CONTROL SHUTDOWN

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.

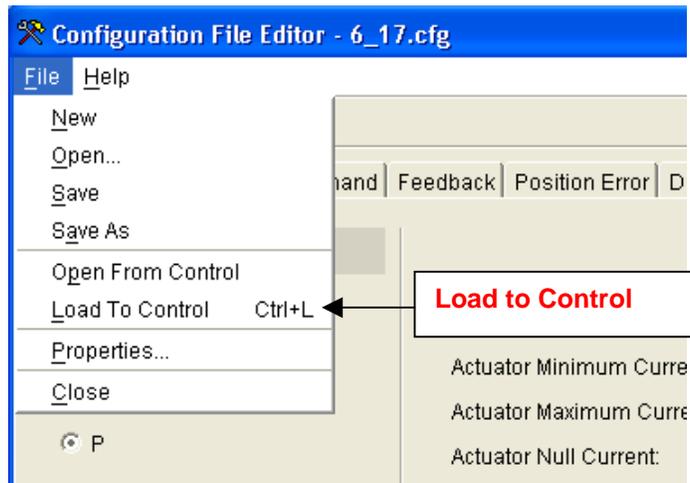


Figure 4-9. Loading Configuration File to the Control

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.

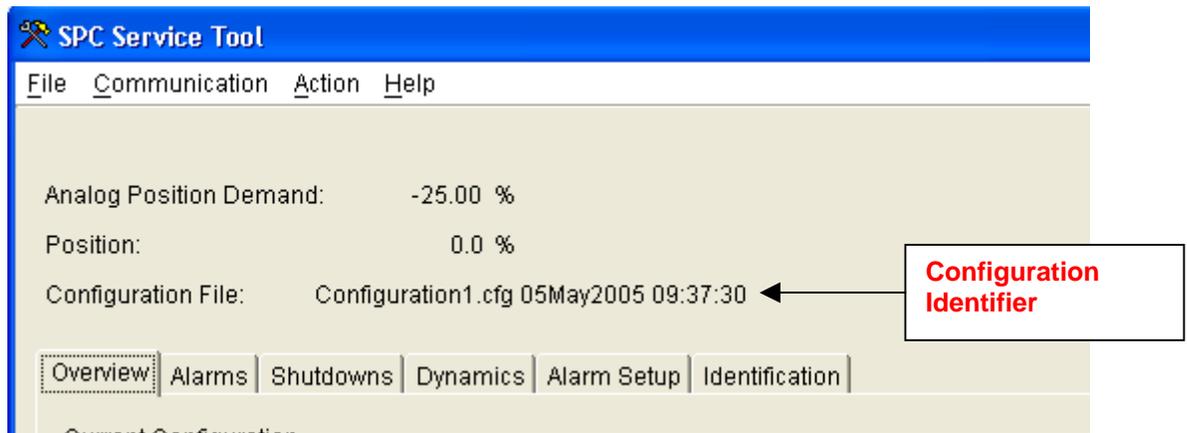


Figure 4-10. Identifying the Configuration File in the Control

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.

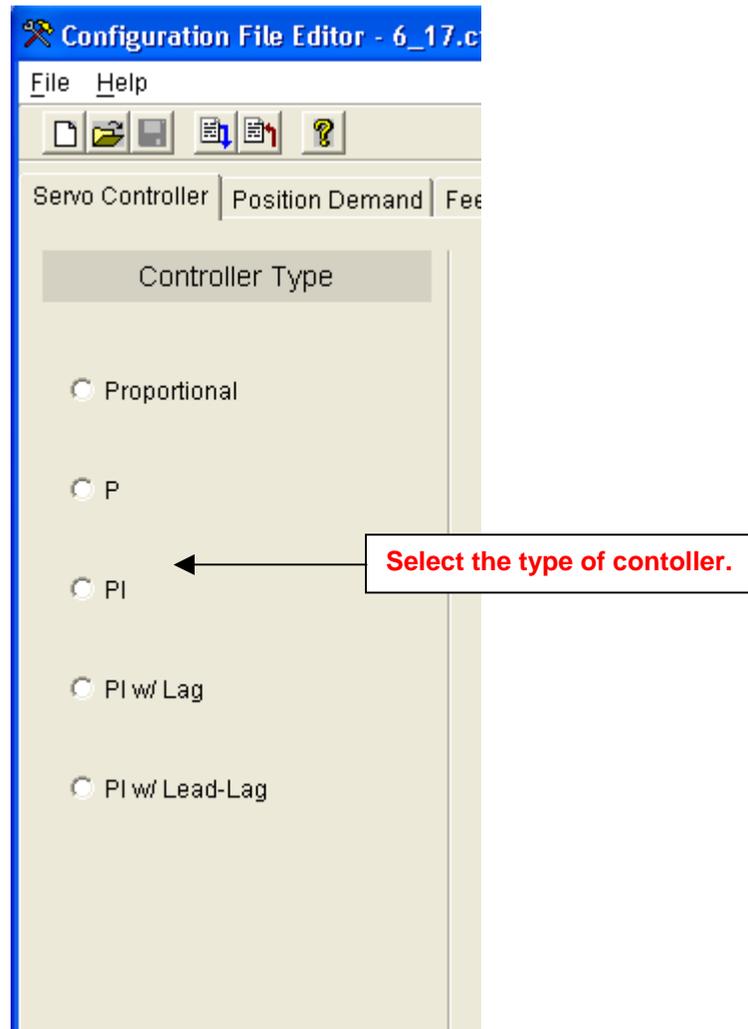


Figure 4-11. Selecting Type of Control

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)

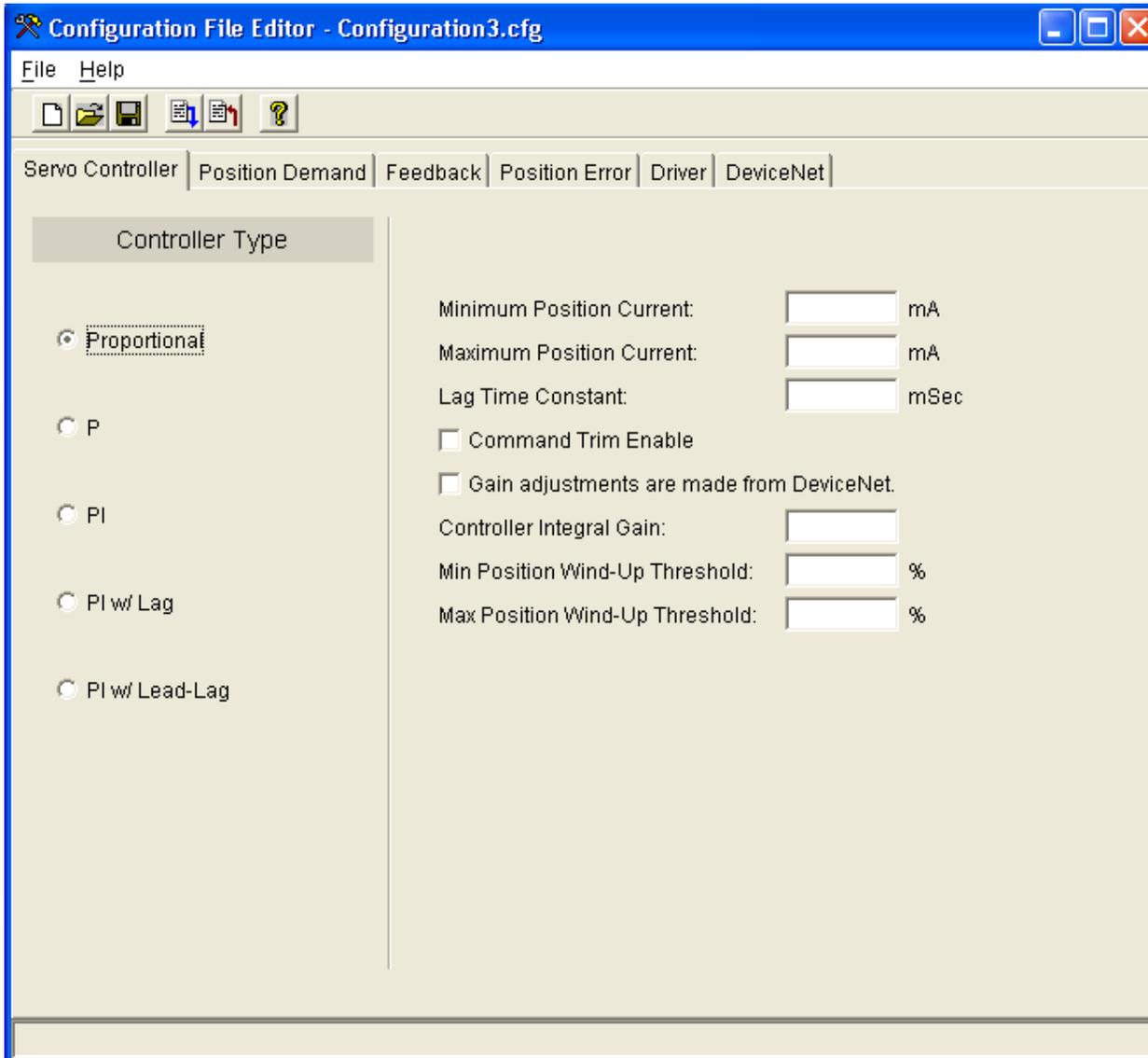


Figure 4-12. Proportional-Control Configuration Settings

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%

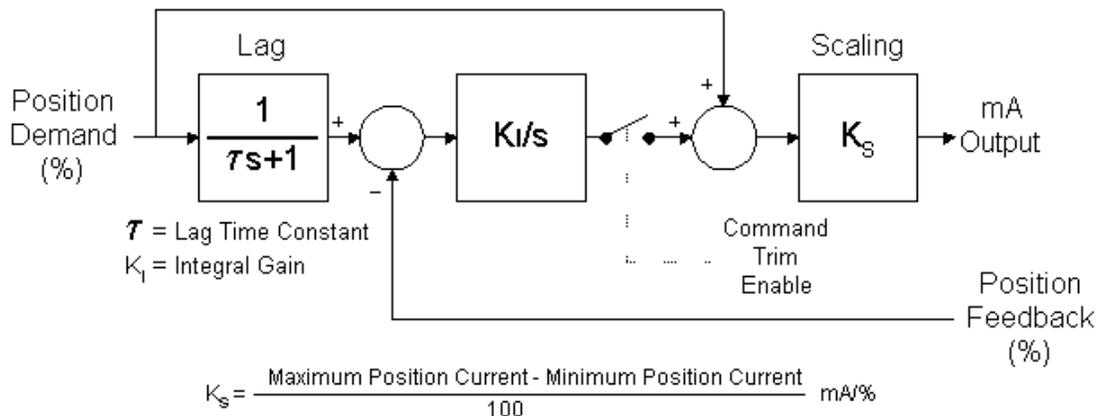


Figure 4-13. Proportional Control Structure

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 $\pm 10\%$ of the range defined by Minimum Position Current and Maximum Position Current.

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

The lag block reduces overshoot when the position demand changes faster than the actuator can respond. Ideally, the lag exactly matches the response of the actuator and therefore no change is required out of the 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 B83402 *PID Control* for additional information on tuning the control.

Configuring and Adjusting a P Control

(Figures 4-14 and 4-15)

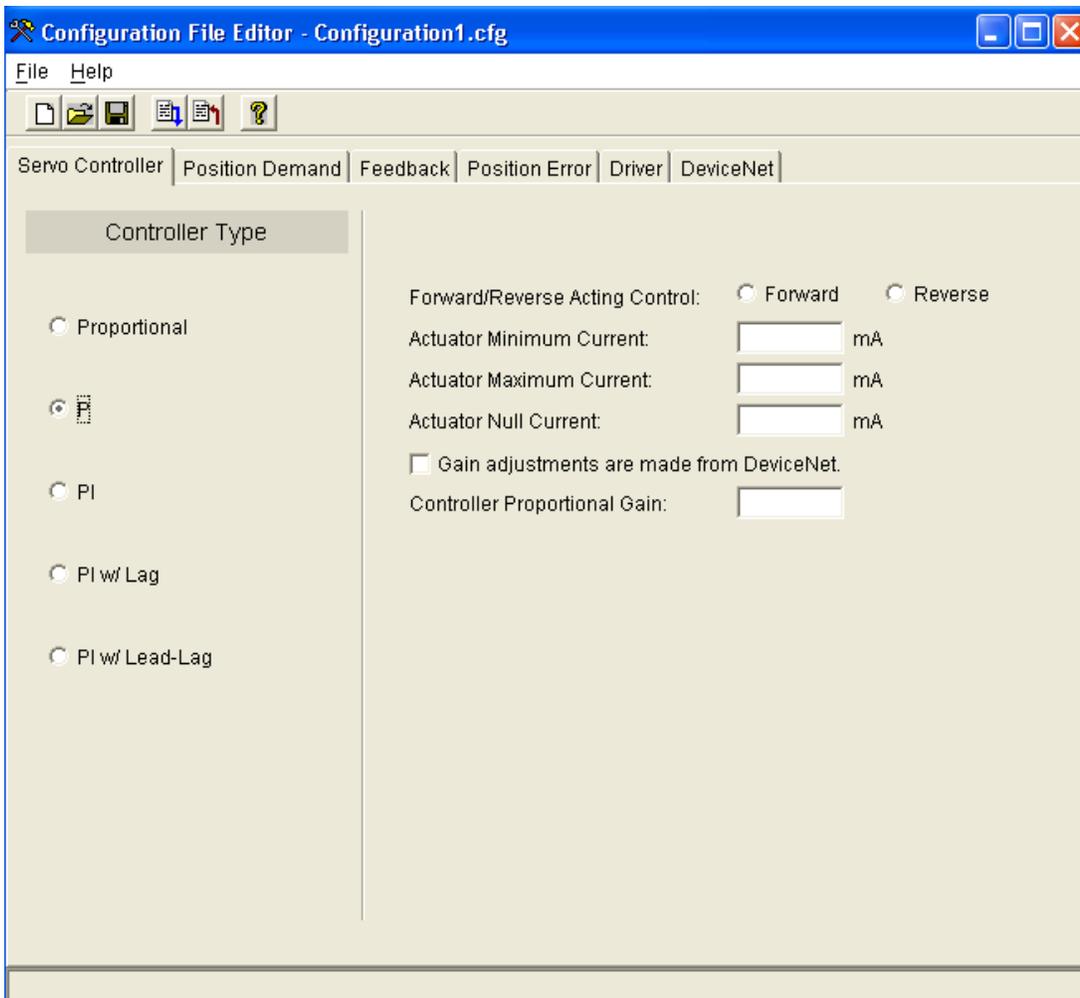


Figure 4-14. P-Control Configuration Settings

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.

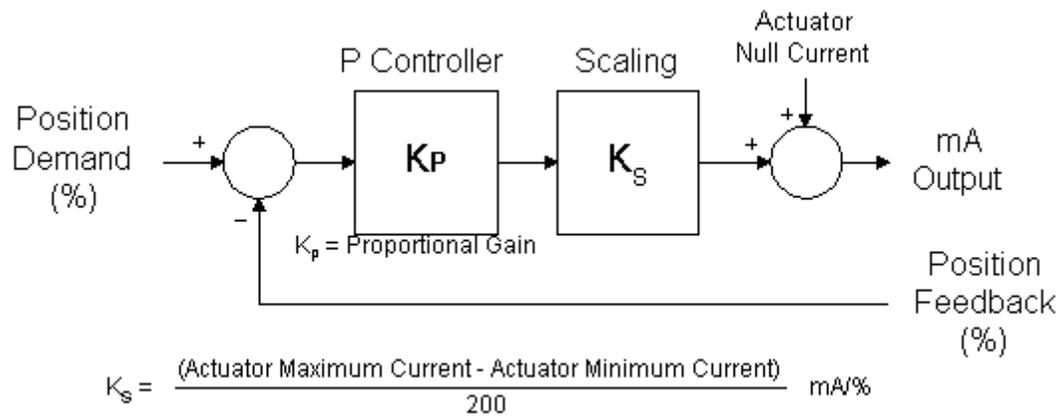


Figure 4-15. P Control Structure

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 B83402 *PID Control* for additional information on tuning the control.

Configuring and Adjusting a PI Control

(Figures 4-16 and 4-17)

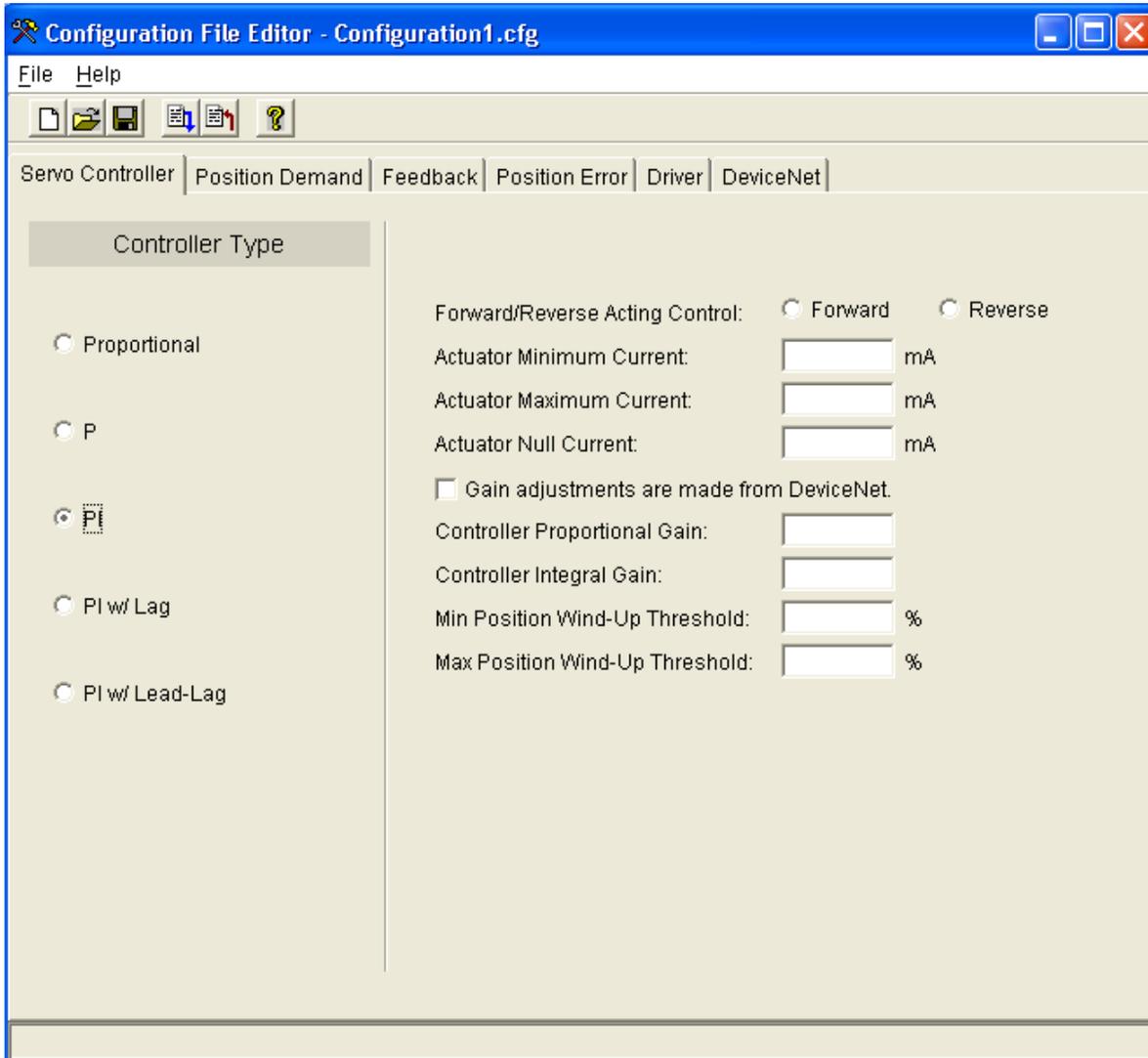


Figure 4-16. PI-Control Configuration Settings

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%

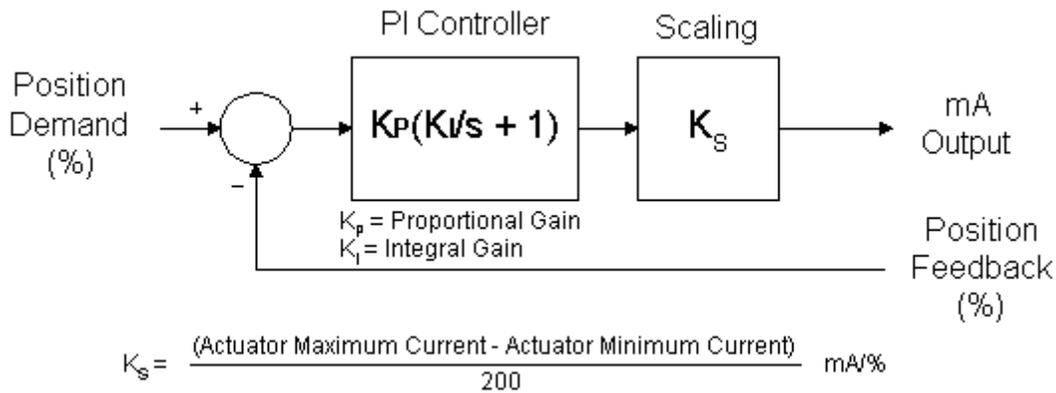


Figure 4-17. PI Control Structure

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 B83402 *PID Control* for additional information on tuning the control.

Configuring and Adjusting a PI w/Lag Control

(Figures 4-18 and 4-19)

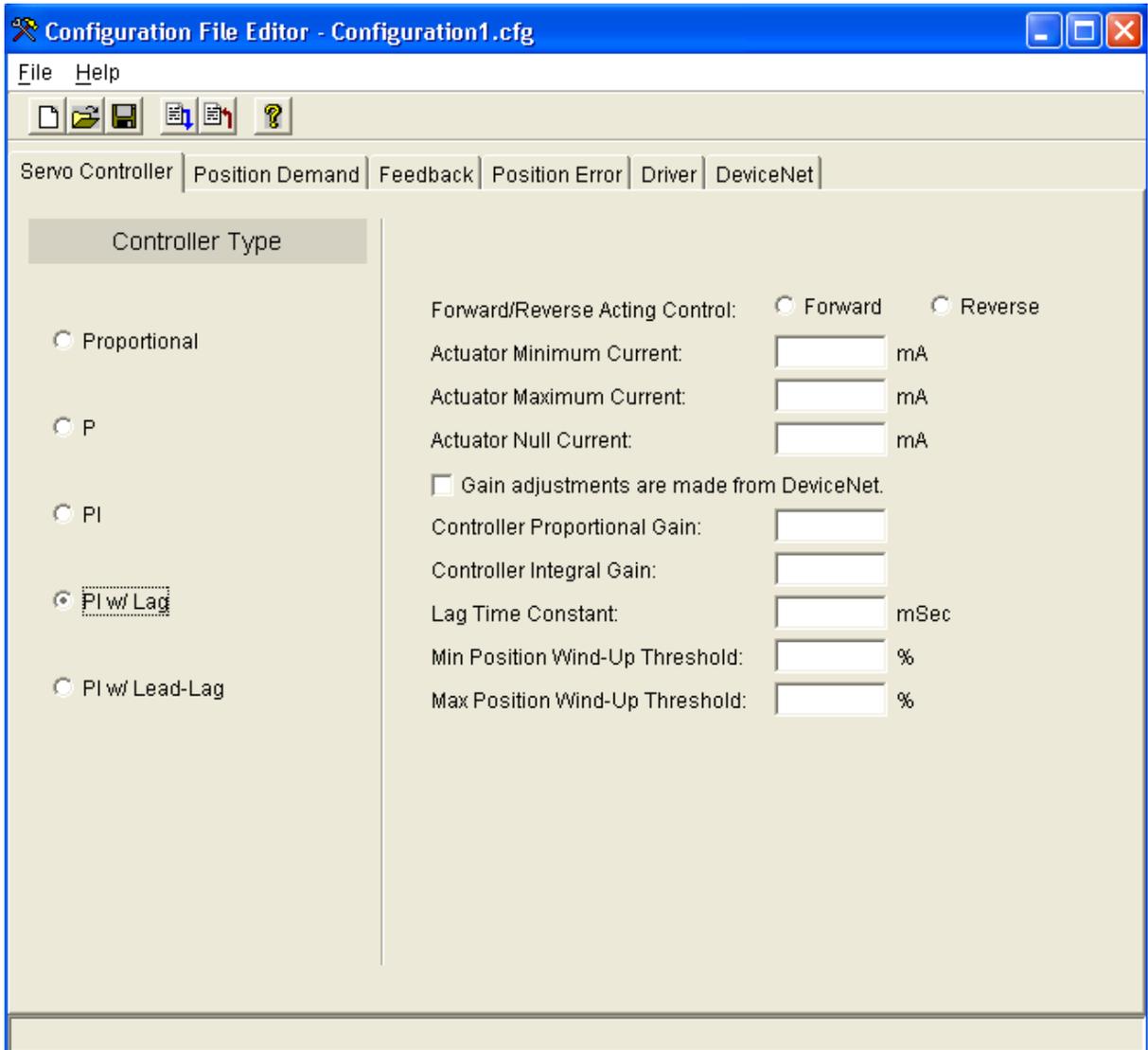


Figure 4-18. PI with Lag-Control Configuration Settings

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%

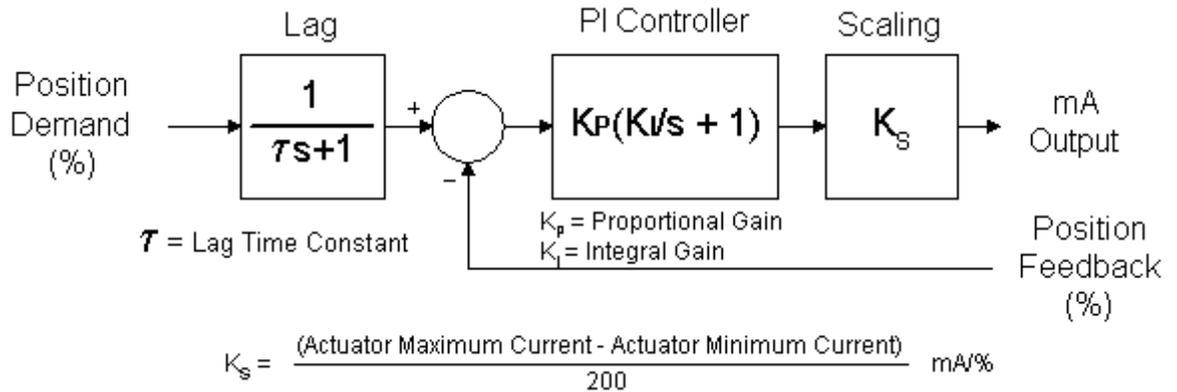


Figure 4-19. PI w/Lag Control Structure

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 B83402 *PID Control* for additional information on tuning the control.

Configuring and Adjusting a PI w/Lead-Lag Control

(Figures 4-20 and 4-21)

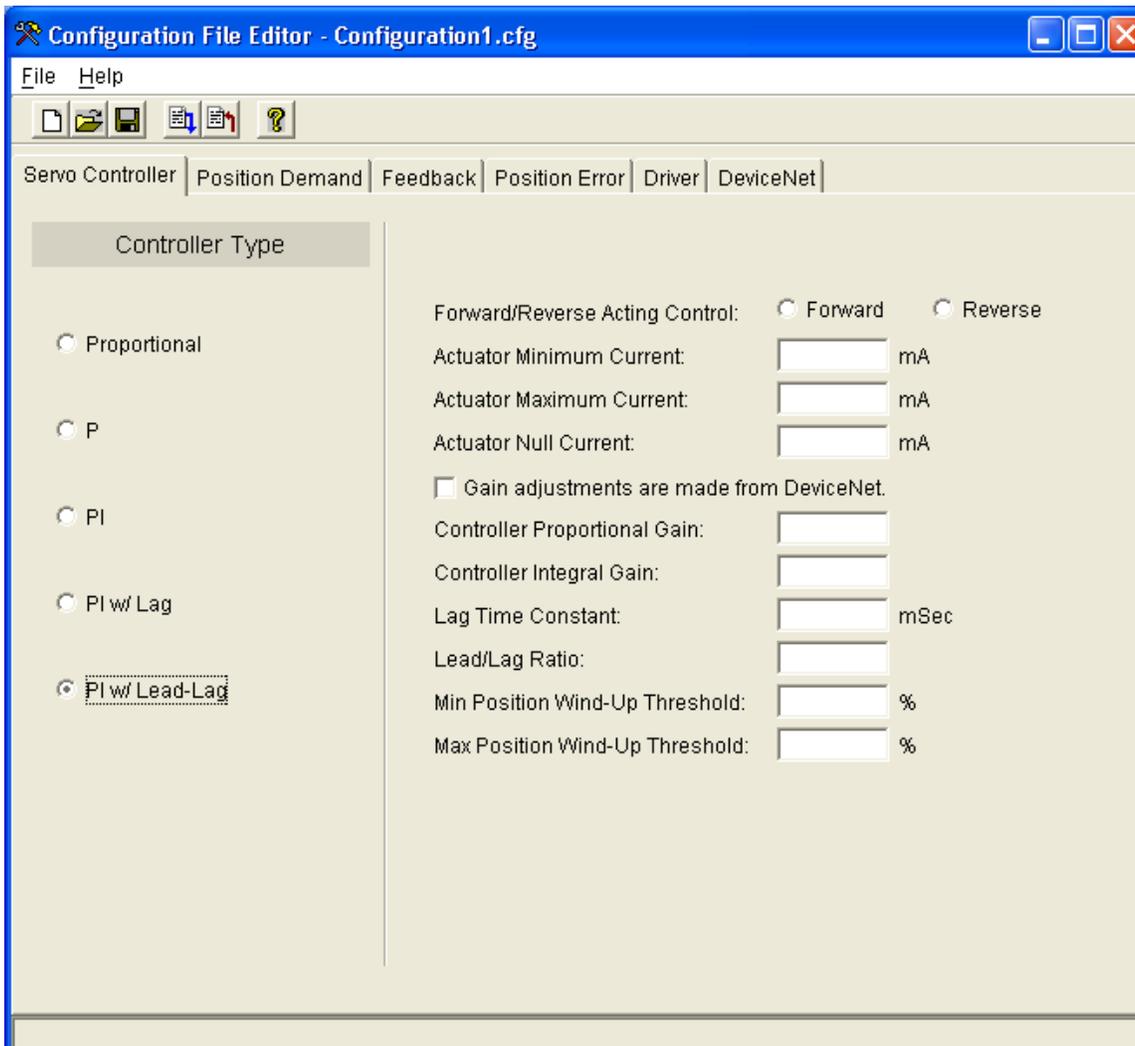


Figure 4-20. PI with Lead-Lag Control Configuration Settings

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%

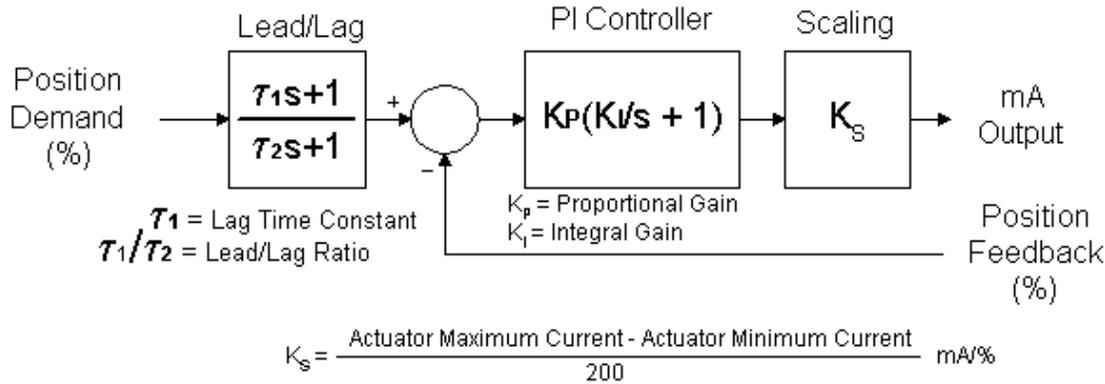


Figure 4-21. PI w/Lead-Lag Structure

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 B83402 *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

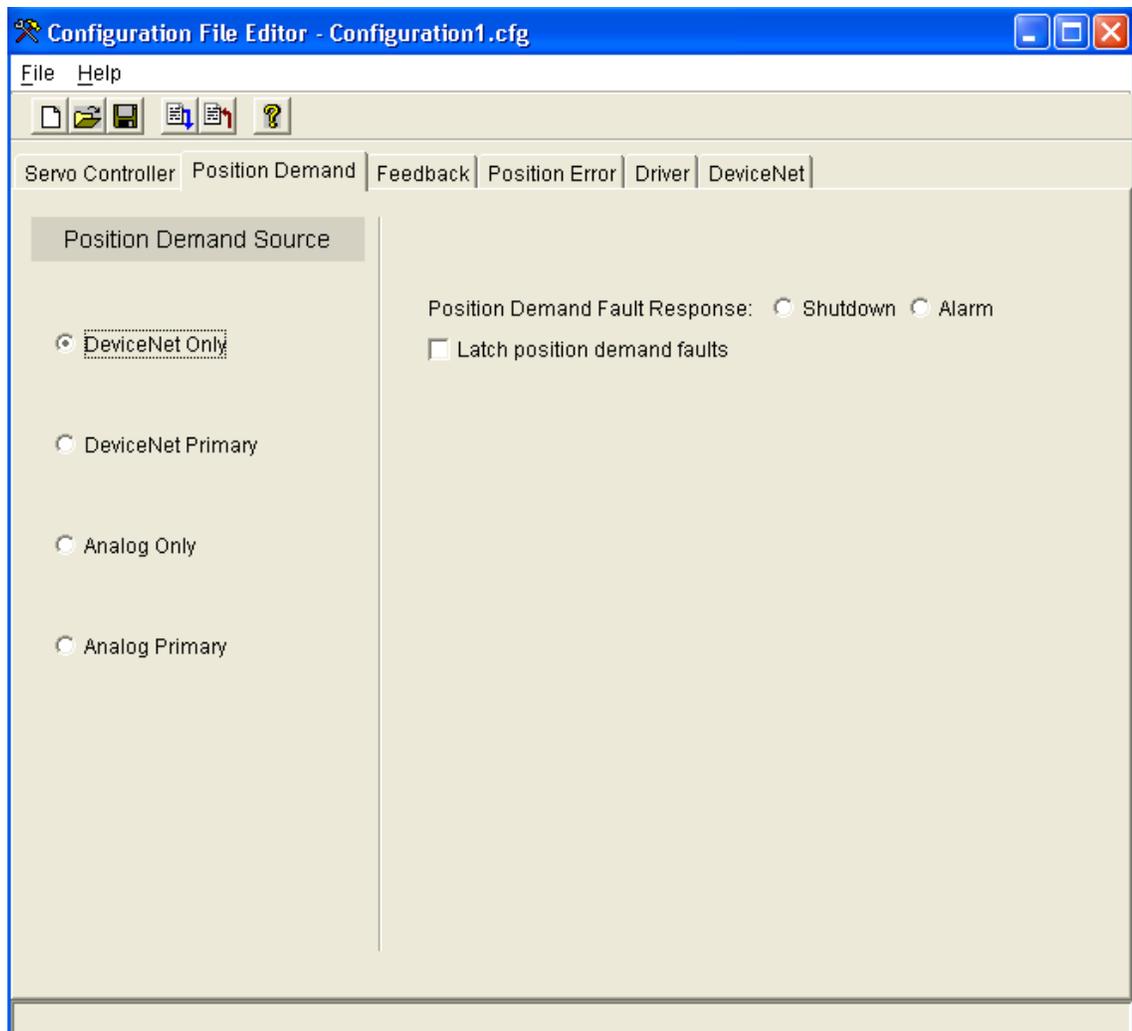


Figure 4-22. Position Demand DeviceNet Only

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.

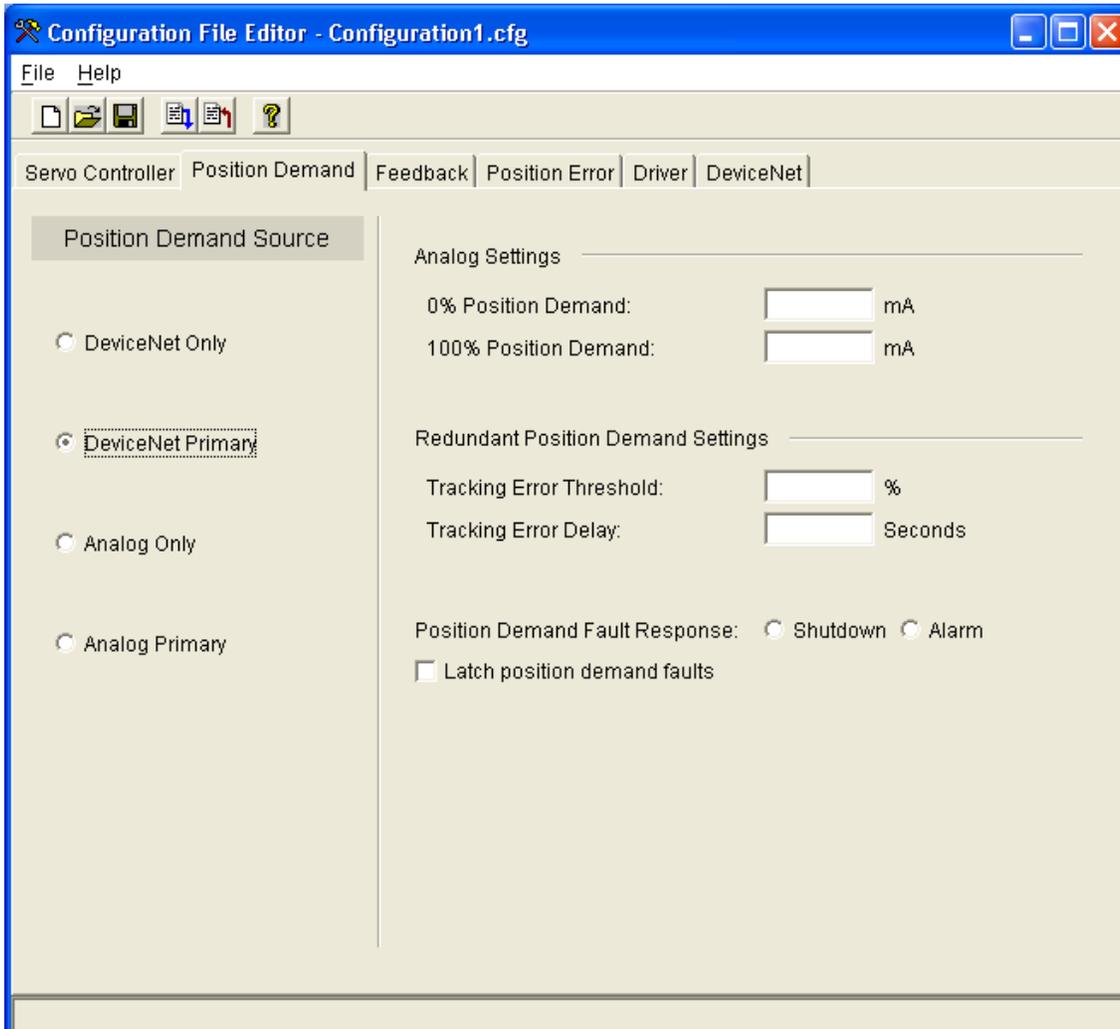
DeviceNet Primary

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

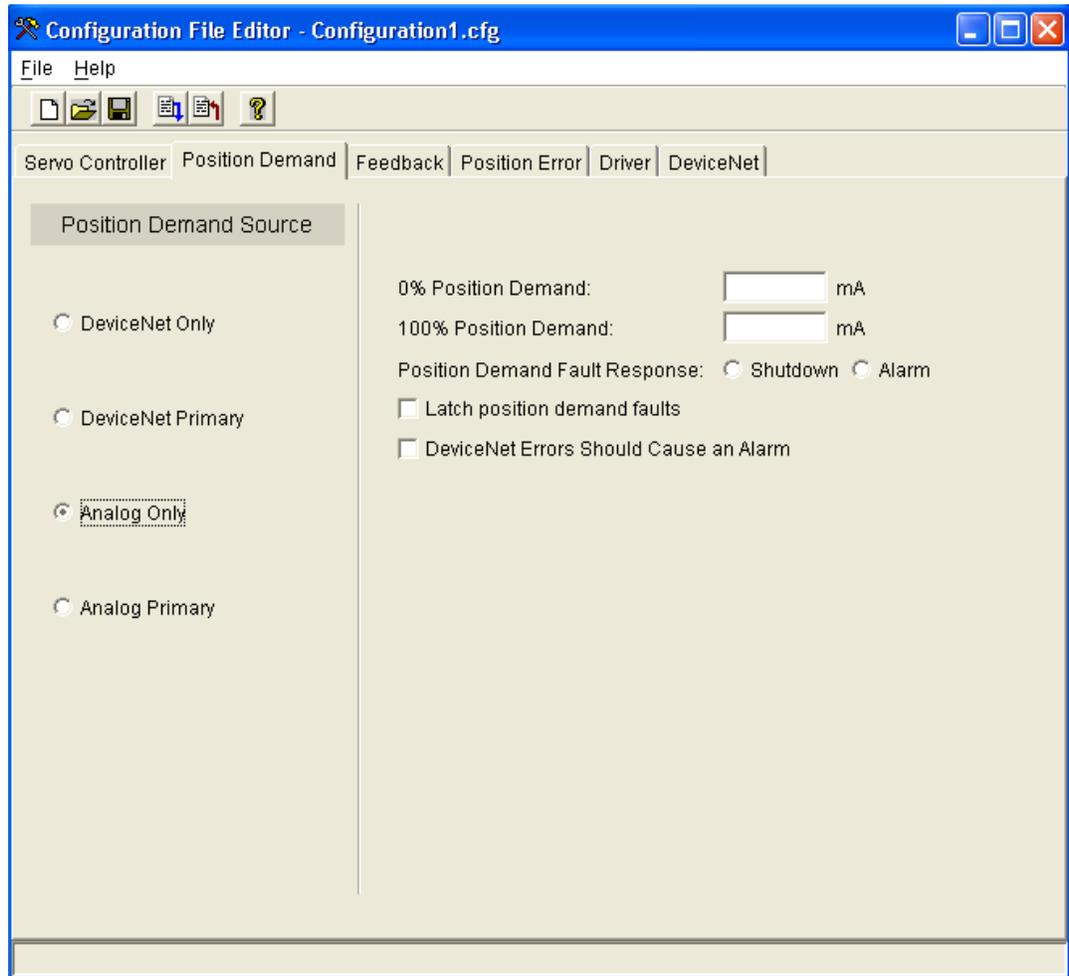


Figure 4-24. Position Demand Analog Only

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.

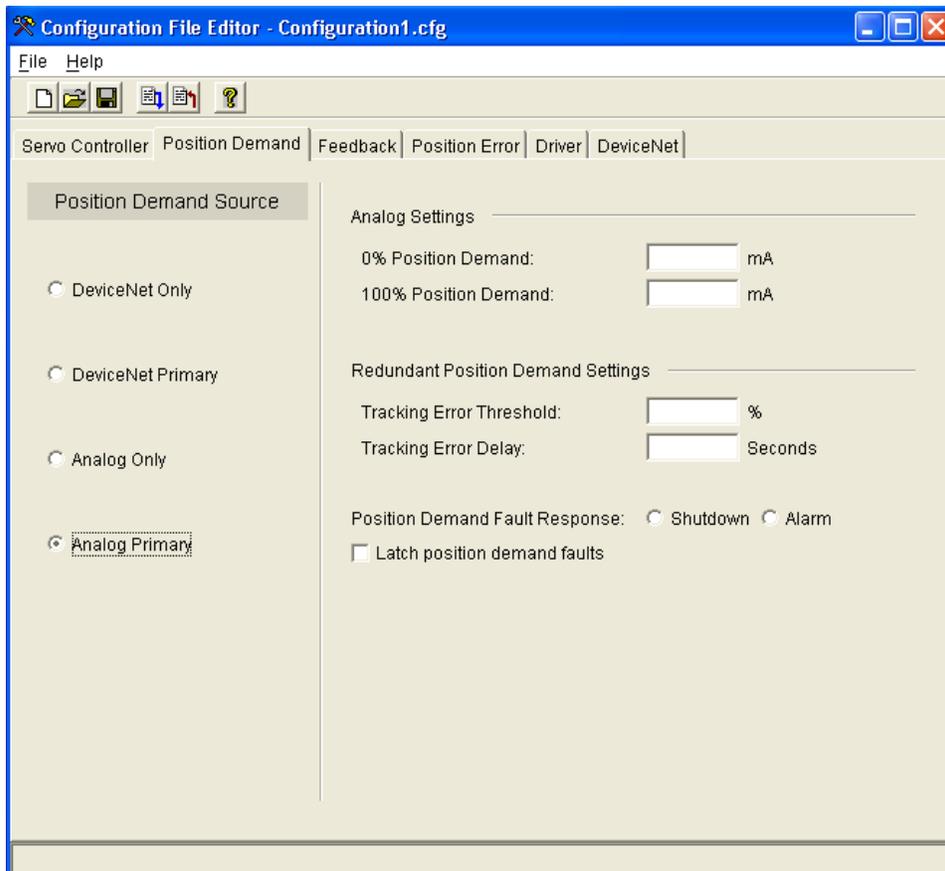
Analog Primary

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 0-10 V output transducers, RVDTs, or LVDTs, or from a single 4–20 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

4–20 mA— Position feedback is provided by a 4–20 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 0-10 Vdc 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 4-20 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.

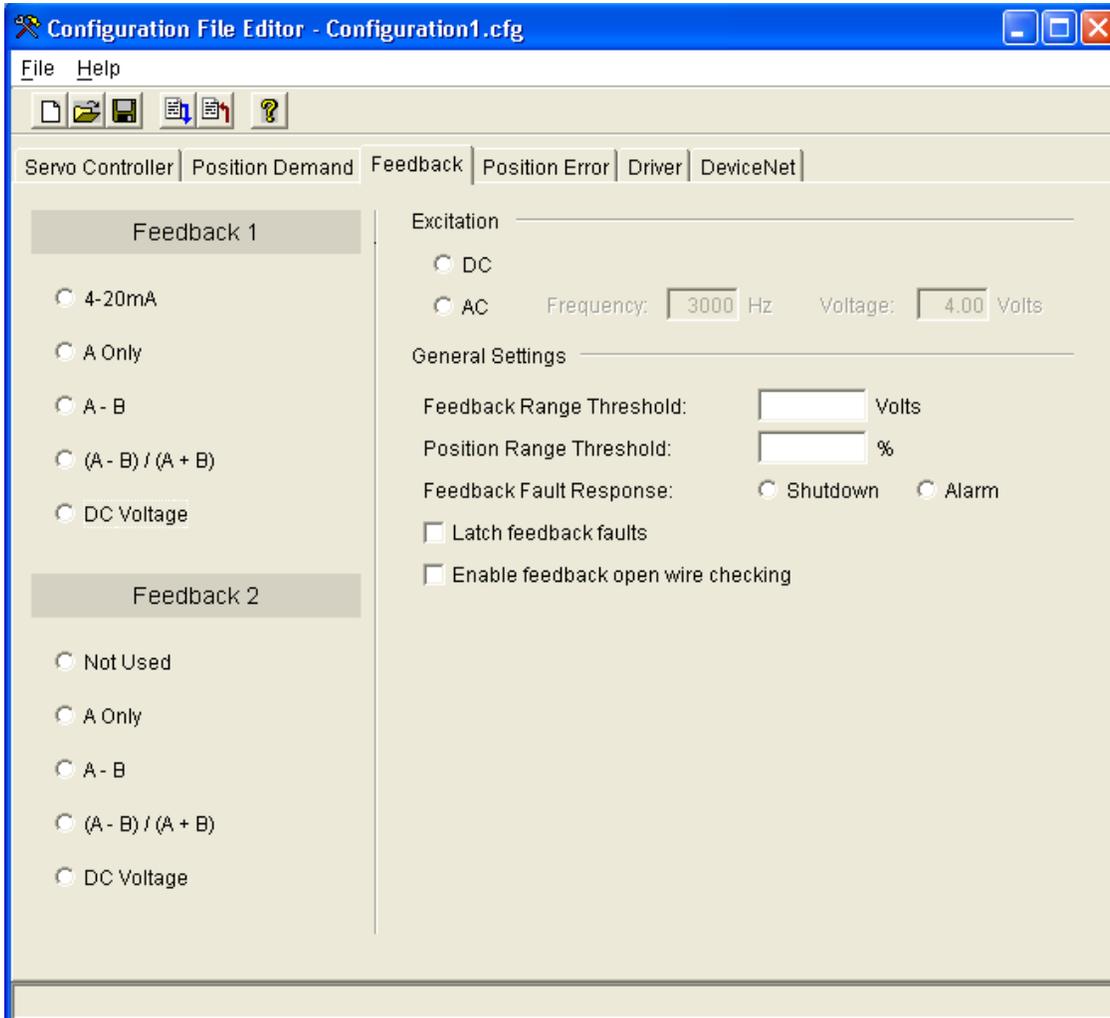


Figure 4-26. Position Feedback Configuration

4–20 mA Position Feedback Devices

There are a variety of position feedback devices available having a 4–20 mA current output. When the SPC is configured for a 4–20 mA transducer, 18 Vdc is provided at the exciter output for powering transducers requiring external power.

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.

0–10 Vdc Position Feedback Devices

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

The output of the transducer need not equal exactly 0 Vdc and 10 Vdc 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 Vdc 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 Vdc at minimum position and 2 Vdc 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.

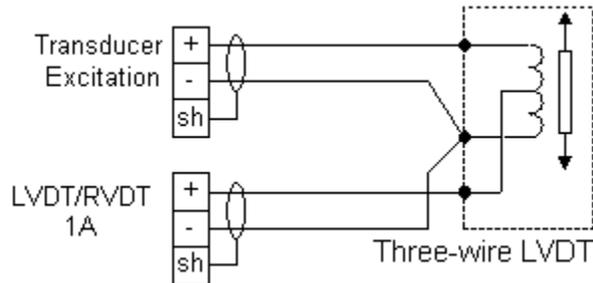


Figure 4-27. 3-wire Device

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.

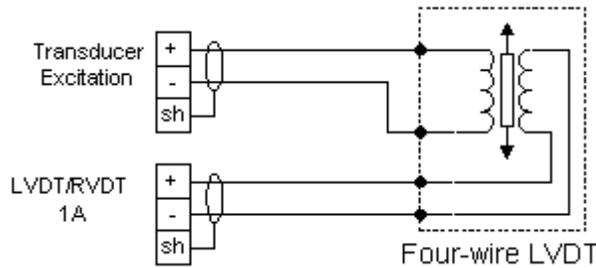


Figure 4-28. 4-wire Device

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.

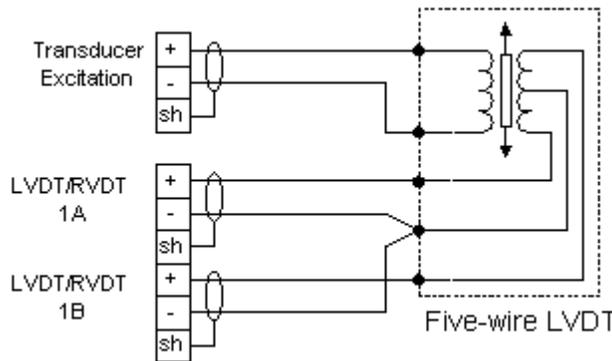


Figure 4-29. 5-wire Device

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:

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

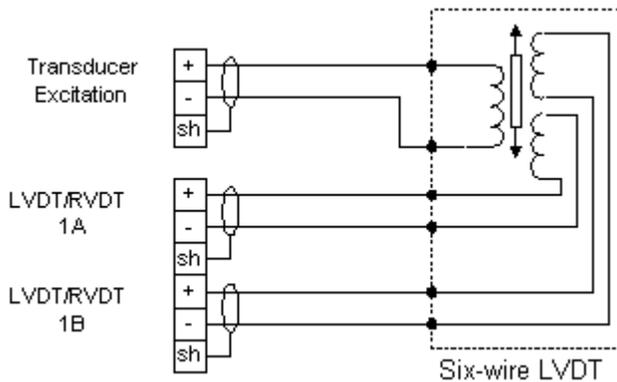


Figure 4-30. 6-wire Device

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:

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

4–20 mA Feedback Configuration Settings

Position Feedback is provided by a 4-20mA 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 Vdc output that may be used for transducer power if required.

Frequency

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

Voltage

Exciter output voltage.
Allowed range: 4 Vrms to 10 Vrms.



NOTE

Excitation values above 8 Vrms are intended for transducers with low gain. The SPC RVDT/LVDT inputs accept 8 Vrms maximum. When using higher gain devices, setting the excitation voltage higher than 8 Vrms 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.

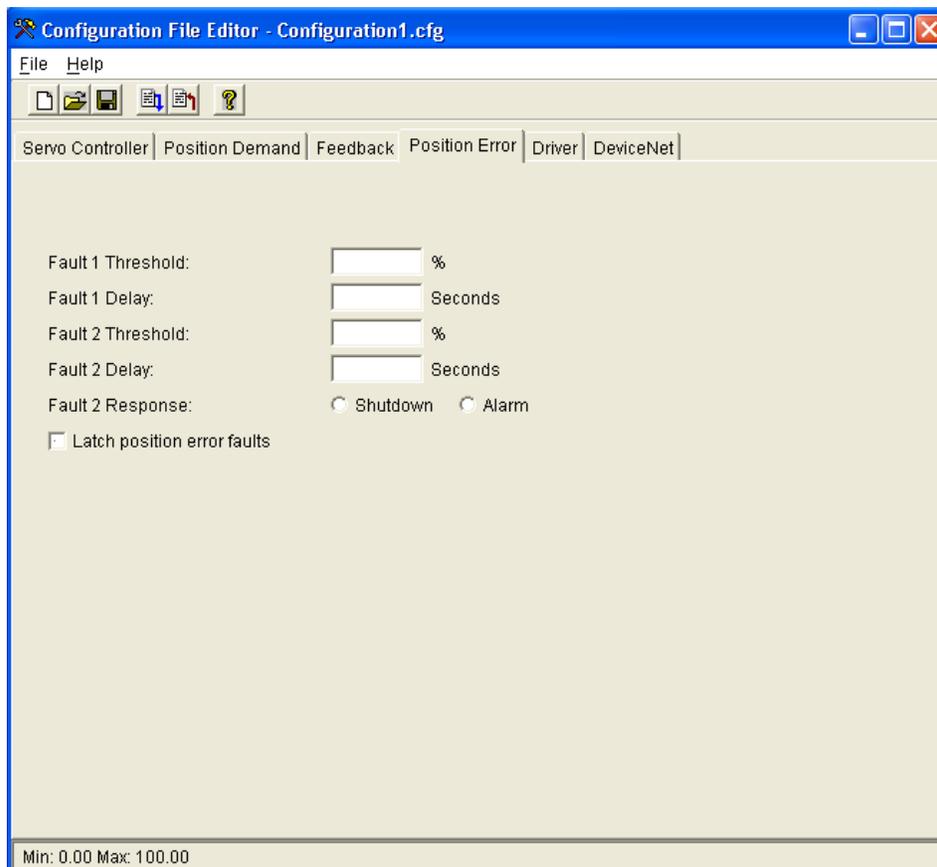


Figure 4-31. Position Error Settings

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.

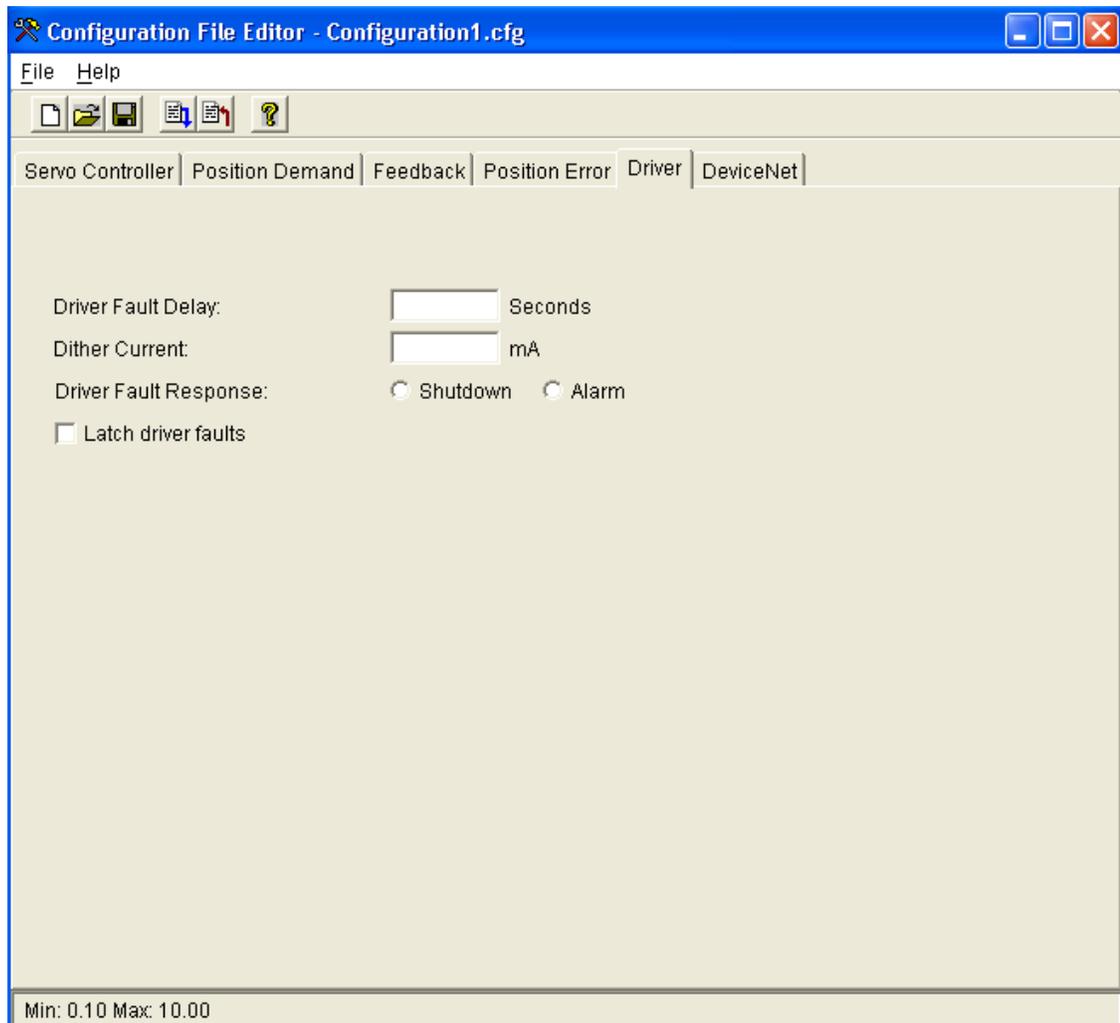


Figure 4-32. Driver Configuration

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.

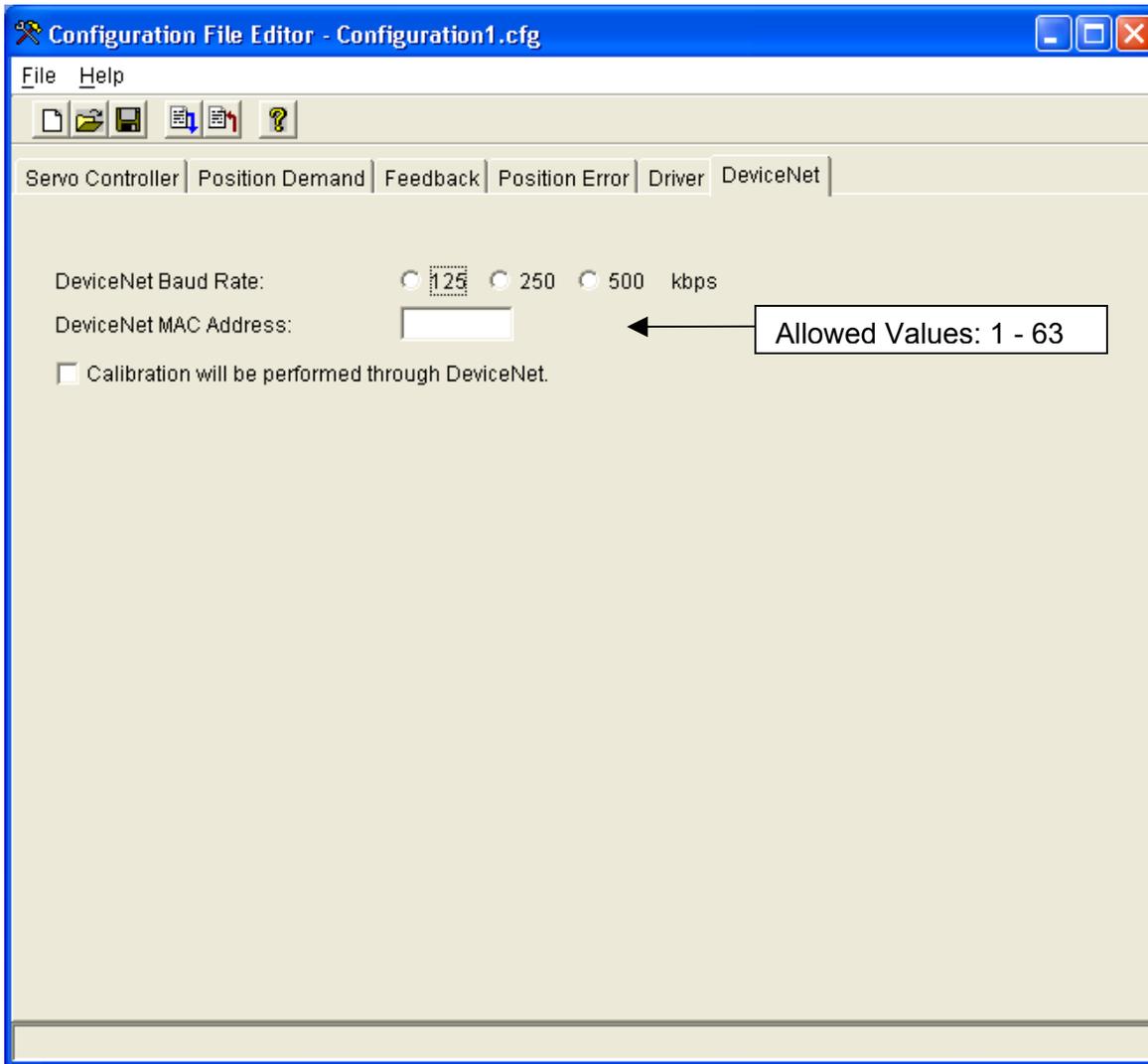


Figure 4-33. DeviceNet Configuration

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.

**NOTE**

Position value is not valid until calibrated.

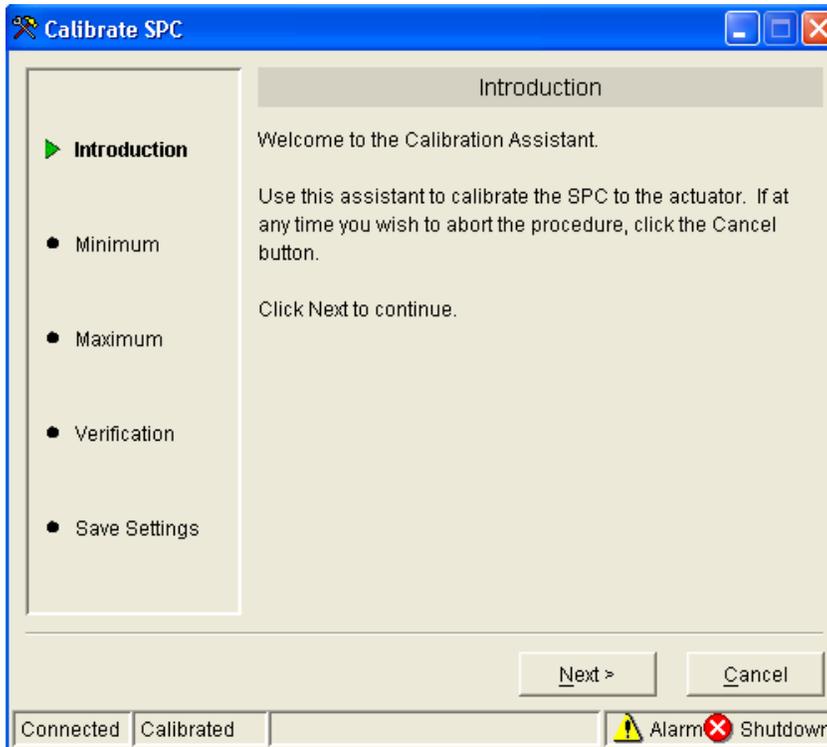


Figure 4-34. Introduction

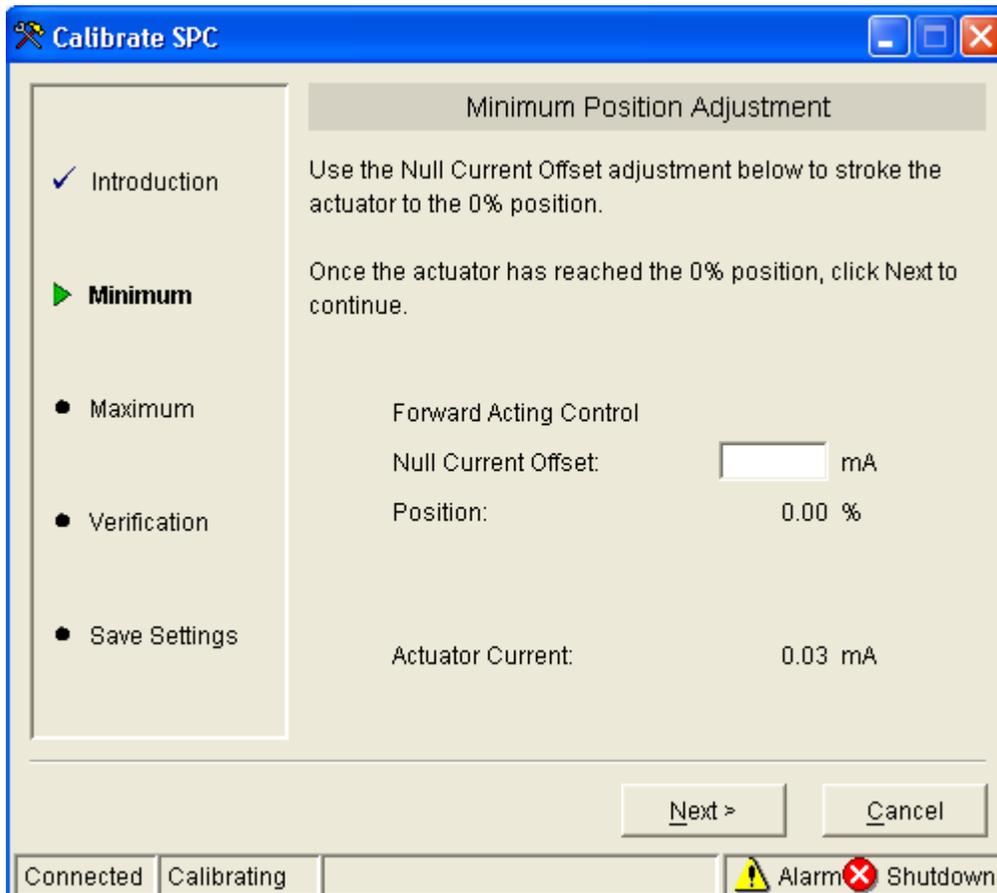


Figure 4-35. Minimum Position Adjustment

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.

**NOTE**

Position value is not valid until calibrated.

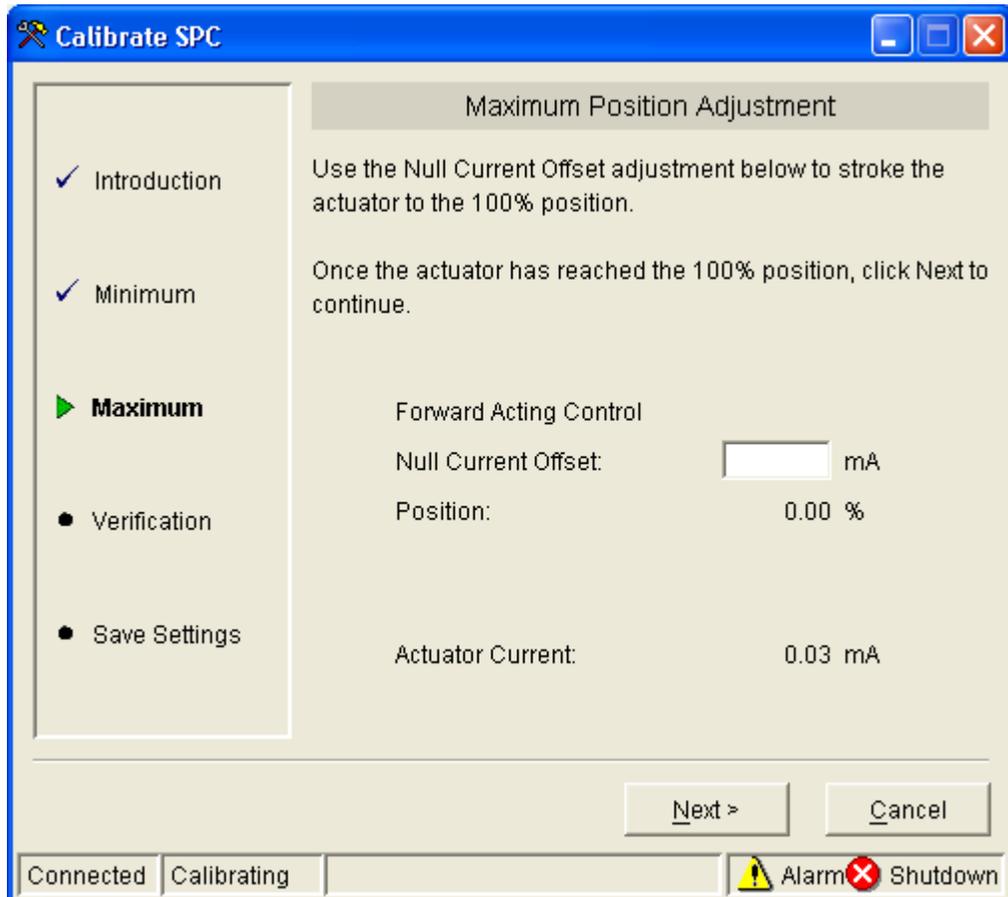


Figure 4-36. Maximum Position Adjustment

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.

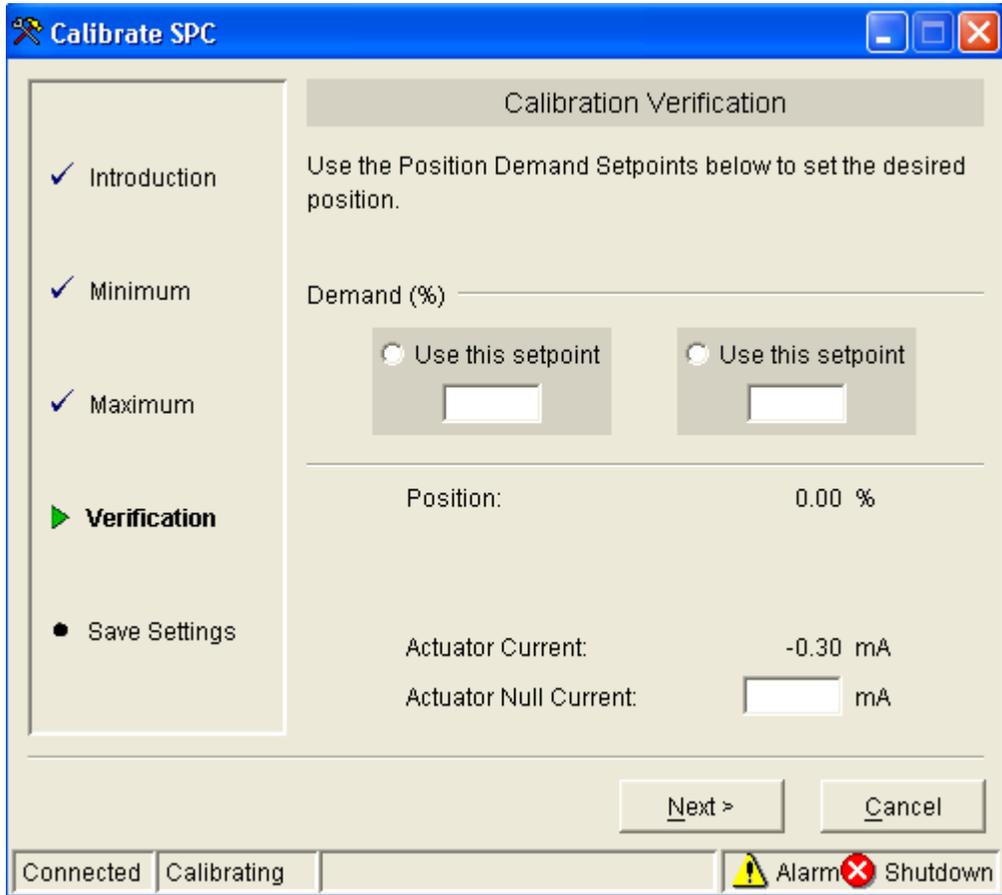


Figure 4-37. Calibration Verification

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

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

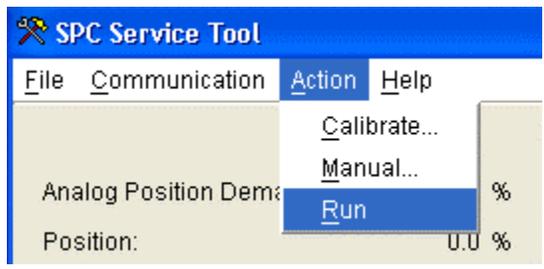


Figure 4-39. Selecting "Run"

Working with a Running SPC

Monitoring the SPC with the Input/Output Lines

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

Analog 4–20 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.

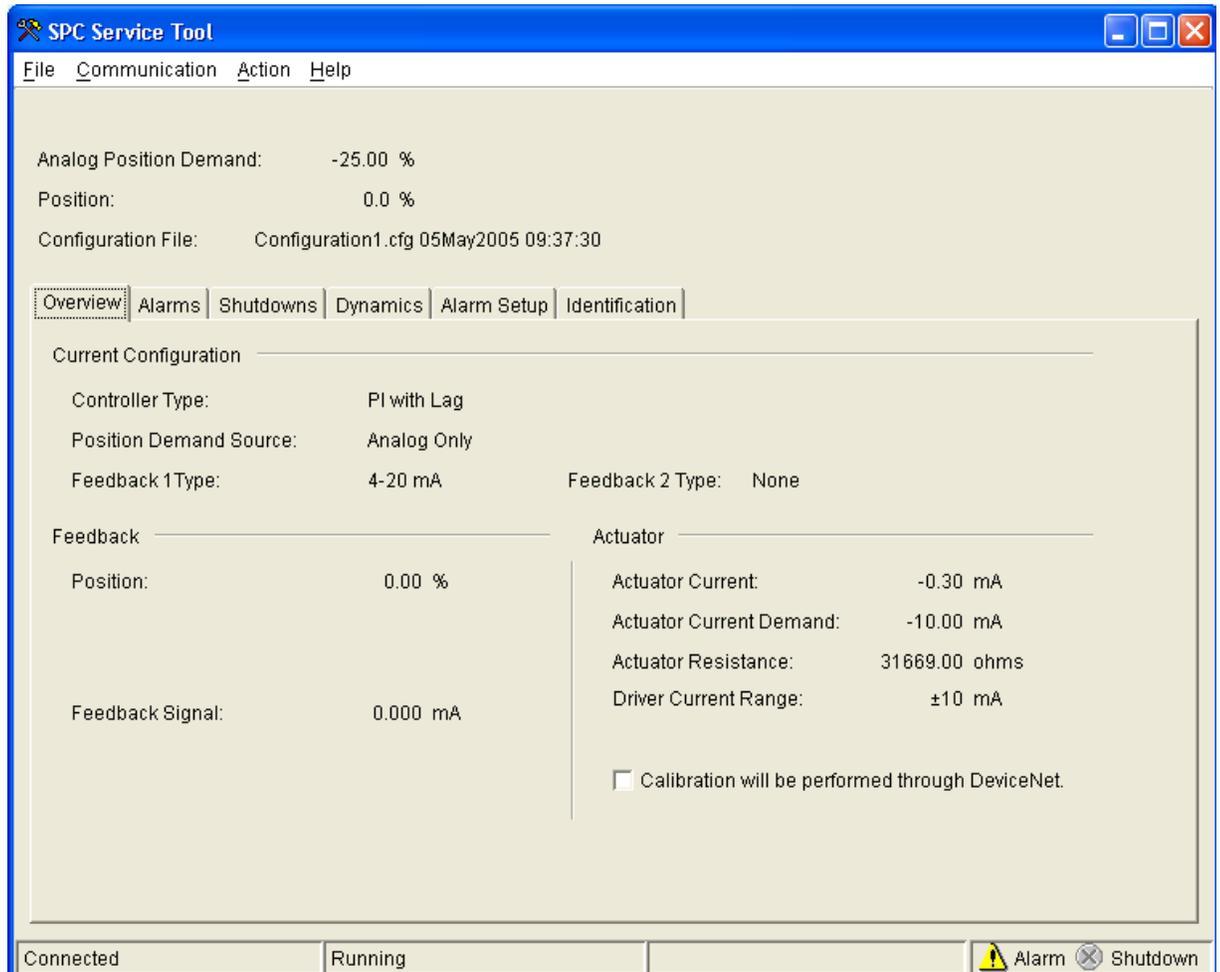


Figure 4-40. SPC Service Tool Overview Tab

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 – 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.

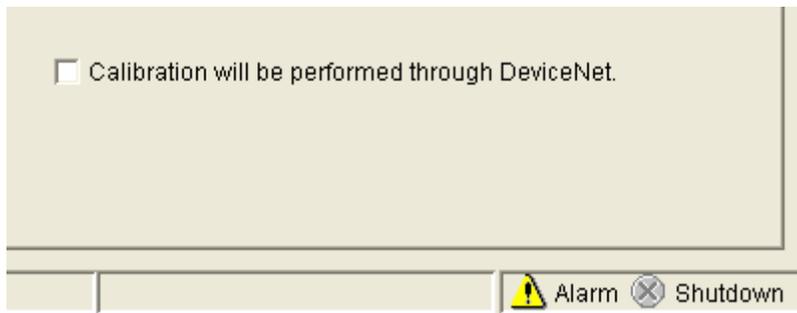


Figure 4-41. Calibration will be performed through DeviceNet

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.

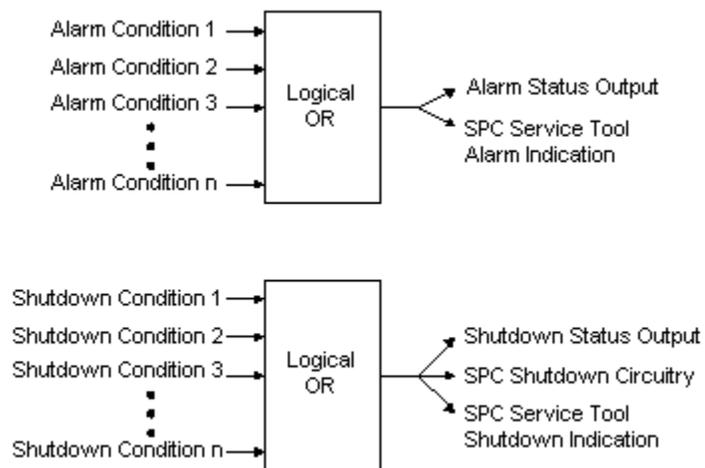


Figure 4-42. Alarm Structure

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.

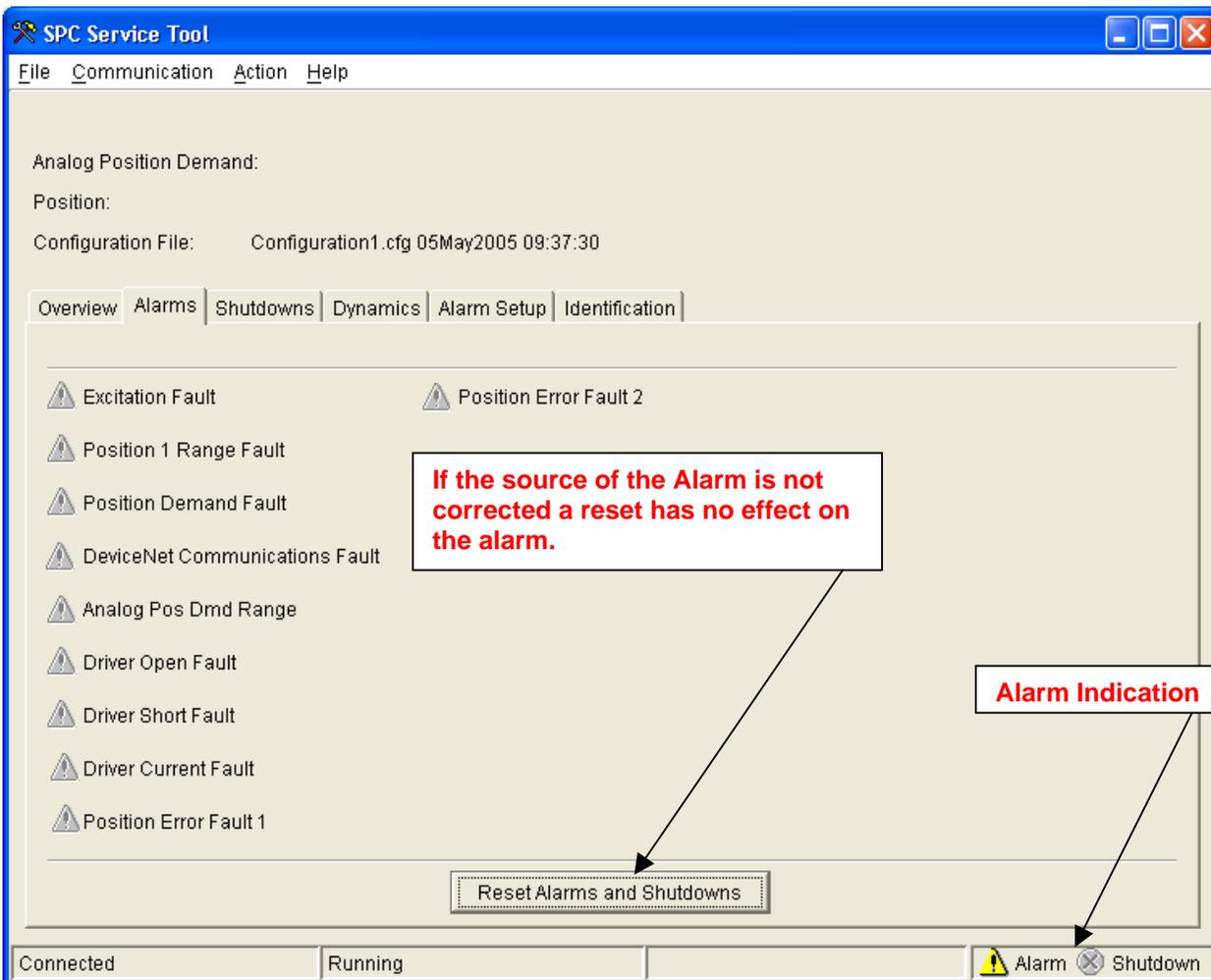


Figure 4-43. Alarms

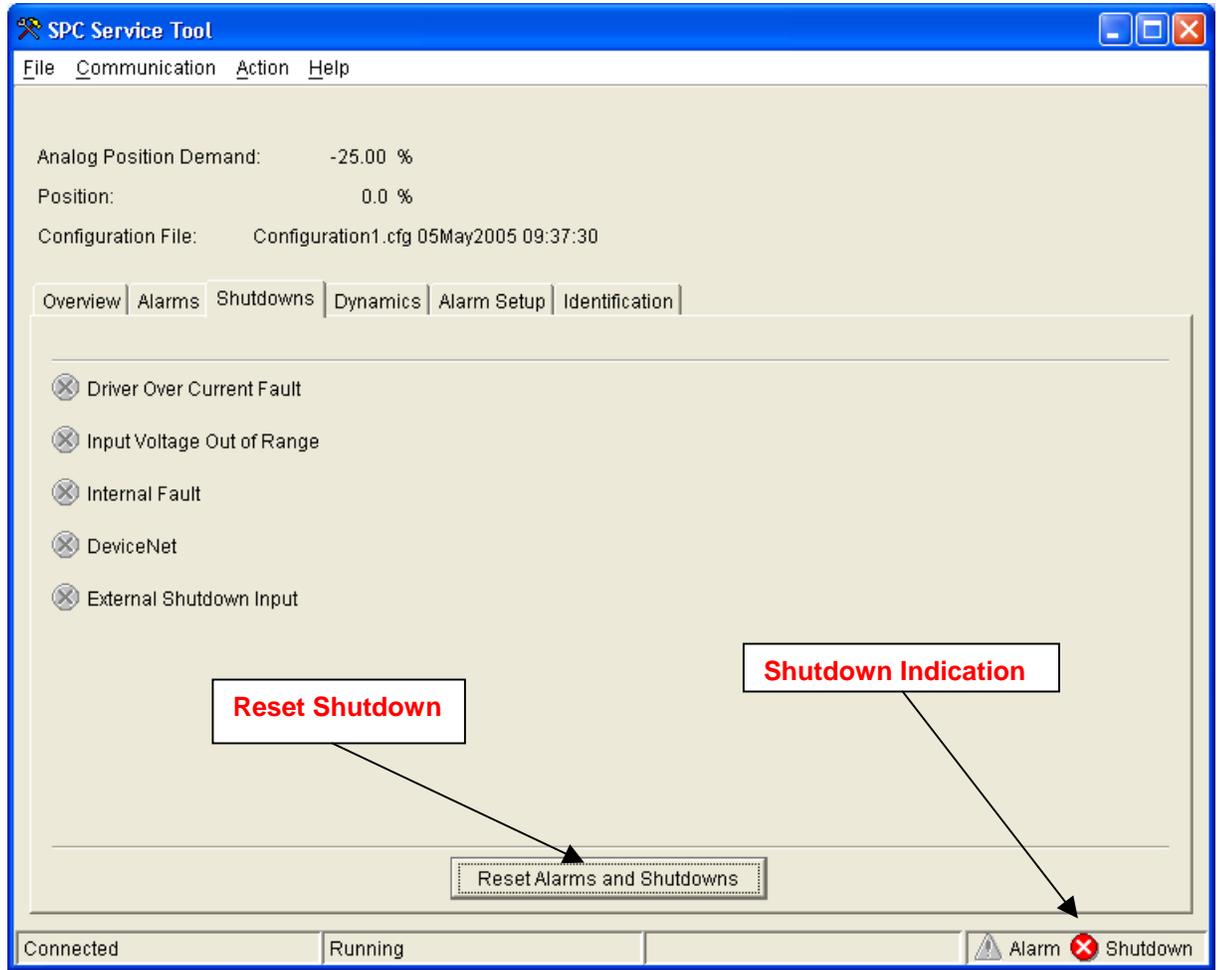


Figure 4-44. Driver Fault Error Shutdown

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.

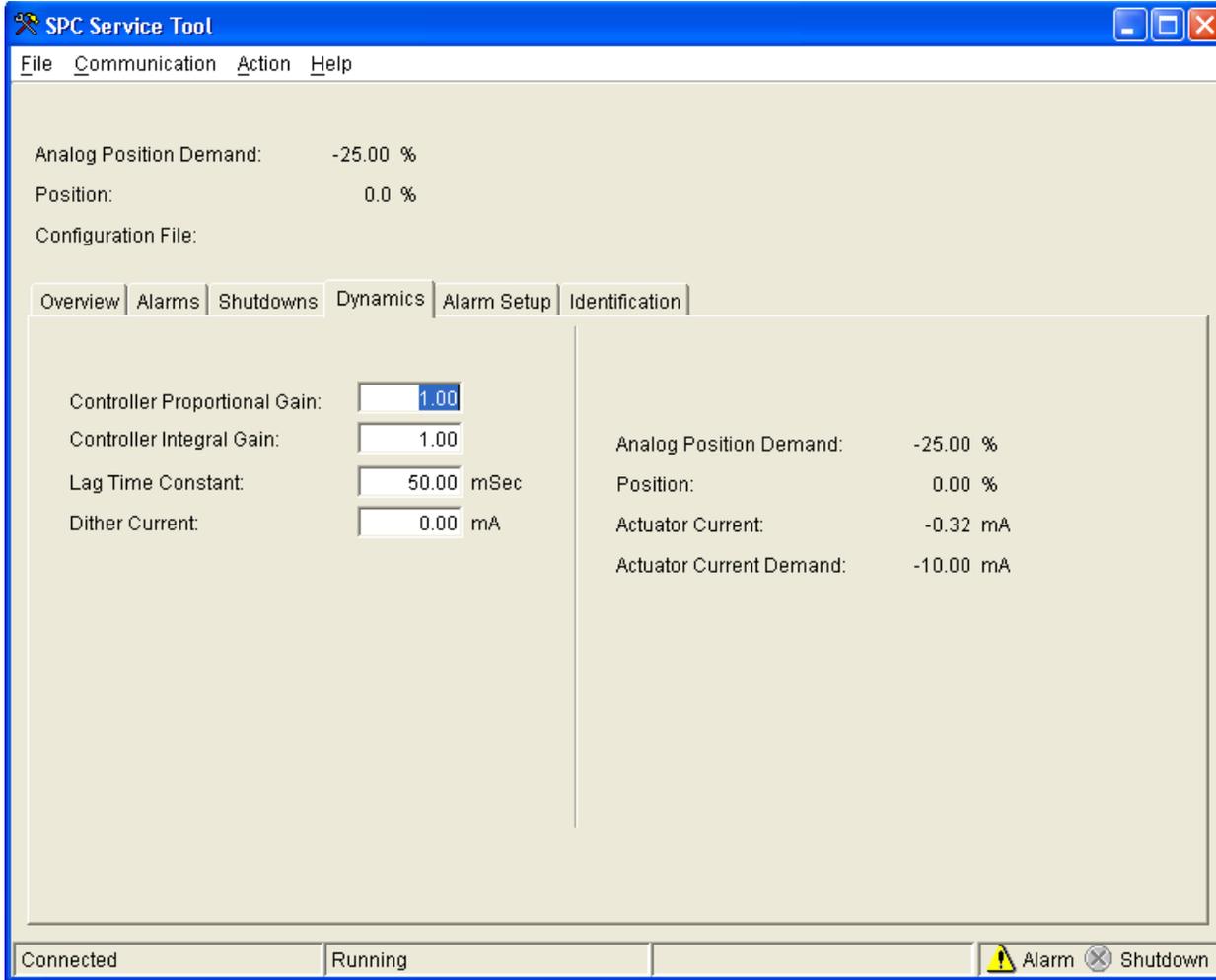


Figure 4-45. Dynamic Settings

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.

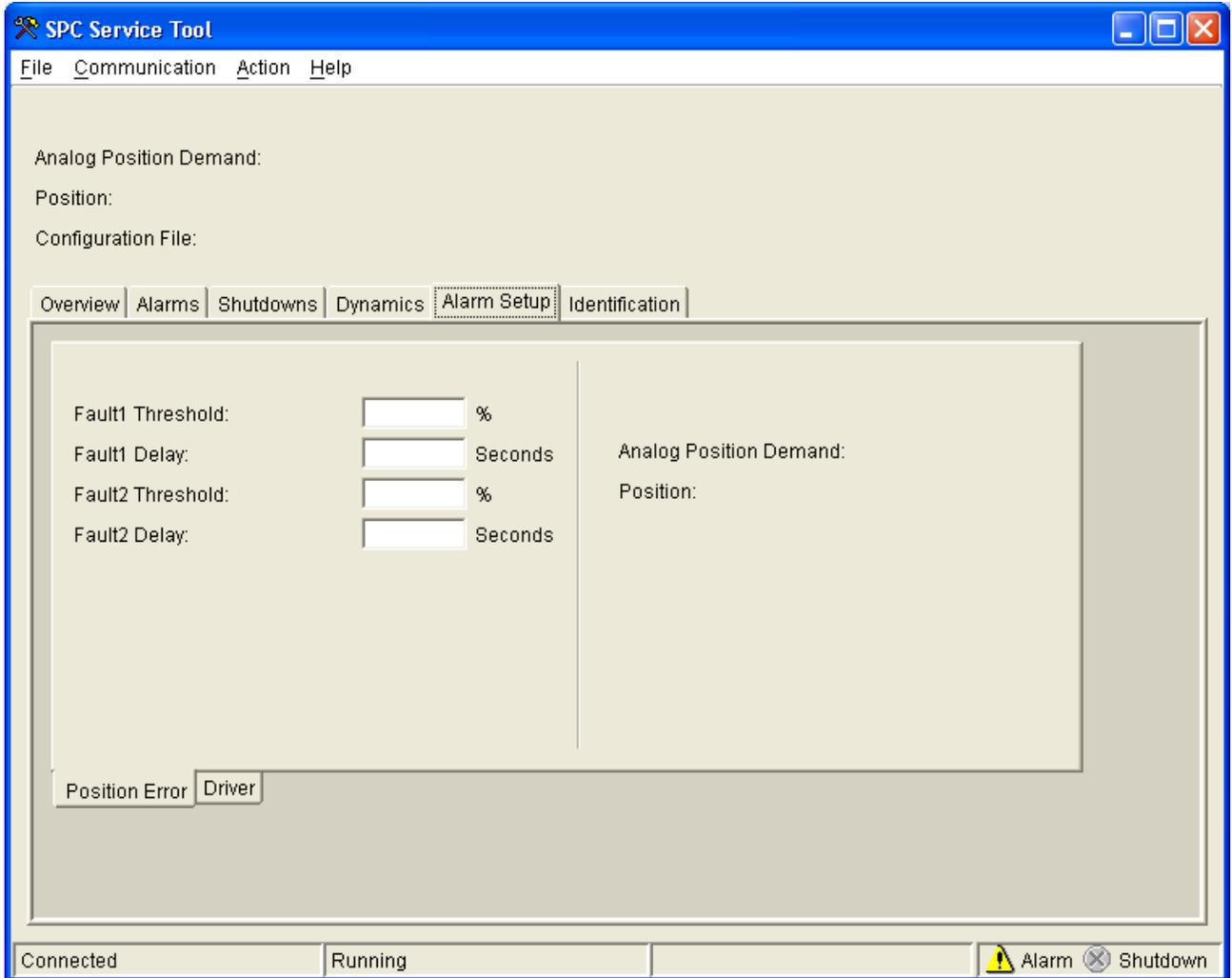


Figure 4-46. Position Error Alarms

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

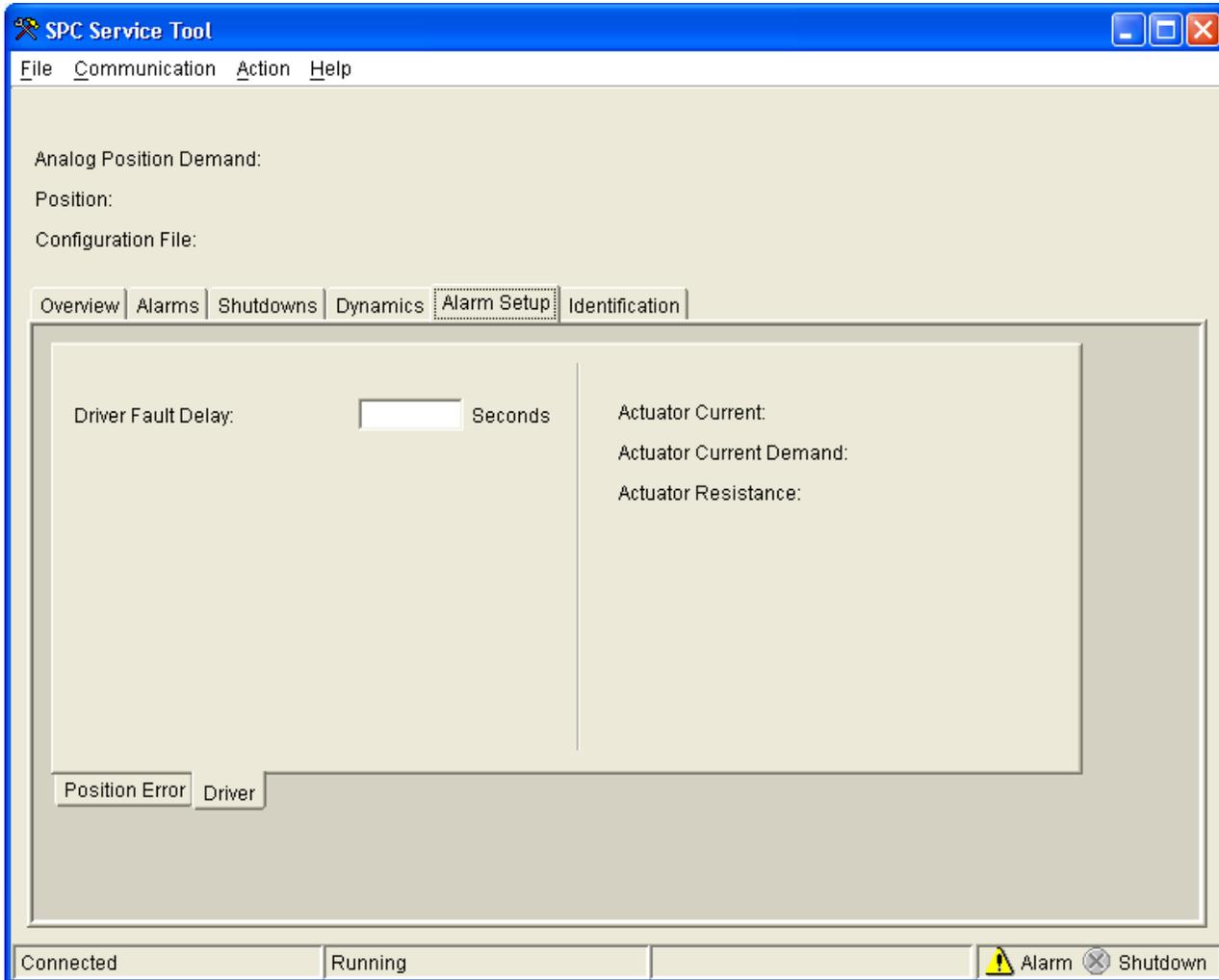


Figure 4-47. Driver Fault Error Alarms

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

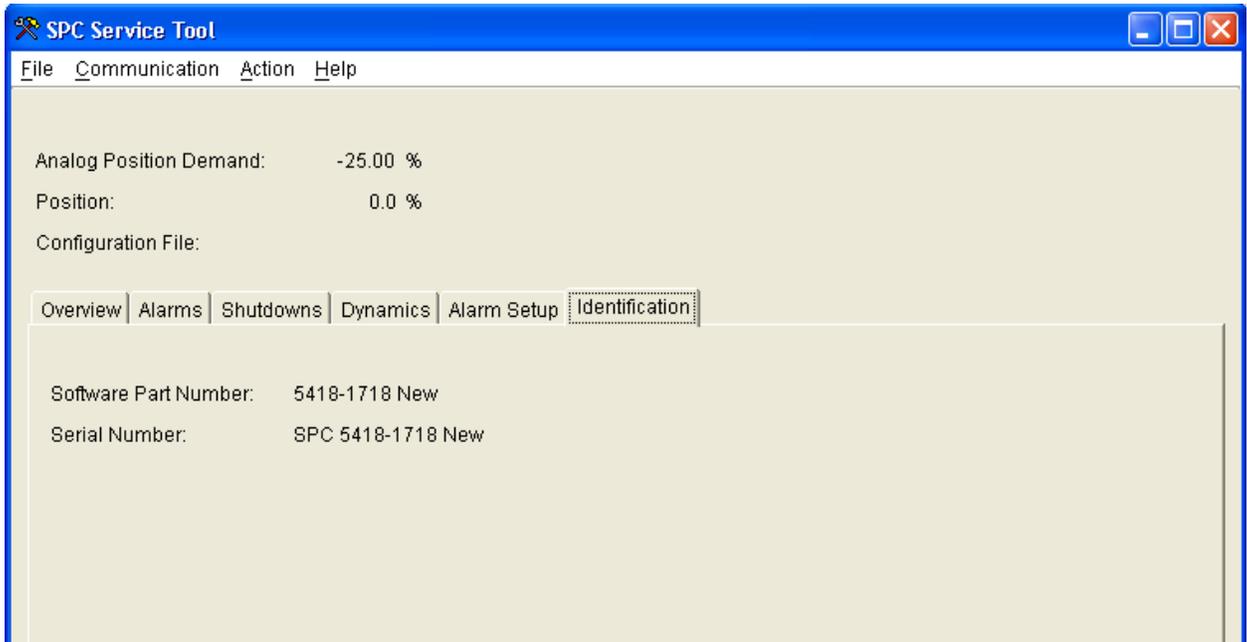


Figure 4-48. SPC Service Tool Identification Tab

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.**

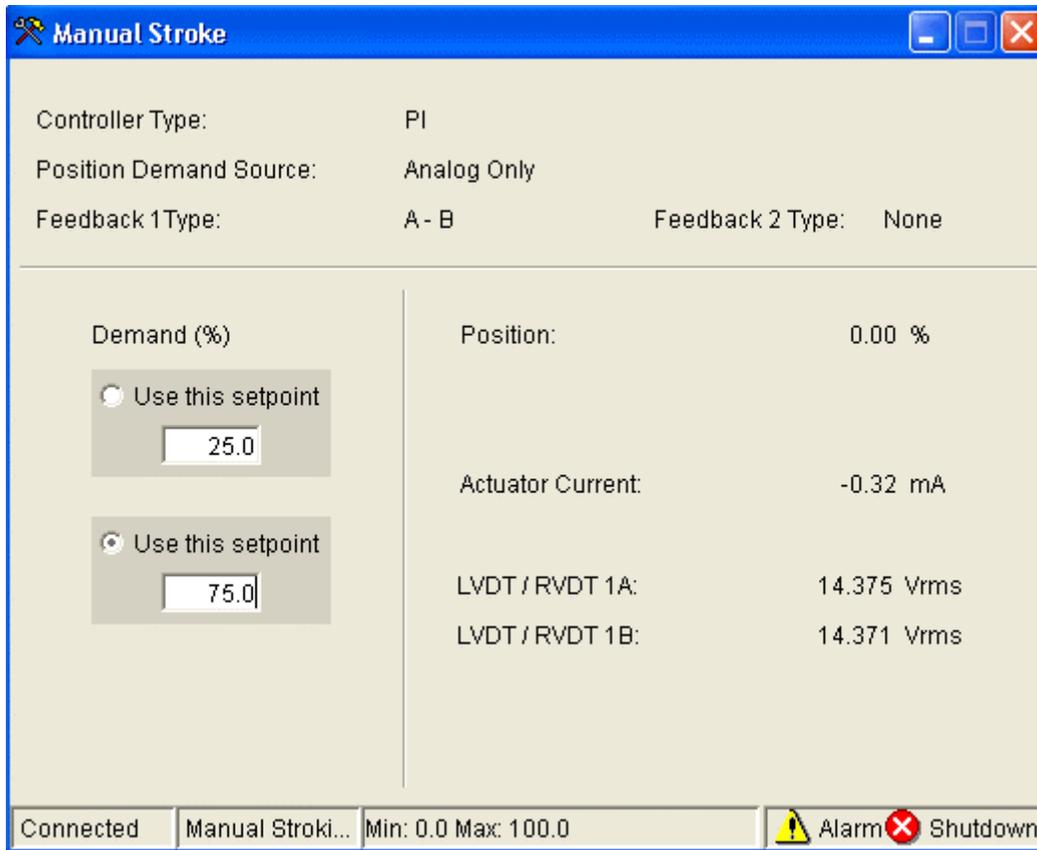


Figure 4-50. SPC Service Tool Manual Stroking

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.

Alphabetical List of SPC Alarms and Shutdowns

Alarm (displayed on the status bar)

- One or more alarms on the Alarms and Shutdowns screen is active. This also reflects the state of the hardware Shutdown Status output.

Analog Position Dmd Out of Range

- The 4–20 mA analog position demand current is below 1 mA or above 24 mA.
- Type (alarm or shutdown): alarm
- 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): alarm 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.
- Latching/non-latching response: configurable

DeviceNet Shutdown

- A shutdown command is being received over the DeviceNet bus.
- Type (alarm or shutdown): shutdown
- Latching/non-latching response: non-latching

Driver Current Fault

- 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

- The SPC has detected an open actuator coil.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: latching

Driver Overcurrent Fault

- The actual driver current exceeds the commanded driver current by more than 20 % of the full-scale current.
- Type (alarm or shutdown): shutdown
- Latching/non-latching response: latching

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.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: latching

Excitation Fault

- The excitation voltage is not within 0.2 Vrms of the configured value.
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

External Shutdown Input

- The external shutdown contact input is open.
- Type (alarm or shutdown): shutdown
- Latching/non-latching response: non-latching

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.
- Type (alarm or shutdown): shutdown
- Latching/non-latching response: configurable

Feedback 1 Open Fault

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

Feedback 2 Open Fault

- 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

- 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 1 A 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): alarm
- Latching/non-latching response: configurable

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.
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

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.
- Type (alarm or shutdown): alarm
- Latching/non-latching response: configurable

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.
- Type (alarm or shutdown): configurable
- Latching/non-latching response: configurable

Input Voltage Out of Range

- The SPC input voltage is below 17 Vdc or above 33 Vdc.
- Type (alarm or shutdown): shutdown
- Latching/non-latching response: latching

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.
- Type (alarm or shutdown): shutdown
- Latching/non-latching response: latching

Position Demand

- 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 Position Demand Timeout.
- Type (alarm or shutdown): shutdown
- Latching/non-latching response: configurable

Position Demand Tracking

- 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

- 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

- 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

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

Position 2 Range Fault

- 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

Shutdown (displayed on the status bar)

- One or more shutdowns on the Alarms and Shutdowns screen is active. This also reflects the state of the hardware Alarm Status output.

Chapter 5.

Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed:

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

If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

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 also a flat rate structured program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call 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 Woodward facility as explained below (see “Returning Equipment for Repair” later in this chapter).

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 to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]

Return Shipment Authorization Label. To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

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 to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the item(s), attach a tag with the following information:

- 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.



CAUTION—ELECTROSTATIC DISCHARGE

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*.

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.

Return Authorization Number

When returning equipment to Woodward, please telephone and ask for the Customer Service Department [1 (800) 523-2831 in North America or +1 (970) 482-5811]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the item(s) to be repaired. No work can be started until a purchase order is received.



NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at 1 (800) 523-2831 in North America or +1 (970) 482-5811 for instructions and for a Return Authorization Number.

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.

How to Contact Woodward

In North America use the following address when shipping or corresponding:

Woodward Governor Company
PO Box 1519
1000 East Drake Rd
Fort Collins CO 80522-1519, USA

Telephone—+1 (970) 482-5811 (24 hours a day)
Toll-free Phone (in North America)—1 (800) 523-2831
Fax—+1 (970) 498-3058

For assistance outside North America, call one of the following international 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.

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
India	+91 (129) 230 7111
Japan	+81 (476) 93-4661
The Netherlands	+31 (23) 5661111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (www.woodward.com) for the name of your nearest Woodward distributor or service facility.

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Contact information:

Telephone—+1 (970) 482-5811

Toll-free Phone (in North America)—1 (800) 523-2831

Email—icinfo@woodward.com

Website—www.woodward.com

Technical Support is available through our many worldwide locations or our authorized distributors, depending upon the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical support, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Technical Support**.

Product Training is available at many of our worldwide locations (standard classes). 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. For information concerning training, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Product Training**.

Field Service engineering on-site support is available, depending on the product and location, from one of our many worldwide locations or from one of our authorized 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 field service engineering assistance, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Technical Support**.

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:

General

Your Name _____
 Site Location _____
 Phone Number _____
 Fax Number _____

Prime Mover Information

Engine/Turbine Model Number _____
 Manufacturer _____
 Number of Cylinders (if applicable) _____
 Type of Fuel (gas, gaseous, steam, etc) _____
 Rating _____
 Application _____

Control/Governor Information

Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Part Number and Revision Letter _____
 Control Description or Governor Type _____
 Serial Number _____

Woodward Part Number and Revision Letter _____
 Control Description or Governor Type _____
 Serial Number _____

Woodward Part Number and Revision 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 100mA range not 125mA 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 100mA range not 125mA 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 100mA range not 125mA 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 100mA range not 125mA 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 100mA range not 125mA 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 100mA range not 125mA range.
036	2	single	ac	latch	fwd	± 20, 40, 125, 250 mA		2 SPCs can work - SPC has 100mA range not 125mA range.
041	2	single	ac	latch	fwd	± 20, 40, 125, 250 mA	PI Controller	2 SPCs can work - SPC has 100mA range not 125mA 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 Vdc transducer power supply**. All controls include **±15 V transducer power supply**.
3. Unipolar ranges are not shown. Example: ±100 mA bipolar becomes 0–200 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 Vdc or Vac. SPC is 18–32 Vdc.
- 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 Vac. The SPC's contact is only rated 18 to 32 Vdc.
- 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								Reserved		
	3								Index	Internal (INDEX_OUT)	
	4								Slow Data		
	5								Reserved		
SLOW TO SPC	4		REAL	0		0	500		0	Reserved	KP (Proportional Gain)
			REAL	0		0	500		4	Reserved	KI (Integral Gain)
			REAL						8	Reserved	NULL_I (Actuator Null Current Setpoint)
			REAL					PERCENT	12	Reserved	NULL_I_OFF (Null Current Offset)
			REAL						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)
									30	Reserved	CAL_MODE_E (Enable Calibration)
			BOOL							Reserved	Internal (Calibration Permissive)
	1								Reserved		
	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	RawHigh	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	FLD_BUS_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.



NOTE

If communications is 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 (Vrms): Voltage on coil "A" of RVDT or LVDT 1.

FDBK_V_1B:

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

FDBK_V_2A:

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

FDBK_V_2B:

LVDT/RVDT 2 Coil B Voltage (Vrms): 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 is 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 Vrms 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 4-20 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 Vdc or above 33 Vdc.

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.

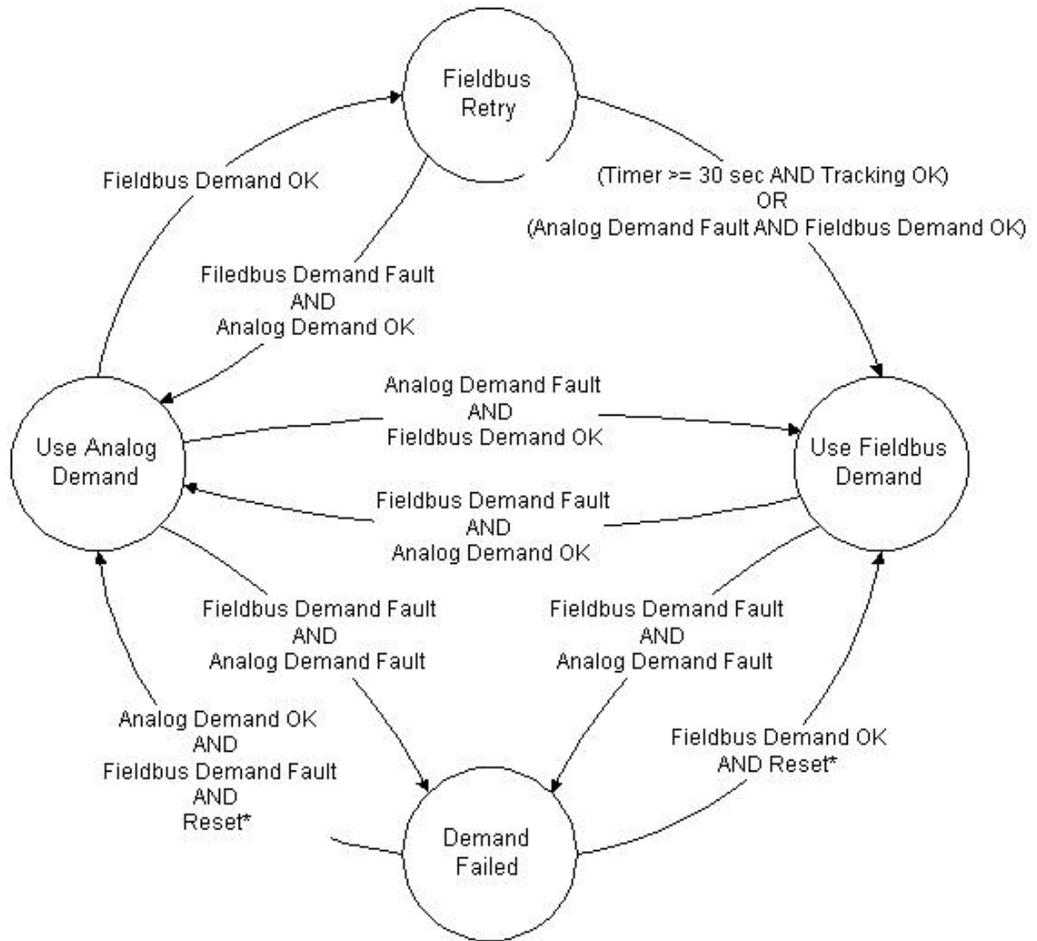
READX_FLT The read from the X word on the Applicom Module has failed

WRITE_FLT Any write to the Applicom Module has failed

Special Instructions

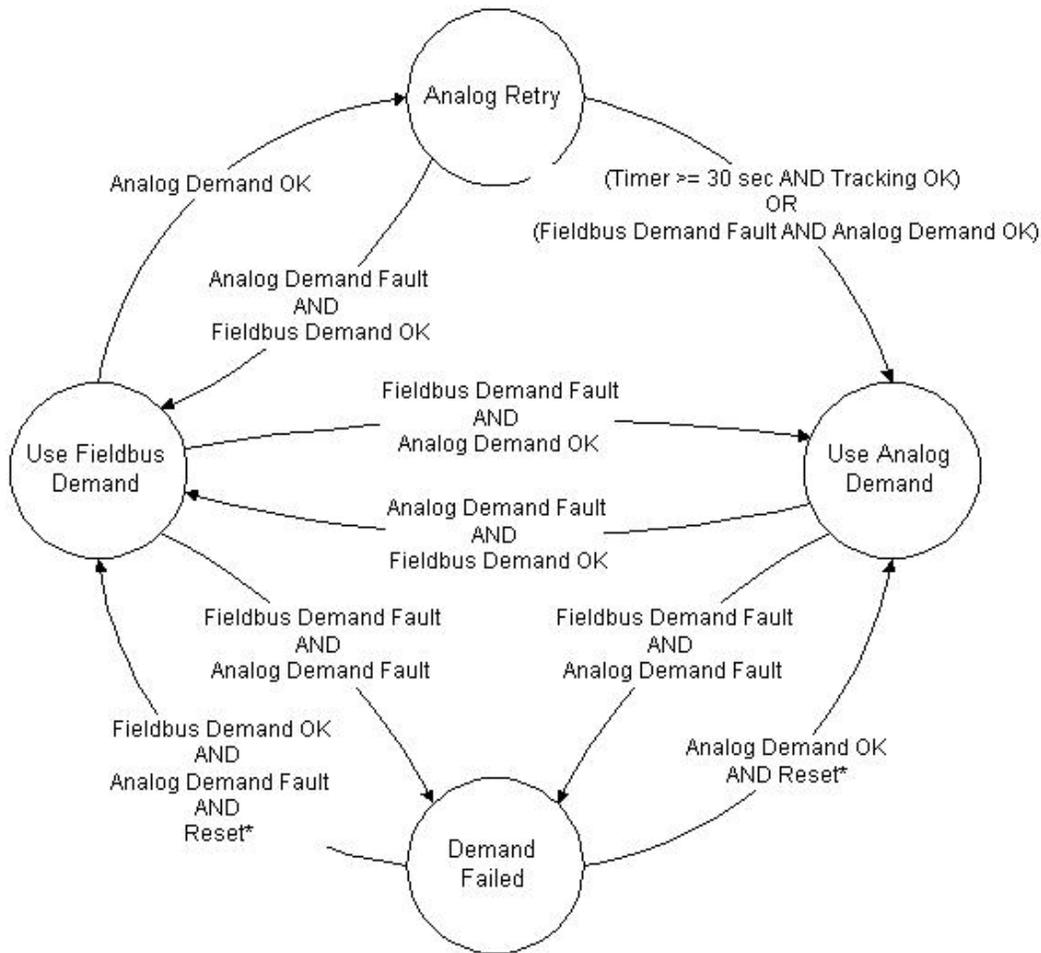
DEMAND FAILOVER LOGIC:

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.



NOTE

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:

**NOTE**

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 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.

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): 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility as amended by 92/31/EEC and 93/68/EEC.

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.

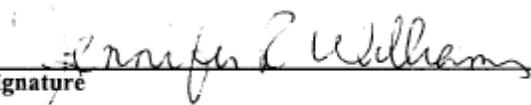
Applicable Standards: EN61000-6-2, January 1999: Electromagnetic Compatibility (EMC) – Generic Standards – Immunity for Industrial Environments
EN50081-2, August 1993: EMC Generic Emissions Standard Part 2: Industrial Environment

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

3rd 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

Jennifer R. Williams

Full Name

Engineering Manager

Position

WGC, Fort Collins, CO, USA

Place

22-January-2002

Date

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please include the manual number from the front cover of this publication.



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