WOODWARD

Product Manual 35154
(Revision -, 07/2019)
Original Instructions

L-Series Position Controller
RoHS Compliant

Installation and Operation Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

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

www.woodward.com/publications

The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

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

Translated Publications

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

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 Out-of-date translations are marked with .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

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 35154

Contents

Illustrations and Tables

Acronyms/Abbreviations

AUX	auxiliary
EEPROM	electrically-erasable programmable read-only memory
EMC	electro-magnetic compatibility
GUI	graphic user interface
I/O	inputs/outputs
Isoch	isochronous
ITB	integrated throttle body
L-Series	Woodward electronic engine governor that contains both a rotary actuator and a controller circuit board
MPU	magnetic pick up
OEM	original equipment manufacturer
PWM	pulse-width modulated
rpm	revolutions per minute
RS-232	a communications standard
TPS	throttle position sensor

Warnings and Notices

Important Definitions

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

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

⚠WARNING

Lockout/Tagout (LOTO)

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

⚠WARNING

Independent Fuel Shutoff Required (Overspeed / Overtemperature / Overpressure)

The engine, turbine, or other type of prime mover should be equipped with an independent fuel shut-off device to protect against fuel leakage or damage to the prime mover with possible personal injury, loss of life, or property damage. The fuel shut off device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

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

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

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

WARNING

Start-up

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

WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

IMPORTANT

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

Regulatory Compliance

European Compliance for CE Marking:
These listings are limited only to those units bearing the CE Marking:

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

RoHS Directive: Declared to 2011/65/EC COUNCIL DIRECTIVE of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Exemptions in Use: 6(a), 6(c), 7(a), 7(c)-I

These listings are limited only to those units bearing the ATEX markings as well as the CE Mark:

ATEX Directive: Declared to Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
Zone 2, Category 3, Group II G, Ex nA IIC T3 Gc X
$-40\ °C \leq T_{amb} \leq +105\ °C$, IP56

Other European and International Compliance:
Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking:

Machinery Directive: Compliant as partly completed machinery with Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery.

Pressure Equipment Directive: Exempt per Article 1.2(j) of 2014/68/EU where pressure is not a significant design factor

North American Compliance:
These listings are limited only to those units bearing the CSA identification

CSA: CSA Certified for Class I, Division 2, Groups A, B, C, & D, T3C at 105 °C Ambient for use in Canada and the United States.
Certificate 1380416

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

Special Conditions for Safe Use:

WARNING

Connect ground terminal to earth ground.

WARNING

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

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

WARNING

The installer of the L-Series must take responsibility for meeting Clause 26.4.2 of EN60079-0 (Ed. 6 or 7) regarding impact testing. The actuator by itself does not meet this requirement and therefore must be sufficiently protected when installed. See Chapter 2, Mechanical Installation, for more details.

IMPORTANT

The actuator should be protected from exposure to sunlight and rain.

WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

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

AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

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

Chapter 1.
General Information

Purpose and Scope

The purpose of this manual is to provide the necessary background information for applying the L-Series control to gas/gasoline reciprocating engines. Topics covered include mechanical installation, electrical wiring, software programming, and troubleshooting. While this manual is primarily targeted at OEM customers, OEMs themselves may find it useful to copy some of the information from this manual into their application user manuals.

How to Use This Manual

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

- Unbox and inspect the hardware.
- Mount and wire the hardware following the procedures and recommendations in Chapter 3.
- Optionally configure the control using the Service Tool (Chapter 4).
- Optionally stroke the valve and verify dynamics and functionality.
- Troubleshooting guidelines are provided in Chapter 5.
- Specifications are provided in Appendix C.

Intended Applications

The L-Series control is designed for various industrial applications, including but not limited to generator sets, welders, portable refrigeration units, irrigation pumps, chipper shredders, and mobile industrial gas or gasoline reciprocating engines. Key environmental characteristics of these applications include extended industrial operating temperatures (–40 to +105 °C/–40 to +221 °F), Industrial EMC Requirements, electrical transients, and lower operating voltages (12/24 V).

L-Series Description

The L-Series provides a building block approach to total engine management. The modular bi-directional actuator design easily attaches to fuel pumps, mixers, or throttle bodies. For information on Woodward throttle body applications, refer to manual 35144 (ITB and LC-50).

Woodward also offers L-Series actuator versions for Speed Control and Process Control, like Air/Fuel Ratio control, applications. Refer to manuals 35141(Speed Control) and 35153 (Process Control).

The L-Series position control accepts a position command and drives the 0–60 degree output shaft to the commanded position based on an internal shaft position sensor. The high-efficiency torque motor delivers 0.34 N·m (0.25 lb-ft) nominally over 60° travel range to operate fuel or air control devices (see specifications in Appendix C for torque performance over the full product temperature range).

The L-Series position control accepts either a PWM command or a 0–5 V command for output positioning. The command signals are issued by the appropriate supervisory engine management system, and the L-Series must be set up properly in software to expect the correct signal for the application.

For status purposes, a relay driver output is available on the L-Series control which changes state whenever a fault or error condition is experienced by the L-Series controller.

If the system so requires, the L-Series provides a direct position output signal in the form of a dc voltage. The throttle position (TPS) output represents full counterclockwise (ccw) to clockwise (cw) rotation of the actuator shaft, and thus gives the operator an external position indication after installation and while the unit is operating.

More detail on the features of the L-Series can be found later in this manual.

⚠WARNING

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

IMPORTANT

The gasket must be ordered separately.

Programmable Features

Control setup and tuning is accomplished through the use of a PC (personal computer), Woodward Service Tool software, and a programming harness. The features identified below are described in Chapters 2 and 4. Briefly, the programmable features include:

- 4 General Setup Parameters
  - Position Demand Select (PWM or Analog)
  - Fail Direction (ccw or cw)
  - Min Position Direction (ccw or cw)
  - Actuator Curve Selection (Linear or Non-linear)
- PWM Setup Parameters
  - PWM Drive Select (Push-Pull, High-Side Drive or Low-Side Drive)
  - PWM Offset
- 4 Valve Position Control Parameters
  - Proportional Gain
  - Integral Gain
  - Derivative Gain
  - Friction/Dither Setting
- 10 Non-Linear Actuator Settings
  - Position Request (5 curve input points)
  - Actuator Position (5 curve output points)
- 12 Discrete Output Settings
  - Output’s Non-Fault Condition (ON or OFF)
  - 11 Selections as Discrete Output Indications
- 10 Fault Settings
  - Latching or Non-Latching Fault Indications
  - Position Error Magnitude
  - Position Error Delay
  - 7 Fault Selections as Alarms or Shutdowns

Service Tool Software

The L-Series Service Tool software is a Microsoft Windows based GUI (graphic user interface). The Service Tool Software is compatible with Windows 95/98/NT/00 and gives the OEM the ability to:

- Configure product settings based on application requirements
- Tune the control with the engine running during application development
- Create configuration files for downloading into multiple controls
- Download configuration files
- Extract and view fault codes for field diagnosis
- Update control dynamics during field service
- Calibrate the control for user stops

Detailed descriptions of software installation are available in Chapter 4.

IMPORTANT

The Service Tool is not included, but can be downloaded from the Woodward Internet website (www.woodward.com/software/).

WARNING

The actuator must be properly set up using the L-Series Service Tool prior to starting the engine.

Chapter 2.
System Description/Application Overview

System Operation

The L-Series actuator is ready for operation immediately (within 0.25 second) when the power supply is connected. Power may be connected to the control at the same time the engine starter motor is engaged. Upon power-up, the actuator will immediately go to the commanded position. The actuator will then drive to maintain the position commanded by the supervisory control.

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

Upon an engine shutdown command, the independent engine shutdown solenoid or solenoid valve in the fuel supply should be de-activated and the power supply disconnected from the speed control. This shutdown signal should be sent directly from the engine control panel and should be independent and separate from the L-Series controller.

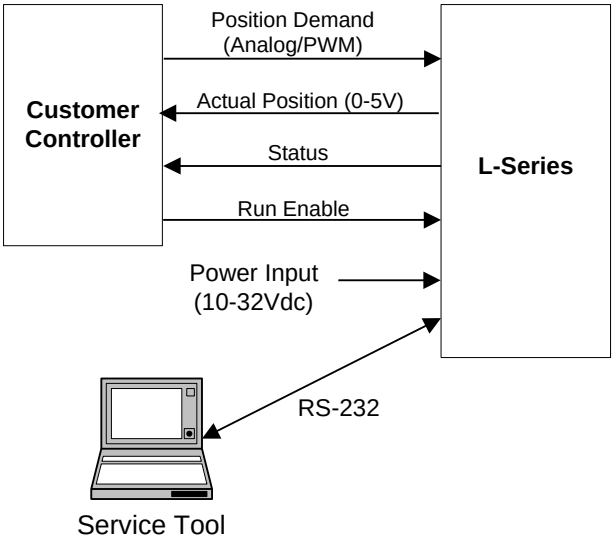


Figure 2-1. L-Series Operation

Driver Input Power

The L-Series will handle a voltage range of 10 to 28 Vdc at full specified torque. The actuator is functional in the range of 8 to 32 Vdc, but accuracy and/or torque can be diminished at the extreme ends of this range.

The supply voltage failure levels are below 6.25 V and above 33 V. The unit can be configured to either alarm or shut down upon detection of a supply voltage fault.

LCS Position Control Functional Overview

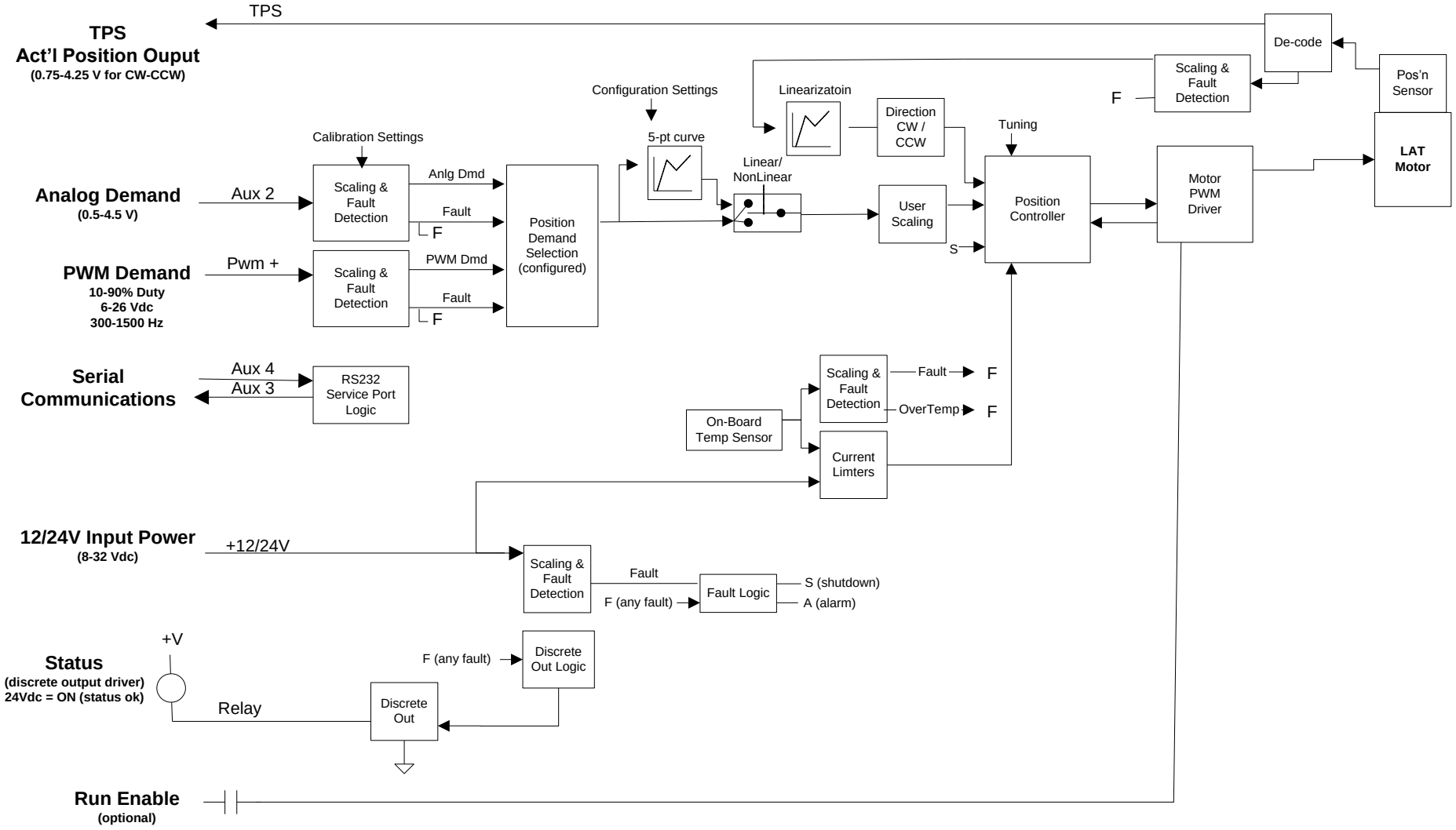


Figure 2-2. L-Series Position Control Functional Overview

Position Command Signal

The L-Series can accept either a PWM command signal input or an analog 0–5 Vdc command signal input, depending on how the software application is configured.

The PWM will function with various types of input sources, including high-side, low-side open collector, and push-pull—depending on the configuration. It will handle a PWM frequency range from 300 to 1500 Hz at amplitudes ranging from 5 V up to battery voltage. Normal operating range is from 10% to 90% duty cycle, representing the hard stops in the actuator (Figure 2-1). The input can be optionally set to a non-linear mode which provides a 5-point curve relationship between position signal and desired position (Figure 2-2).

The input failure levels are below 3% and above 97% duty cycle. The unit can be configured to either alarm or shut down on detection of a position command failure. The shutdown failsafe direction is also user configurable as either clockwise or counterclockwise.

A user-configurable offset is available to adjust the input duty-cycle reading, as needed.

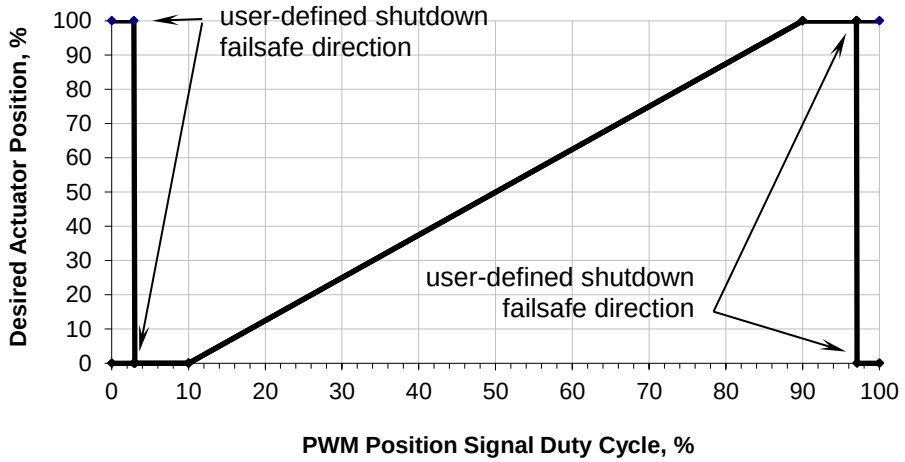


Figure 2-3. PWM Linear Demand to Position

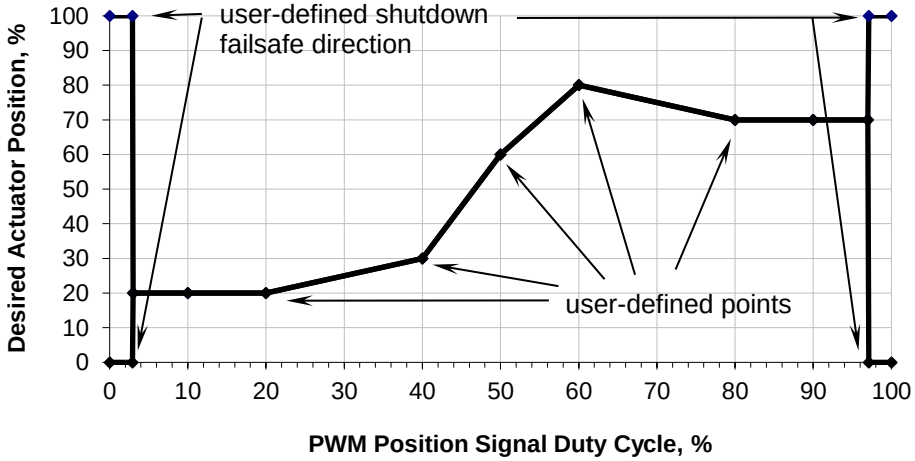


Figure 2-4. PWM Non-Linear Demand to Position

The 0–5 V input uses a different pin in the connector, and it has a usable range of 0.5 to 4.5 V to command the throttle from minimum to maximum position (Figure 2-3). The input can be optionally set to

a non-linear mode which provides a 5-point curve relationship between position signal and desired position (Figure 2-4).

The input failure levels are below 0.2 and above 4.8 V. The unit can be configured to either alarm or shut down on detection of a position command failure. The shutdown failsafe direction is also user-configurable as either clockwise or counterclockwise direction.

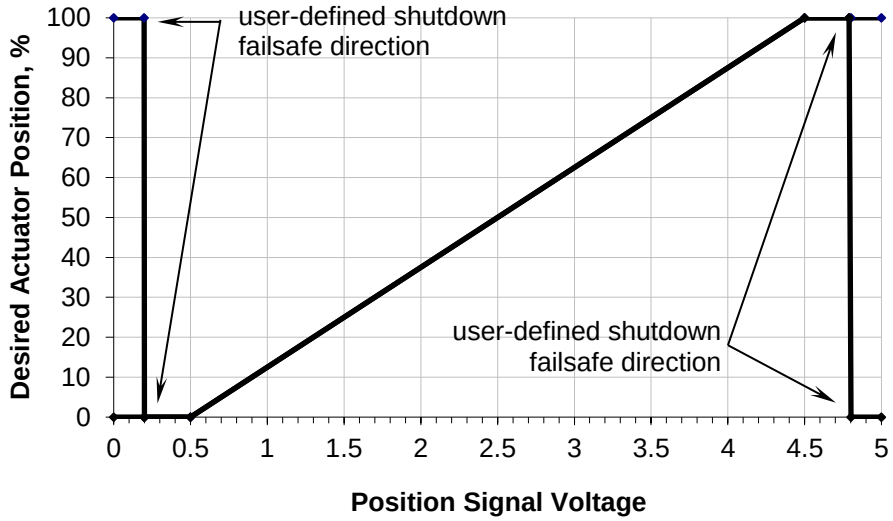


Figure 2-5. Analog 0–5 V Linear Demand to Position

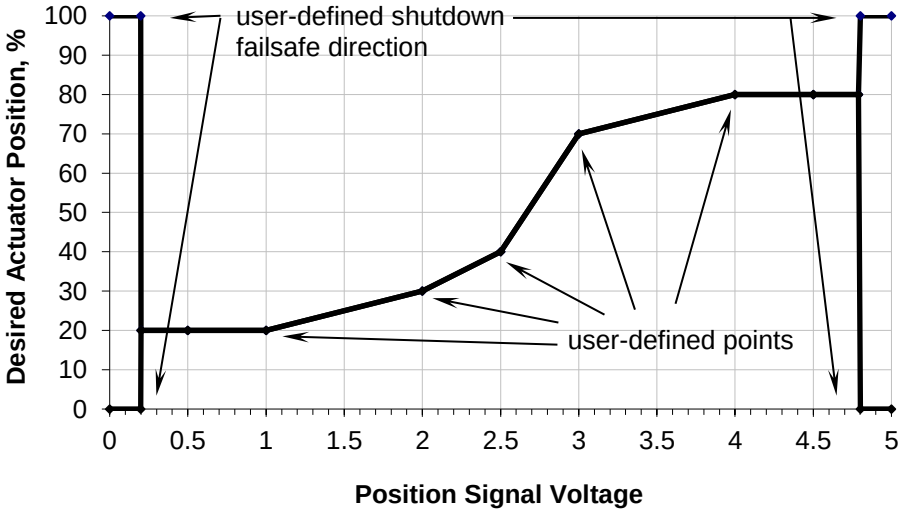


Figure 2-6. Analog 0–5 V Non-Linear Demand to Position

Discrete Output

A discrete output is provided to serve as a status indicator. This switchable discrete output is a closure to ground capable of sinking 250 mA with an output voltage rise of less than 1.5 V, and it is available to power external relays for devices such as alarms or fuel shutoff solenoids. The circuit is protected internally against overcurrent and inductive spikes, so external clamping is not necessary.

This output can be configured to be either normally on/open (preferred failsafe setting) or normally off/closed. In addition, the faults that drive the relay status can be configured individually. For details refer to Chapter 4 (Service Tool).

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

Run Enable Discrete Input

An optional Run Enable discrete input can be configured for use. The Run Enable operation provides a closed-to-run and an open to force the shaft controller into a low-current “limp” mode. The Run Enable can also be used to clear a latching shutdown condition since a closure of the input will issue a reset command.

Actual Position Feedback (TPS)

The L-Series provides a 0–5 V signal representing actual shaft rotational position, where 0.75 V and 4.25 V correspond to full counterclockwise to clockwise rotation, respectively. This signal is fed directly off the position sensor to ensure no delays are introduced by the processor. However, this signal is also uncorrected, so the difference between this signal and actual position can vary up to ±10% over the operating temperature range.

Additional Inputs/Outputs

Auxiliary Inputs—There are four auxiliary inputs on the L-Series controller, all of which are capable of both analog and discrete functions. They can all be functionally defined for purpose in the software application. Although they are very flexible, two of them are shared with the serial communications, so will be unavailable if the L-Series is connected to the Service Tool. More detail concerning the auxiliary inputs is provided in Chapter 3 (Installation).

5V Output—A 5 Vdc output has been provided on the L-Series actuator to power external sensors, if necessary. The 5 V output is limited to 10 mA, but this is sufficient for most light-duty ratiometric sensors.

Communications

RS-232 communications are available on the L-Series when used with an external transceiver connected to pins 4 and 6. Serial communications allow for the use of a service and configuration tool with the L-Series actuator. The simplest way to establish this interface is to use Woodward kit # 8923-1061.

Functions available through this port include tuning, monitoring, and configuration of the position controller. Detailed driver status information is also available.

Any RS-232 wiring must meet the requirements in the EIA RS-232 Standard document. The RS-232 standard states that the length of the RS-232 cable between the driver and the PC must be less than 50 ft (15 m) with a total capacitance less than 2500 pF. The RS-232 data rate is fixed at 19.2 kbps. The communication port is non-isolated and susceptible to both EMI noise and ground loops related to PC connections and typical industrial environments.

IMPORTANT **The service port is not isolated and is not intended to function while the prime mover is in normal operation. The service port is provided for configuration and setup only.**

Temperature Sensing

The L-Series has an on-board temperature sensor to monitor board temperatures and protect the unit from overtemperature. This temperature is monitored and a fault is annunciated if the set point is exceeded.

Current Limiting based on Temperature

The controller provides actuator current limiting based on the electronics temperature. Dependent on board and actuator thermal models, the software reduces current as necessary to avoid conditions that would damage the device due to extreme temperatures.

Current limiting based on temperature begins when the combined current and temperature environment causes board temperatures greater than 117 °C. The limit curve is a linear derate from full current at 117 °C down to zero current at 125 °C. At 125 °C, an OverTemp fault is annunciated. Depending on the current (actuator torque) and ambient operating temperatures, the unit may never reach a reduced level.

Faults

Faults are separated into two categories: Logged Faults and Current Faults. The Current Faults are volatile and reset every time power is applied. The Current Faults annunciates faults that are presently active/detected; they may latch or not latch depending on the fault. All latching Current Faults are reset by a power cycle or Service Tool reset. All logged faults are latched and written to the EEPROM. They must be cleared through the Service Tool.

A fault can have three effects on the control: change the discrete output state (Alarm), Shutdown–drive to fail direction and change the discrete output state (Alarm), or Shutdown–go limp and change the discrete output state (Alarm). A parameter is available to configure the fault to either an alarm or a shutdown. The shutdown action performed (go limp or drive to fail direction) is fault-dependent. Some faults are dedicated shutdowns and cannot be configured—they are identified as such below. A "go limp" command overrides a "drive to fail position" if more than one fault is set.

Faults can be configured as either latching or non-latching. This is a general setting that applies to all faults, unless otherwise noted. When configured as non-latching, a Reset is not needed. If latching mode is configured, a Reset or power-cycle is required to clear the fault and resume positioning.

Watchdog Reset

Watchdog Reset is true if a watchdog timer timeout occurred which resulted in a reset of the microprocessor. This is a hard-coded alarm. If detected, the control will attempt to continue normal operation.

Brownout Reset

Brownout Reset is true if CPU Voltage drops below 4.2 V but not below 1 V. The brownout detect circuit will reset the CPU. This is a hard-coded alarm. If detected, the control will attempt to continue normal operation.

EEPROM Fail

EEPROM Fail indicates failure or corruption of the internal non-volatile memory. If the CRC is not correct for the EEPROM data, this fault will be set true. This is a hard-coded internal shutdown. If detected, the control output will go limp. A power cycle is required to clear this fault.

Position Sense Fail

This indicates a failure of the internal Position Sensor. This is a hard-coded internal shutdown. If detected, the control output will drive to the Fail Direction using current control. This fault latches and requires a reset or power cycle to clear.

Failure levels: >4.75 V and < 0.25 V
Persistence: 650 ms

Voltage Sense Fail

Indicates an out-of-range signal on the input power. Could indicate input power out of range or a fault in the supply voltage sense circuitry.

Failure levels: >33 V and <6.25 V
Persistence: 650 ms

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using current control) if this fault is detected. If configured as an alarm, the control will internally default to an assumed 32 V power supply voltage (decreased torque at lower actual voltages) and attempt to continue normal operation if this fault is detected. The value displayed on the Service Tool will show sensed value, not default.

Temp Sense Fail

Indicates a failure of the internal on-board Temperature Sensor.

Failure levels: >150 °C and <–45 °C
Persistence: 650 ms
Hysteresis: 5 °C (<145 °C or >–40 °C to clear)

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will internally default to 25 °C and attempt to continue normal operation if this fault is detected. The value displayed on the Service Tool will show sensed value, not default.

OverTemp

If the on-board temperature sensor reads above 125 °C, this error will be set. Above 125 °C, the processor can fail in an unpredictable manner, so this fault is recommended as a shutdown. The Current Limiting based on temperature will effectively make the output "limp" by reducing the drive current to zero.

Failure levels: >125 °C
Persistence: 650 ms
Hysteresis: 5 °C (<120 °C to clear)

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will go limp if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

Position Error

Position Error detection logic will indicate a difference between commanded position and actual position exceeded for longer than the set delay. The error magnitude and duration are customer-configurable parameters.

Failure levels: Set by customer variable, Error > |PosErrorMax|
Persistence: Set by customer variable, Position Error Delay.
Hysteresis: none
Override: Whenever the current is being limited to a factor of 1/2 normal maximum or less. This would be because of high temperature (see section on Temp Sensing and Current Limiting) or a shutdown that causes the output to go "limp".

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

Relay Output Shorted

The relay driver is thermally protected against wiring errors. If incorrectly wired, the output will turn off and then set the Error Bit.

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

PWM Input Failed (Position Demand Failed)

PWM Input Failed is only active when the position demand is configured for 'PWM'.

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

Failure levels: >97% Duty and < 3% Duty
Persistence: 250 ms
Hysteresis: 1% (<96% or >4% to clear)

0.5 V Analog (Aux2) Input Failed (Position Demand Failed)

Analog (Aux2) Input Failed is only active when the position demand is configured for '0.5 V'.

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

Failure levels: >4.8 V and < 0.2 V
Persistence: 650 ms
Hysteresis: 0.05 V (<4.75 V or >0.025 V to clear)

Run Enable Shutdown

Run Enable discrete input is opened, only active when this input is configured for use.

This is a hard-coded shutdown. The control will go limp if this condition is detected.

Chapter 3.
Installation

Introduction

This chapter provides instructions on how to mount and connect the L-Series controller into a system. Hardware dimensions are provided for mounting the device to a specific application.

WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

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

AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

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

WARNING

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

CAUTION

The L-Series is used on engines that typically have a high noise level. Always use appropriate hearing protection while working around the L-Series.

CAUTION

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

NOTICE

Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figure 3-4).

General Installation, Operation Notes and Requirements

WARNING

Use an independent device for positive shutdown, such as a fuel shut off valve is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

Use of an external spring to return to minimum fuel is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

Use of a predicted min fuel shutdown procedure is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

Unpacking

Be careful when unpacking the actuator. Check the unit for signs of damage, such as bent or dented panels, scratches, and loose or broken parts. Notify the shipper and Woodward if damage is found.

Mechanical Installation

Mounting Location

Locate the L-Series control a distance from sources of extreme radiant heat, such as exhaust manifolds or turbochargers. The operating temperature range of the control is –40 to +105 °C (–40 to +221 °F). In spark-ignited applications, make sure the L-Series is located away from the ignition coil, and that harness wires are not routed next to the spark plug wires.

Mounting Orientation

While it is not a requirement, it is good practice to orient the connector feature on the control in a horizontal or downward orientation to minimize fluid accumulation between the enclosure and the mating connector's gasket.

Actuator Configuration

The L-Series actuator utilizes a 2" (51 mm) square mounting bolt pattern and is intended to fit within an envelope of 2.618 x 2.618 x 2.540 (66.50 x 66.50 x 64.52 mm) with the short dimension along the shaft axis. Two shaft seal configurations are available, an internal lip seal and an external lip seal with spring backup (Figure 3-2). In addition, six independent output shaft configurations are available (Figure 3-3). Consult Woodward Applications Engineering for the application appropriate seal and shaft configuration.

Mounting Hardware

Use #10 or M5 fasteners to attach the L-Series control to the mounting bracket. The bracket and attaching hardware must be designed to hold the weight and to withstand the vibration associated with prime mover mounting. Use the appropriate fasteners for securing the mounting bracket to the engine.

WARNING

The installer of the L-Series must take responsibility for meeting Clause 26.4.2 of EN60079-0 (Ed. 6 or 7) regarding impact testing. The actuator by itself does not meet this requirement and therefore must be sufficiently protected when installed. See Chapter 2, Mechanical Installation, for more details.

IMPORTANT

The actuator should be protected from exposure to sunlight and rain.

⚠WARNING

Leak-check all gaseous fuel connections. Leaking gaseous fuel can cause explosion hazards, property damage, or loss of life.

⚠WARNING

The L-Series ITB valve should be used in a well-ventilated area. A methane detector should be used if the valve will be used in an enclosed installation.

⚠CAUTION

The L-Series ITB represents a pinch hazard with the power connected or disconnected. The internal return spring keeps the valve loaded closed. To prevent bodily harm or injury, keep all hands, fingers, etc. away from the valve element at all times.

NOTICE

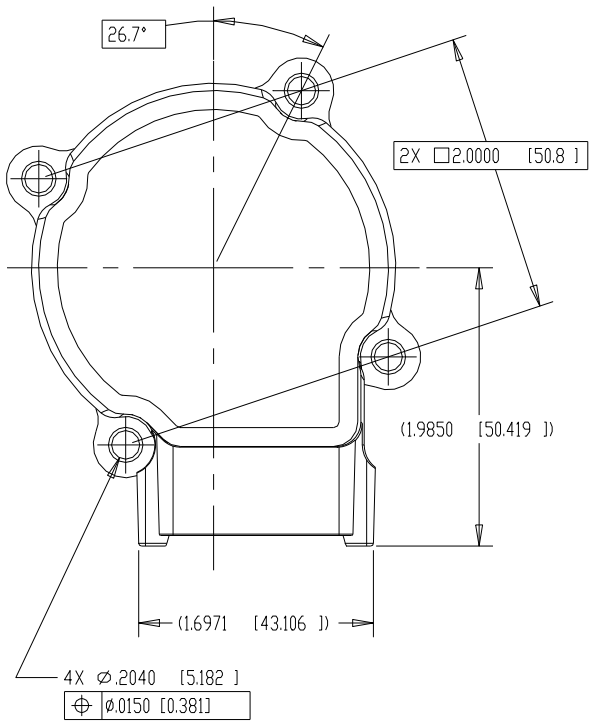
The L-Series actuator output shaft is integral to the unit's accuracy and performance. Take special care to prevent damage to the output shaft or ITB bore. Do not use a sharp or metallic object to open the ITB.

NOTICE

Secondary retention of the bolts should be utilized. Consult the OEM regarding retention methods.

⚠WARNING

The L-Series ITB is not intended to support the inlet or outlet piping. A suitable bracket must be constructed to support the valve and piping separately to prevent damage to the throttle body.



NOTES:

1. MOUNTING HARDWARE TO BE SOCKET HEAD CAP SCREWS -- #10(.190)-24, M5, OR EQUIVALENT. NO WASHERS TO BE USED. RECOMMENDED SCREW TORQUE = 35 IN-LB [4 N-M].
2. FOR BRACKET-MOUNT APPLICATION, A BRACKET OUT-OF-FLATNESS OF .010 [0.25] MAXIMUM IS RECOMMENDED.
3. FOR CONNECTOR INFORMATION, REFER TO CONNECTOR TABLE AND APPROPRIATE WIRING DIAGRAM.
4. USE OF INTERNAL ACTUATOR STOPS IN APPLICATION NOT RECOMMENDED. TORQUE AGAINST STOPS NOT TO EXCEED 200 IN-OZ.
5. DIMENSIONS ARE SHOWN IN INCHES [MM].
6. DETAILS SHOWN HERE ARE COMMON TO ALL ACTUATOR ASSEMBLIES. HENCE, NEITHER COVERS NOR SHAFTS ARE SHOWN IN THESE VIEWS. SEE COVER AND SHAFT DETAILS ELSEWHERE IN THIS MANUAL.

INTEGRATED DEUTSCH CONNECTOR (REF: DT04-12PA)		
ITEM	*RECOMMENDED*	*OPTIONAL*
MATING CONNECTOR	DT06-12SA-P012	DT06-12SA
SECONDARY LOCK	W12S-P012	W12S
SOCKETS	0462-201-16141	0462-201-16141
WIRING HARNESS STRESS RELIEF SUPPORT	WITHIN 16 INCHES FROM CONNECTOR	
NOTE: IN THE EVENT A WIRE IS NOT USED FOR EACH OF THE 12 PINS ON THE CONTROL, A DEUTSCH 114017 PLUG MUST BE USED IN PLACE OF EACH MISSING WIRE TO ENVIRONMENTALLY SEAL THE CONTROL.		

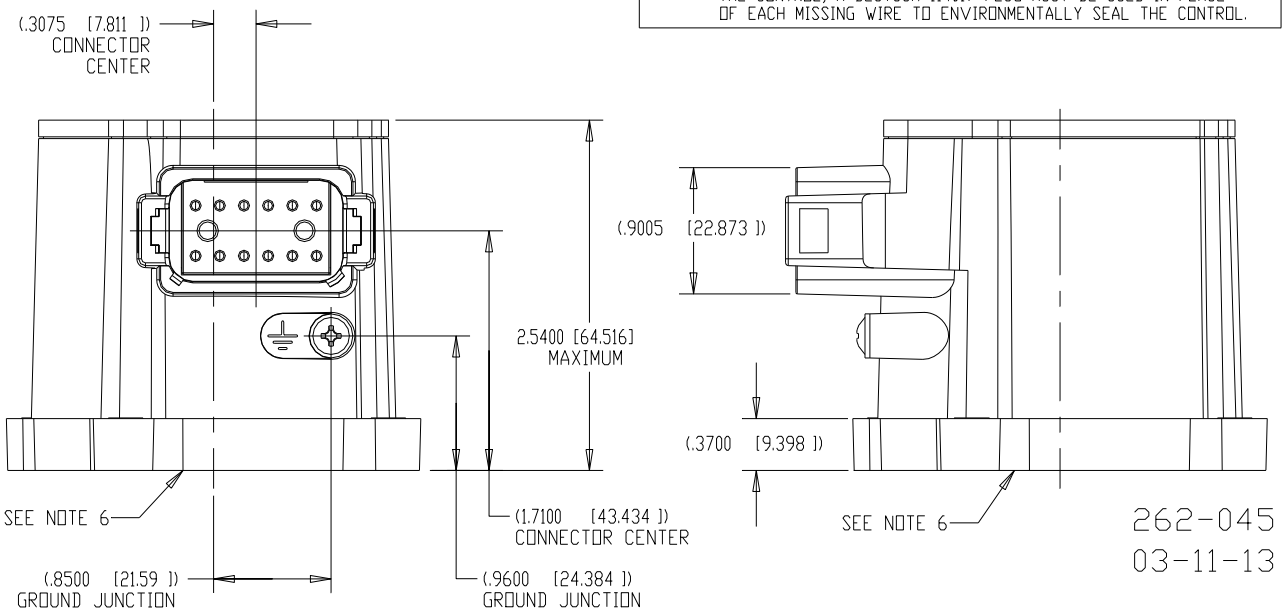


Figure 3-1. L-Series Outline Drawing

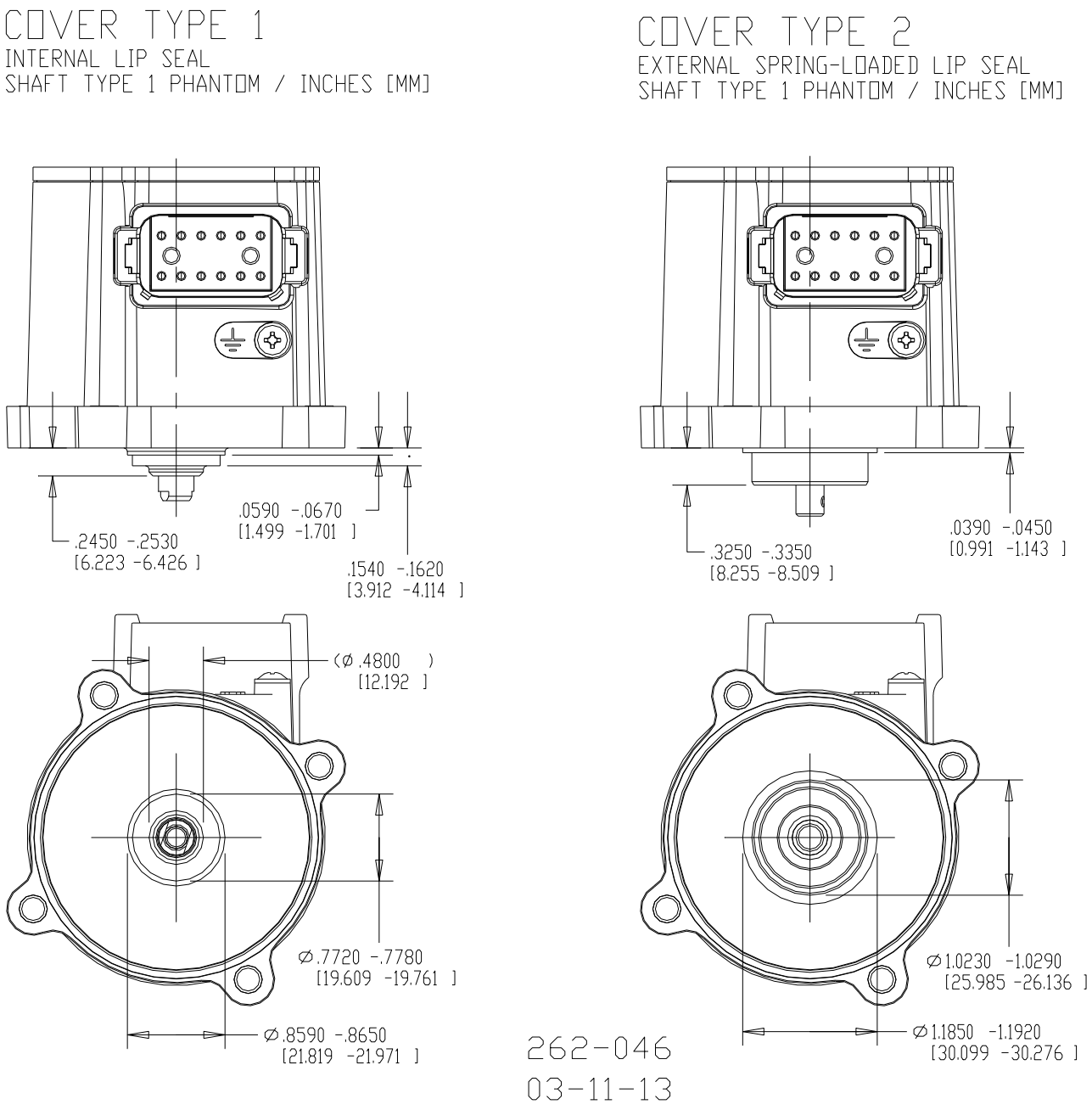


Figure 3-2. L-Series Cover Types

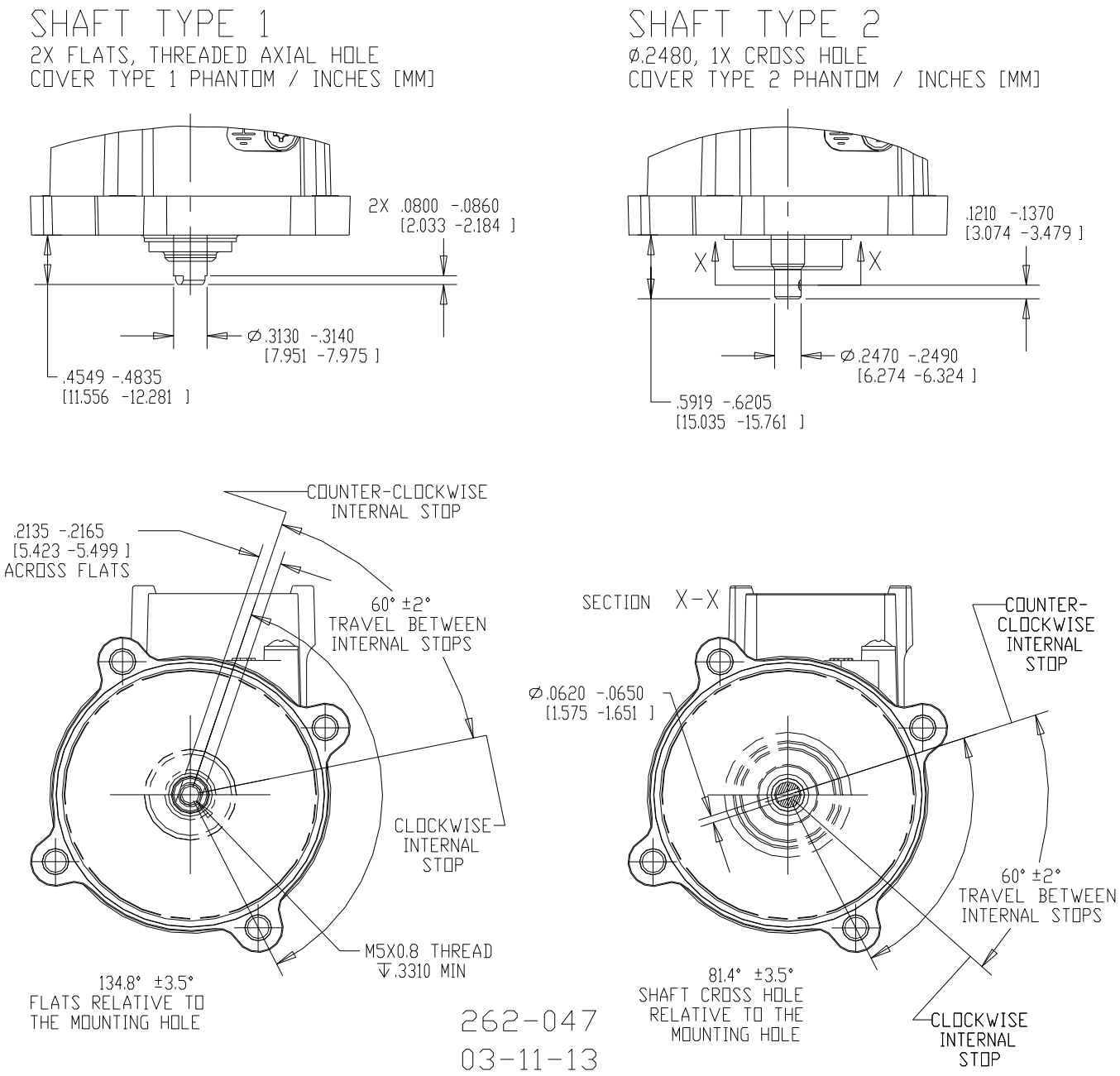


Figure 3-3a. L-Series Shaft Types

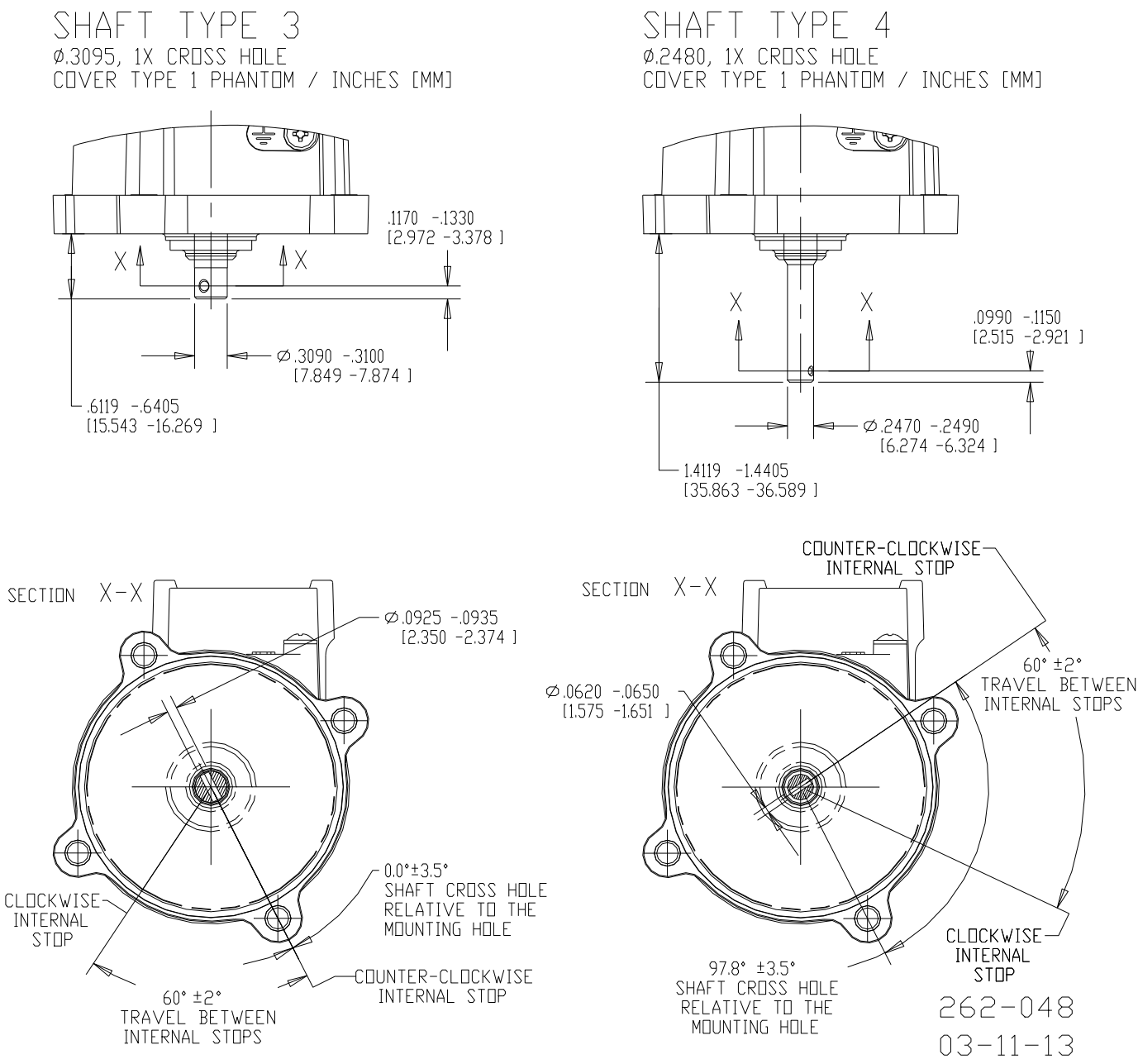


Figure 3-3b. L-Series Shaft Types

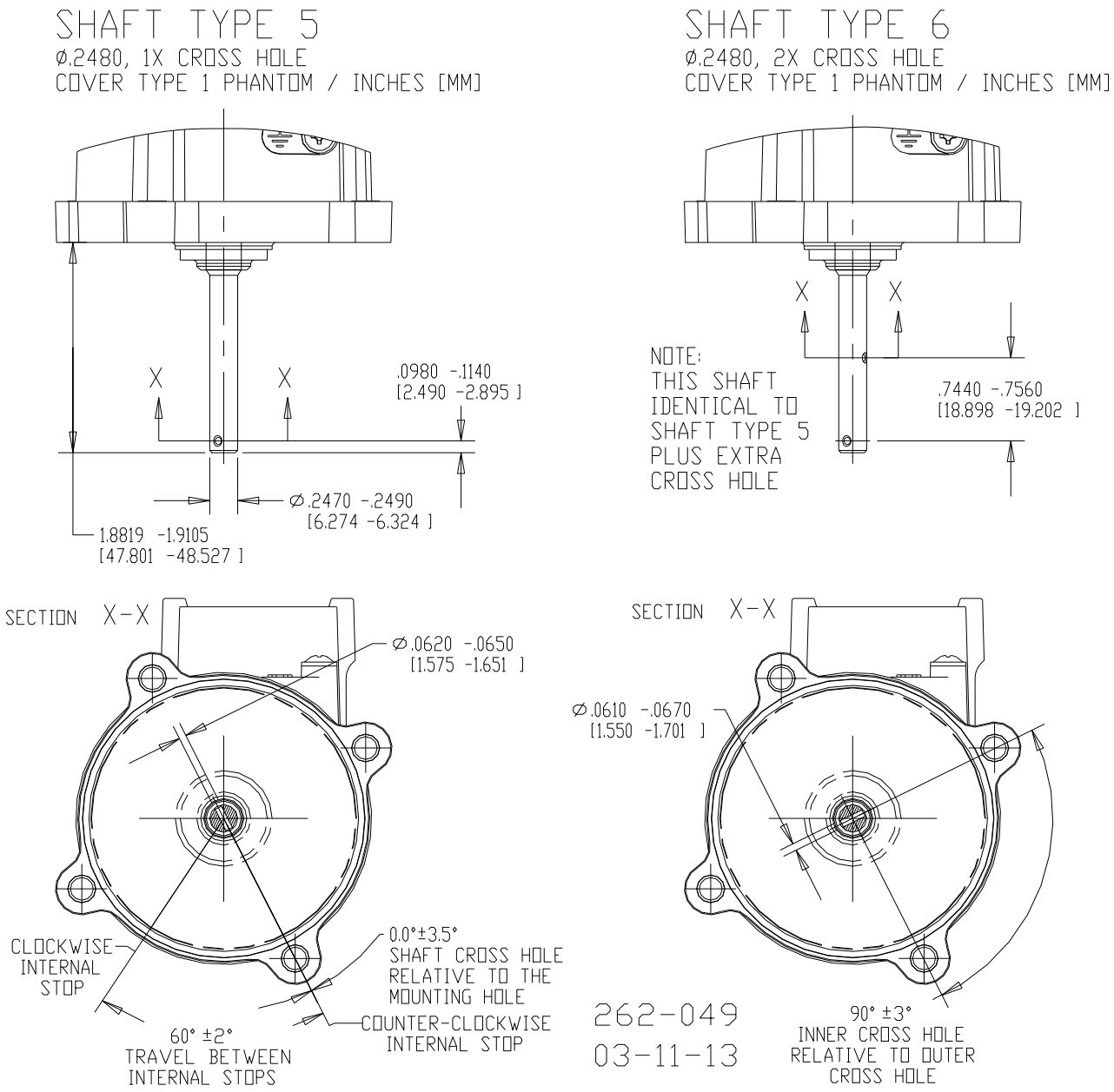


Figure 3-3c. L-Series Shaft Types

Electrical Installation

A wiring pinout of the L-Series control, as viewed by looking into the control's connector feature, is shown in Figure 3-4. Typical connections to external devices are also shown.

The L-Series has an operating voltage range of 8 to 32 Vdc with nominal voltages of 12 or 24 Vdc. The power supply is reverse polarity protected, and consumes 32 W maximum power at a peak current of 1 A (32 V) assuming 4 Ω stator resistance at 25 °C. These assumptions are based on the fact that the software limits the power to the rotary actuator to 25 W at any given time and input voltage (in the valid range). The control system should be protected with a 6 A slow-blow fuse in the voltage supply lines. Typical max average current is 2.1 A, or max 25 W at 12 V. The application should be configured to turn on power to the actuator when the engine is first cranked.

Electrical Connections

WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

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

AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

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

Prior to installation, refer to the wiring diagrams and the representative I/O interfaces schematic in this chapter. Also, review the hardware I/O specifications in Appendix C.

WARNING

The control will only meet ingress protection specifications while the Deutsch connector is installed in the unit. As such, the unit should not be exposed to operating environments unless the mating connector is installed. In addition, if a wire is not used for each of the 12 pins on the control, a Deutsch 114017 plug must be used in place of each missing wire. Failure to adhere to these guidelines may result in product failure or decreased life.

IMPORTANT

Use 1 to 1.5 mm² (16 to 18 AWG) stranded copper wire with insulation that meets temperature requirements in the harness design. A wiring harness stress relief within 400 mm (16") of the control's connector is recommended. Limit all I/O and signal lines to less than 30 m (98 ft). Also limit input power (B+/B–) connections to an earth grounded battery or conditioned power interface to less than 10 m (33 ft) from the L-Series product.

WARNING

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

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

IMPORTANT

A conditioned power interface is an interface which offers equivalent common mode and differential mode conditioning of that of a grounded 24 V lead acid battery.

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

Connector

The following Deutsch connector components are recommended for harness designs:

	Recommended	Optional
Mating Connector	DT06-12SA-P012	DT06-12SA
Secondary Lock	W12S-P012	N/A
Sockets	0462-201-16141	0462-201-16141

Woodward part number 8928-396 is a kit that provides all the necessary Deutsch components.

IMPORTANT

Crimping methods for the Deutsch connector pins must be followed as prescribed by the manufacturer. Woodward is not responsible for damage or loss of performance resulting if any other method of crimping is used. Use of the listed part numbers of Deutsch connector components is strongly recommended.

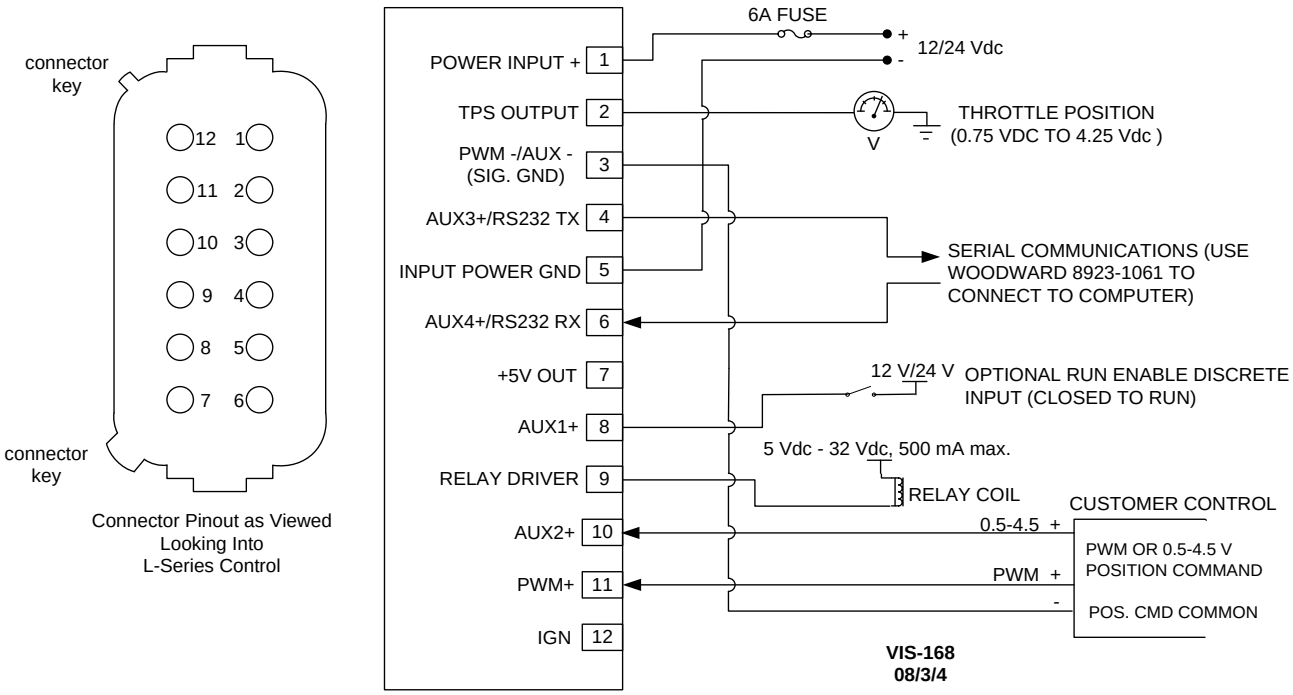


Figure 3-4. Typical L-Series Position Control Application Wiring

Table 3-1. Connector Pins

Connector Pin #	Description	Comment
1	+12V/24 Vdc Input Power	Supply power
2	TPS Signal Output	Direct position feedback output indication
3	PWM – / AUX –	Ground for the PWM or AUX command signal common
4	RS-232 transmit	For use with the service tool
5	Input Power Ground	Ground for the 12 V/24 V input power
6	RS-232 receive	For use with the service tool
7	5 V Out	Power for external sensors (10 mA max)
8	Aux Input 1	Optional Run Enable discrete input
9	Relay Driver Output	Status signal and fault detection output
10	Aux Input 2	0–5 V command signal input
11	PWM +	PWM command signal input
12	Ignition Input	Not used—Leave open

Description of Electrical I/O

Representative circuitry for the L-Series inputs/outputs is provided in Figure 3-5 below.

Power Supply Input (+12 Vdc/24 Vdc at pin 1, ground at pin 5)—The L-Series is configured for 12 or 24 V nominal operation, although it will handle 8–32 V. The power supply terminals are reverse polarity protected, and in the case that a reverse polarity condition exists, the L-Series actuator will not power-up and will remain at the minimum stop if attached to a throttle body with an internal return spring.

Woodward recommends using a 6 A slow-blow fuse on the power supply line feeding pin 1 of the L-Series actuator.

WARNING

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

PWM Command Input (+PWM at pin 11, PWM ground at pin 3)—This actuator can be configured to handle a PWM signal from a high-side or low-side open-collector or open-drain source, as well as from a push-pull (customer pull-up) source. The necessary pull-up and pull-down voltages to accommodate the open-collector sources are handled within the L-Series actuator. Nominally, the frequency of PWM is 1 kHz, but it will handle the full range of 300 to 1500 Hz. See Figure 3-5 below, which describes the possible input types and configurations for the PWM input.

IMPORTANT

This actuator can also be commanded using an analog signal of 0–5 V. See the description below for the auxiliary input pins. AUX2 is used as the analog command input. The PWM and AUX2 input pins should not be tied together.

RS-232 Connections (pin 4 and pin 6)—These pins are for serial communication with the L-Series actuator. An external RS-232 transceiver is necessary to make communications possible with the Woodward L-Series Service Tool. A connectivity kit can be purchased from Woodward to accomplish this. Further instructions for using this connectivity kit are provided in Chapter 4. See also the description below on Auxiliary Inputs.

TPS Output (pin 2, referenced to either pin 3 or pin 5)—This pin feeds the output of the Hall effect position sensor to the terminal wiring. The output range of this pin should be approximately 0.75 Vdc when the actuator is full counterclockwise (when viewed at the end of the shaft), and approximately 4.25 Vdc when the actuator is at full clockwise. This gives the end user an indication of throttle position.

IMPORTANT

The TPS output is meant for an approximate indication of shaft position only. The unconditioned output accuracy must be considered when using this signal externally. Refer to the specification for TPS accuracy.

WARNING

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

WARNING

Do not try to inject signals *into* the TPS output, as it will negatively impact the performance of the L-Series actuator. This output is meant to be used with a high impedance device, such as a voltmeter. Do not tie pin 2 directly to battery or ground. If the application does not use this output, leave it open.

For this type of PWM Source... **...the L-Series PWM Input looks like...**

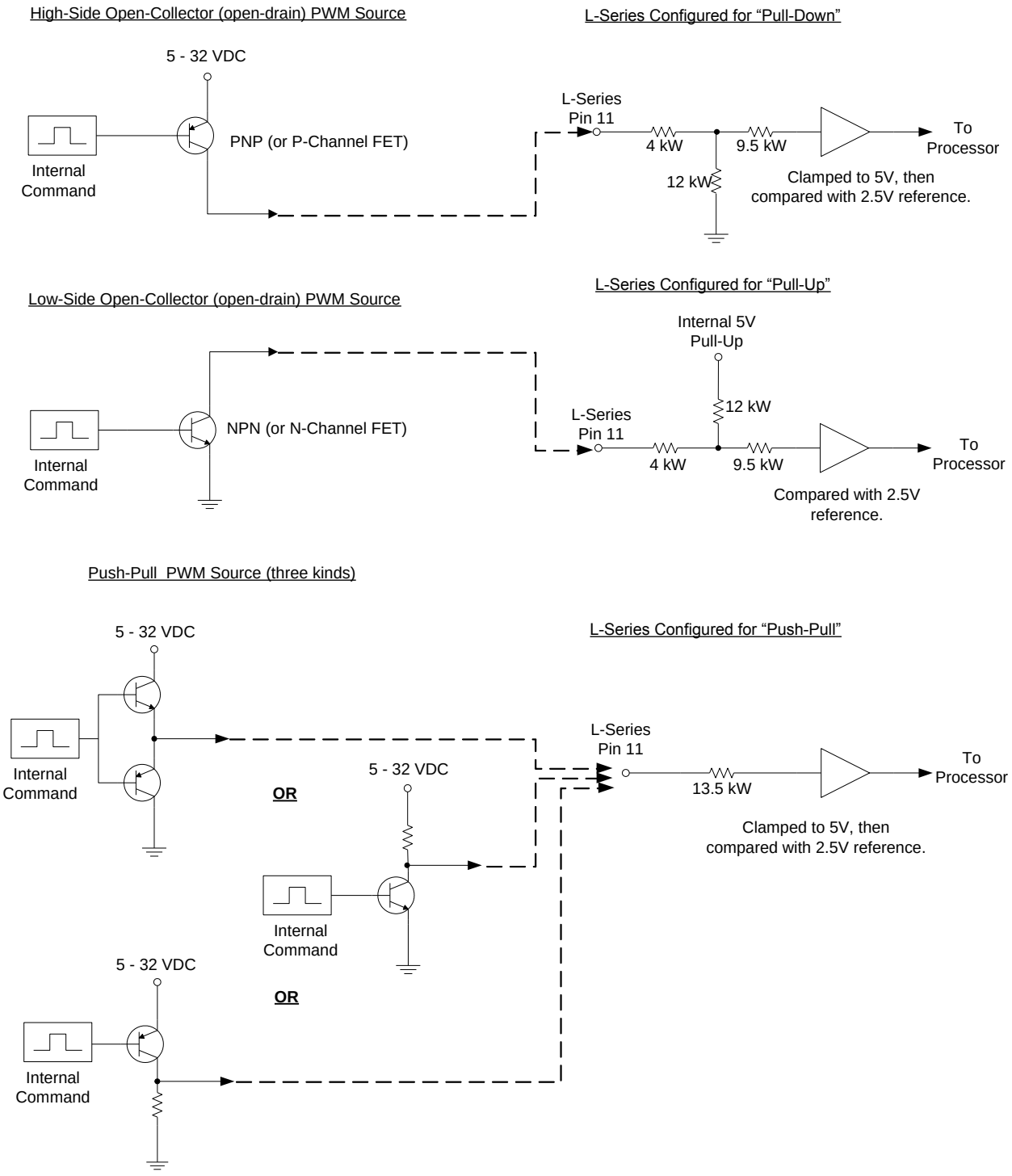


Figure 3-5. Acceptable PWM Input Types

Relay Driver Output (pin 9)—This pin provides the end user with a means for detecting a fault or shutdown condition that is experienced by the L-Series actuator. It is a low-side driver capable of sinking 250 mA (not to exceed 500 mA) through an external load such as a lamp or relay. This circuit is internally protected against over-current conditions and inductive flyback, such as from a relay coil. By default, this circuit will be configured in a failsafe manner, meaning it will be active (conducting) when no fault exists, but if power is lost or a fault is detected by the L-Series actuator, the circuit will open. See Figure 3-6 below for typical usage of this feature.

WARNING

It is recommended the Relay Output be configured for the failsafe 'Normally On' mode, to ensure maximum fault protection and annunciation. Failure to follow these guidelines could, under exceptional circumstances, lead to personal injury and/or property damage.

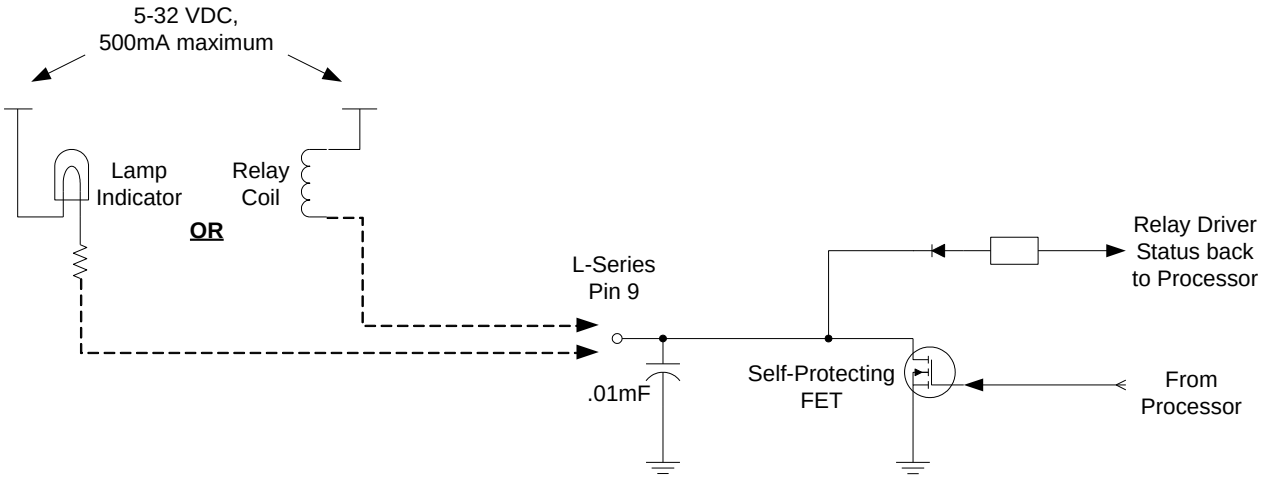


Figure 3-6. Relay Driver Output

5V Output (pin 7, referenced to pin 3)—The +5 Vdc Power Output is intended to power any external transducer that depends on a steady 5 V source. The maximum output current is 10 mA.

Auxiliary Inputs (pins 4, 6, 8, and 10)—The L-Series has three dedicated digital inputs (AUX2, AUX3, and AUX4) used to activate various features of the control. Shorting an auxiliary input pin to battery voltage activates it. Removing battery voltage from an input pin or shorting the pin to ground deactivates the input. If it is decided not to use battery voltage with the auxiliary digital inputs, it is recommended that at least 3 V be present on an input pin in order to change its state from inactive to active. All discrete inputs will be the same voltage as the system power supply and will be active only while the input is in a high state. For AUX2, AUX3, and AUX4, greater than 2.5 Vdc is considered high, and less than 0.8 Vdc is considered low. For the AUX1 discrete input only, the input must exceed 3 V to activate the discrete state. AUX3 and AUX4 are also used for digital communications such as RS-232 (service tool) or CAN (If the CAN option was purchased). RS-232 and CAN will NOT run simultaneously.

When used as a position control, AUX1 on the L-Series actuator can be configured as a run enable discrete input. This configuration must be specified in the configuration of the device using the Service Tool. If AUX1 is selected to perform the run enable function, then 5 V (5–32 V) applied to pin 8 will allow the control to run normally. When this input is opened, the actuator will be in stand-by mode. When in stand-by, the actuator driver will be disabled, and the shaft will be limp.

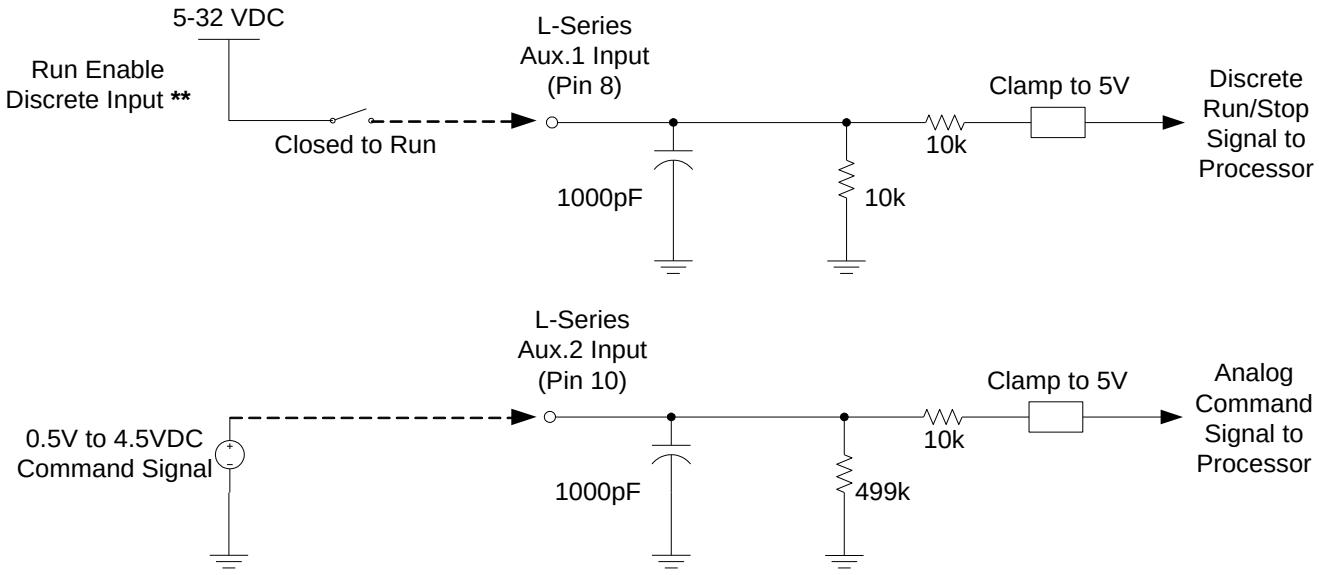
AUX2 can be used as a 0–5 V command signal for position control. The software must recognize that the unit is expecting an analog command as opposed to a PWM command. See Figure 3-7 below for typical usage of AUX1 and AUX2 when the L-Series is configured as a position control.

IMPORTANT

This actuator can also be commanded using a PWM signal. See the description above in the PWM Command Input section. The PWM and AUX2 input pins should not be tied together.

IMPORTANT

All connector pins are short-circuit protected to ground and power except pins 3 and 5, which are not protected against shorts to battery positive. Installation of a fuse on the power ground wire to pin5 would provide protection to these pins but does not mean one is not needed in the power connection. Pin 1 (B+) still needs protection against a short to ground.



** if optional external Run Enable is chosen during L-Series configuration, Aux. 1 can be used to enable or disable the actuator output shaft torque.

Figure 3-7. Typical AUX1 and AUX2 Usage

Ground Junction—This grounding junction is provided for joining external ground wires. THERE IS NOT AN INTERNAL CONNECTION TO CIRCUIT GROUND. Terminal pins 3 and 5 must be used for access to the circuit ground. This junction point is completely electrically isolated from the L-Series actuator's electronics, and is solely for convenience during installation.

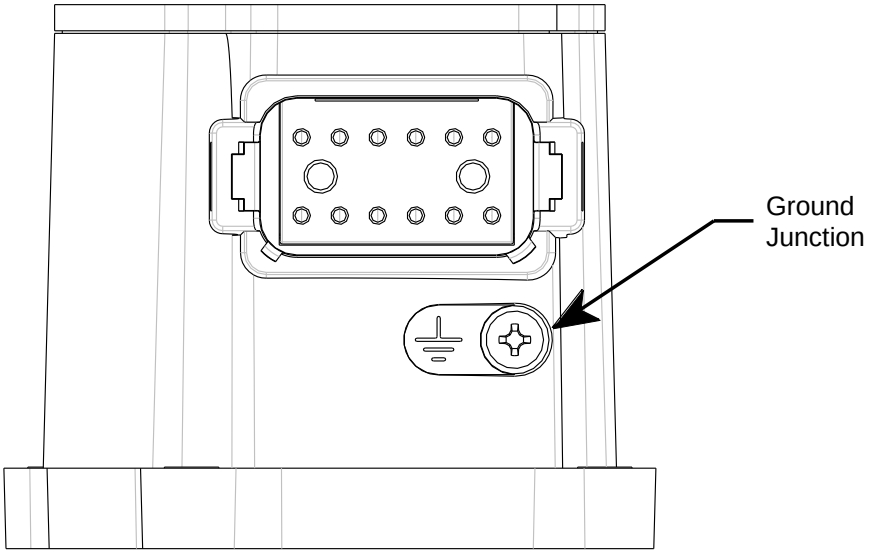


Figure 3-8. Ground Junction Point

Chapter 4.
Service Tool

Introduction

This chapter covers the process of tuning, configuring, calibrating, and servicing the control via the L-Series Service Tool. It is assumed that the control has already been installed on the engine.

IMPORTANT **Many applications are delivered pre-configured, calibrated, and tuned. These units do not require the use of the Service Tool.**

Description

The Service Tool software is used to configure, tune, and troubleshoot the L-Series controller. This chapter describes installation and use of the Service Tool. It identifies the parameters available that can be viewed. It also provides detailed information on configuring and setting up the L-Series to the customer-specific field application.

The Service Tool software resides on a PC (personal computer) and communicates to the L-Series through connector pins 4 and 6. An external
RS-232 transceiver is necessary to make communications possible with the Woodward L-Series service tool. A connectivity kit (Woodward # 8923-1061) can be purchased from Woodward to accomplish this.

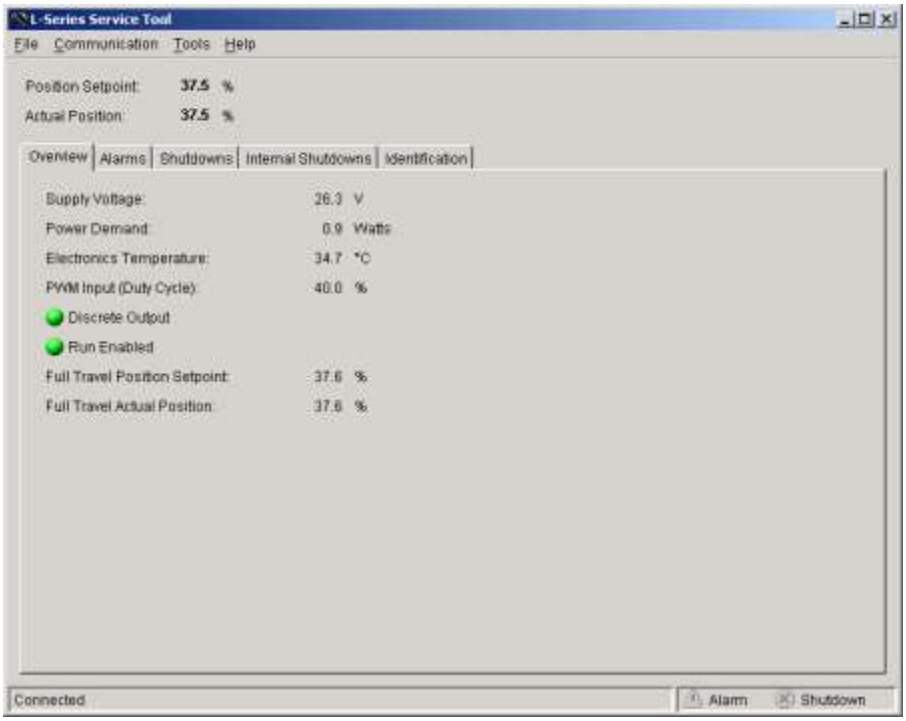


Figure 4-1. Example Service Tool Screen

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

- PC-compatible laptop or desktop computer* with at least one available serial communications port, and Windows 95/98/00/NT/Me/XP as the operating system.
- Programming/datalink harness as shown in Figure 4-2.

In addition to the hardware, the following are the distributions of tool software needed to communicate with the control:

- Woodward part number 9927-1222, L-Series Service Tool

NOTICE

There is a potential for serial port damage when communicating with the L-Series control. This is caused by a difference in ac voltage between neutral and earth ground. If the PC RS-232 port ground is referenced to ac neutral, and the L-Series control is referenced to battery ground (ac earth ground), a large amount of current can be experienced. To avoid this situation, we strongly recommend placing an isolation transformer between the ac outlet and the PC.

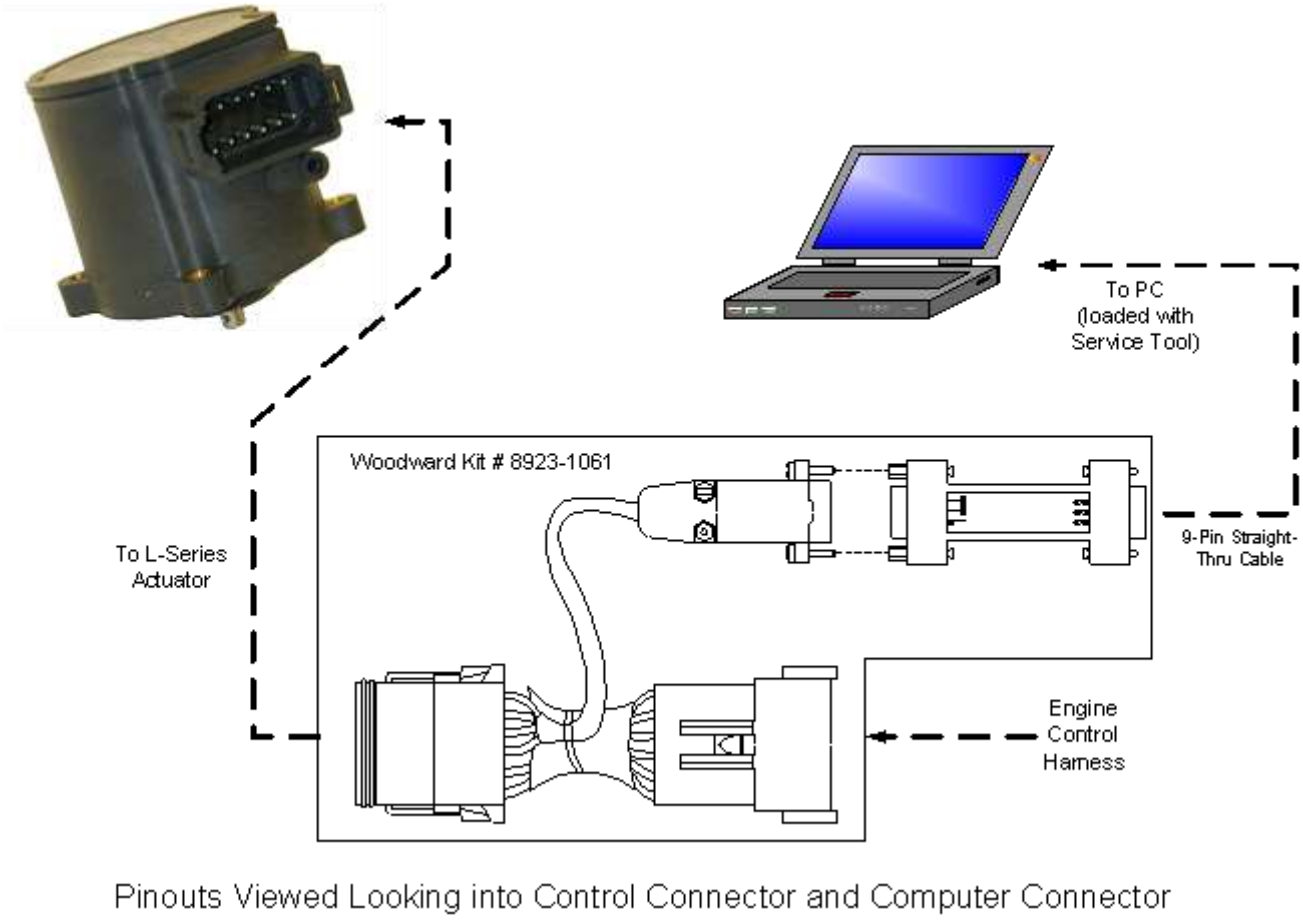


Figure 4-2a. Typical Programming Datalink Harness Wiring

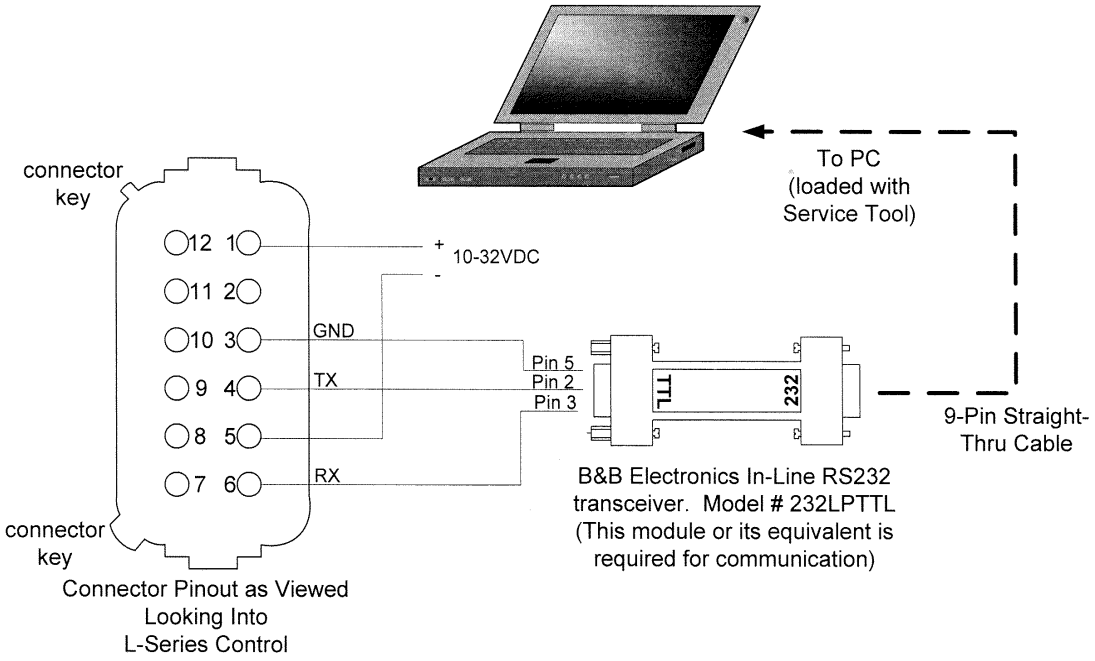


Figure 4-2b. Programming Harness Wiring

Getting Started

Installation Procedure

The Service Tool software can be downloaded and installed from the Woodward internet site (**www.woodward.com**).

WARNING

An improperly configured control could cause an overspeed or other damage to the engine. To prevent possible serious injury from an over-speeding engine, read and follow this entire procedure before starting the engine.

What to do next

After the software is installed, connect a serial communications cable between the RS-232 connections on the L-Series control and an unused serial port on your computer. Run the Service Tool program and select the appropriate comm port. Once connected to the control, the status bar will display ‘connected’ and the Service Tool screen will populate with monitor parameters.

WARNING

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

Service Tool Help

More help on using Service Tool is available and included with the installation of the Service Tool product. Service Tool Help can be accessed from the Service Tool ‘Contents’ drop-down window selection under the Help menu located on the Main Window.

Software Version Identification

The Service Tool software version can found by selecting ‘About’ under the Help menu. The L-Series software version can be found on the right-most tab sheet (Identification) of the Service Tool screen. The Service Tool and Control must be connected to view this information. Refer to this version information in any correspondence with Woodward.

Configuration Password

If a password has been saved in the configuration file, the file cannot be opened without first entering the password. Once a configuration with a password has been loaded into the L-Series driver, the control configuration cannot be opened without the password. All other service tool functions do not require a password including: writing over a password protected file configuration, writing over a password protected control configuration, using the Position Calibration Tool, and using the Edit Position PID.

L-Series Configuration

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

IMPORTANT

If using non-linear mode, control power must be cycled after loading a new configuration.

The current L-Series control configuration settings can be viewed at any time when connected to the control by opening the Configuration Editor (File/Open Control Configuration). See Figure 4-3.

A Configuration Summary worksheet is provided in Appendix Bf this manual to allow documentation of application configuration settings.

OEM Configuration File Data

The OEM can save configuration file specific data with the service tool by selecting Properties under the File menu pull down. This is a text field and can be used to store data such as:

- Customer
- Engine Type
- Application Type
- Notes

Configuring the Unit—On-Line

Unit configuration is summarized as follows:

- Open the Configuration Editor Dialog by selecting ‘File/Open Control Configuration’.
- Edit the configuration settings.
- Load the configuration to the L-Series control.

IMPORTANT

As changes are made to Configuration parameters, they are not used by the driver until a ‘load’ command is issued. Selecting the ‘Close Window’ box/button closes the Configuration Editor and does not make any changes to the driver.

Configuring the Unit—Off-Line

Unit configuration is summarized as follows:

- Open the Configuration Editor Dialog using the File/New or File/Open options.
- Edit the configuration settings.
- Save the configuration to a file. At a later date simply open the configuration and load it into the control.

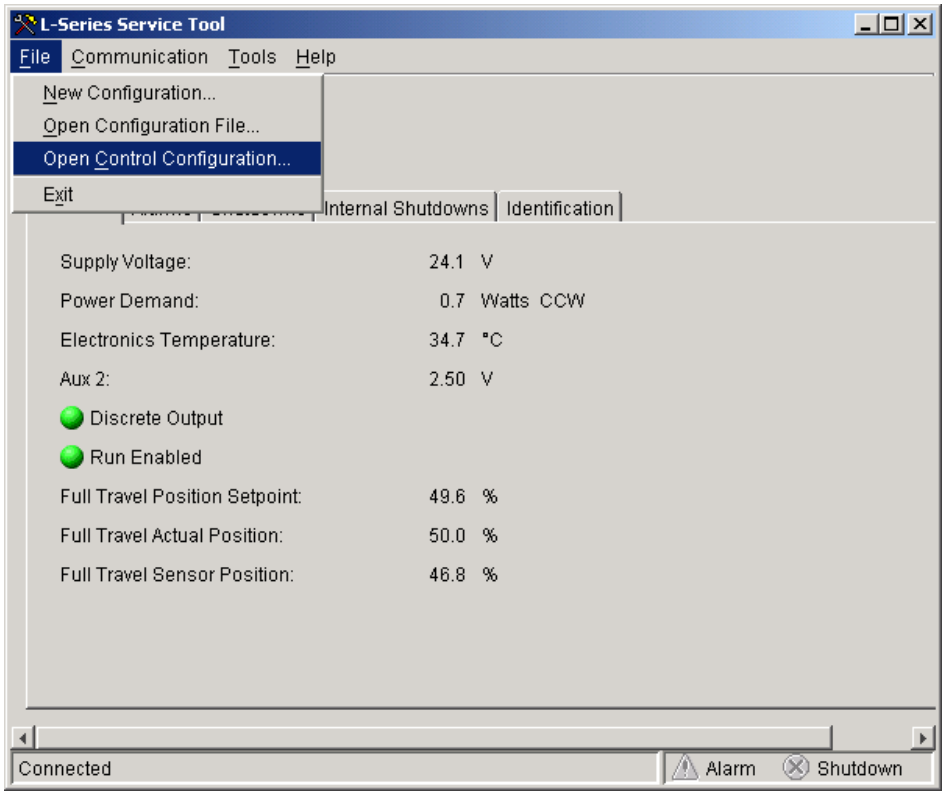


Figure 4-3. Configuration Selection Options

Configuration Parameters

There are three tab sheets that contain all the configuration settings: Overview, Discrete Output, and Alarm/Shutdown.

Overview Tab Sheet

Changing the Demand Source will modify the parameter settings available as well as the displayed indications within the Service Tool.

A description of each configuration parameter and its adjustment range is also available in the contents of the Service Tool Help.

Position Demand Source

The Position Demand Source can be set to one of the following:

0.5 V Selects an analog (0–5 V) position demand input.
PWM Selects a PWM position demand input.

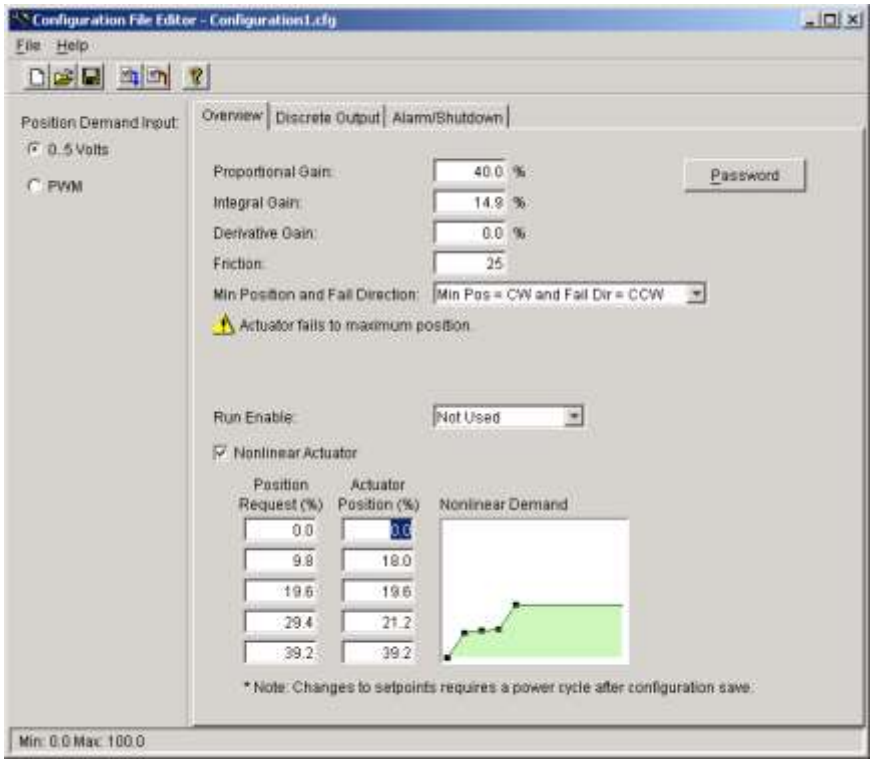


Figure 4-4. Configuration Editor—Analog Settings

Proportional Gain
Sets the position controller PID's proportional gain. Increased gain corresponds to increased PID output (higher proportional = faster response). This setting can also be dynamically adjusted using the PID Tuning screen. Allowed values: 0–100%.

Integral Gain
Sets the position controller PID's integral gain. Increased gain corresponds to increased PID output (higher integral = faster response). This setting can also be dynamically adjusted using the PID Tuning screen. Allowed values: 0–100%.

Derivative Gain
Sets the position controller PID's derivative gain. Increased gain corresponds to increased PID output (higher derivative = faster response). This setting can also be dynamically adjusted using the PID Tuning screen. Allowed values: 0–100%.

Friction/Dither Setting
Sets the position controller's friction and dither values. This parameter should be set to zero (no effect) while tuning the PID and then increased for optimum response. If unsure, a typical value would be 25. Allowed values: 0–100.

Min Position and Fail Direction
Sets the position controller direction. Also sets the shutdown failsafe direction. Allowed values: cw and ccw.

Non-linear Actuator
Selects either a Linear position command, when unchecked, or a Nonlinear 5-point curve command. Linear/Nonlinear refers to the relationship between the position requested and the position commanded to the position PID. When this box is checked, additional parameters appear to set up the 5-point demand curve (Figure 4-4).

IMPORTANT **If the non-linear curve is changed, control power must be cycled.**

Position Request (%)
There are five breakpoint values that correspond to the position requested by the analog or PWM input signal. These values set up the curve inputs. Allowed values: 0–100%.

These values must maintain a monotonic increase in their values, in order from lowest to highest. Also, after the configuration is loaded into the control, power must be cycled on the control before the settings take effect.

Actuator Position (%)
There are five breakpoint values that correspond to the modified actuator position command. These values set up the curve outputs. Allowed values: 0–100%.

Analog (0.5 V) Settings
There are no additional settings when this mode is configured.

PWM Settings
Two additional configuration parameters appear when the position demand is set to PWM (see Figure 4-5).

PWM Pull Up Select
Selects the appropriate PWM source. This configures the L-Series input internally to provide the proper pull-up logic. For details on selection of this parameter, refer to Chapter 3. Allowed values: Push-Pull, High Side Drive, or Low Side Drive.

PWM Offset
Sets the PWM Duty cycle offset. This setting is provided to compensate for duty cycle variations in PWM input frequencies, voltages, and types. Allowed values: –5.01 to +5.01%

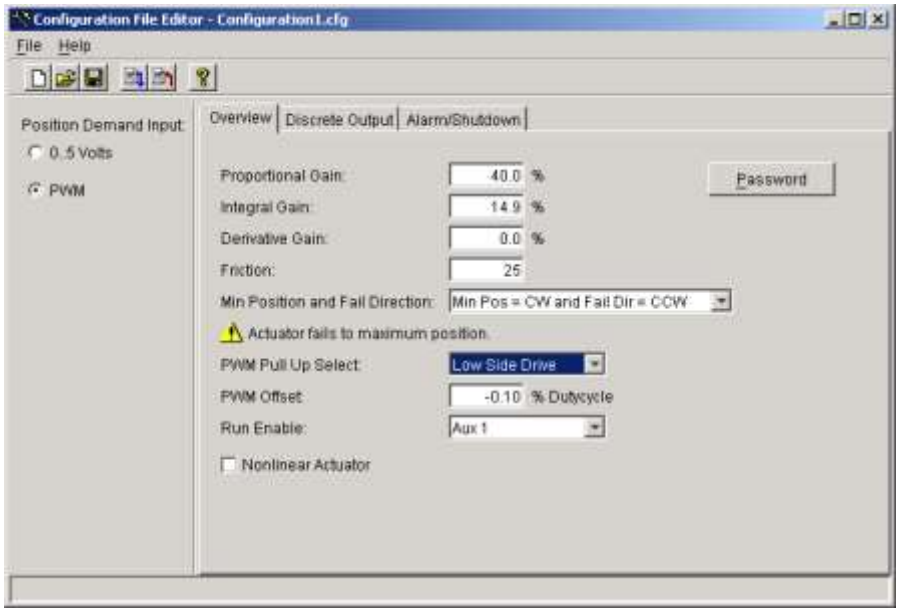


Figure 4-5. Configuration Editor—PWM Settings

Discrete Output Tab Sheet

This screen contains the discrete output configuration settings. If the discrete output is not used, then these settings can be skipped.

Relay Output Configuration

The relay output can be configured to one of the following:

Normally On Sets the relay driver to a normally on mode that turns off for any of the faults selected. This is the preferred, failsafe output configuration.

Normally Off Sets the relay driver to a normally off mode that turns on for any of the faults selected.

WARNING

It is recommended that the Relay Output be configured for the failsafe 'Normally On' mode, to ensure maximum fault protection and annunciation. Failure to follow these guidelines could, under exceptional circumstances, lead to personal injury and/or property damage.

Relay Output Fault Selections

The list of faults displayed can be individually selected to activate the relay output. Any of the selected faults will either turn the output off if configured for Normally On or turn the output on if configured for Normally Off.

WARNING

It is recommended that all faults be configured to activate the discrete output, this ensures maximum fault annunciation.

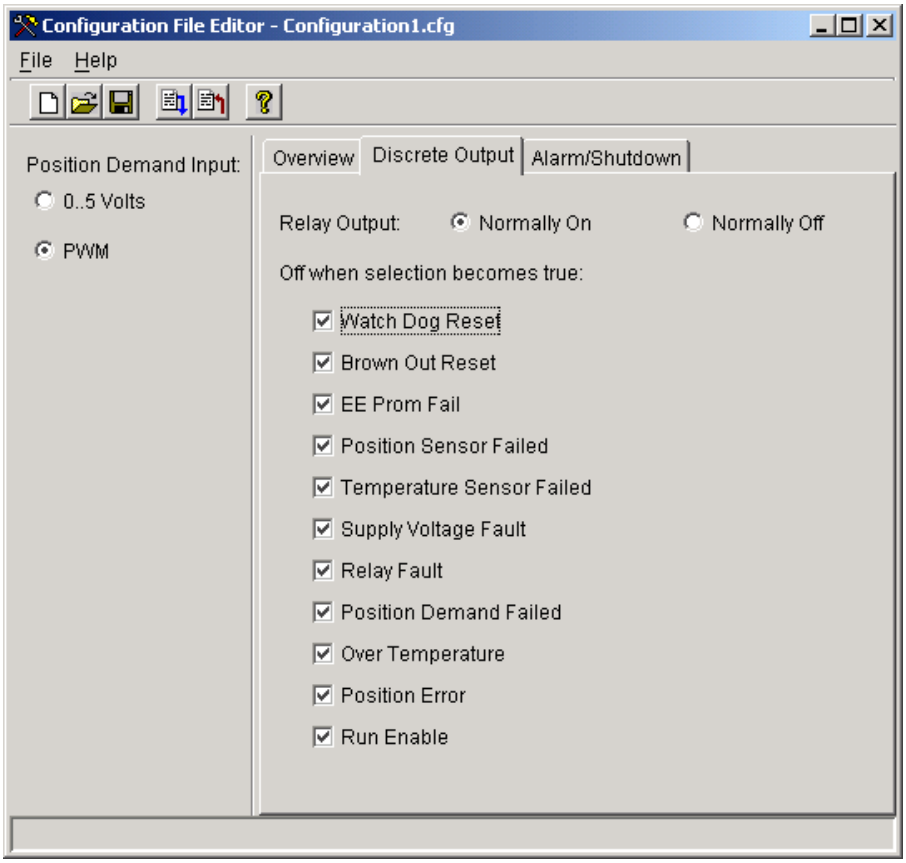


Figure 4-6. Configuration Editor—Discrete Output Settings

Alarm/Shutdown Tab Sheet

This screen contains the alarm and shutdown configuration settings.

Shutdown/Alarm Fault Selections

The list of faults displayed can be individually selected to either perform a Shutdown or just Alarm (no action).

WARNING

It is recommended that all faults be configured as shutdowns and selecting 'Enable Fault Latching', this ensures maximum fault protection. Failure to follow these guidelines could, under exceptional circumstances, lead to personal injury and/or property damage.

Enable Fault Latching

This setting determines whether the faults are latching or non-latching. When set to latching, a reset command is required to clear the fault.

Position Error Maximum (%)

Maximum deviation between the actual position and the position command. If the Error is exceeded for longer than the Position Error Delay, then the Position Error fault is annunciated. Allowed values: 0–100%.

Position Error Delay (sec)

There are 5 breakpoint values that correspond to the modified actuator position. Allowed values: 0–10 seconds.

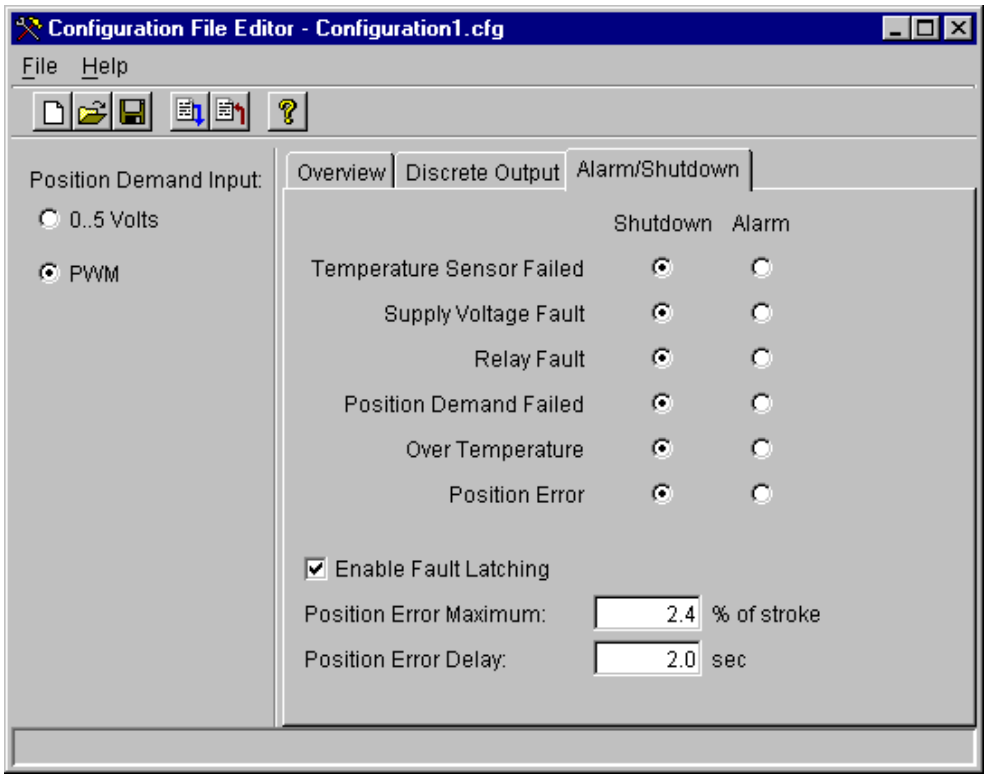


Figure 4-7. Configuration Editor—Alarm/Shutdown Settings

Loading the Configuration (Save)

Select the File/Load to Control from the menu or Blue Arrow icon on the Configuration Editor to load the changes into the control.

Monitoring the Driver

The Service Tool has five different tab sheets to monitor driver parameters. The tab sheet screens include:

- Overview (Figure 4-8)
- Alarms (Figure 4-9)
- Shutdowns (Figure 4-10)
- Internal Shutdowns (Figure 4-11)
- Identification (Figures 4-12)

Each screen displays the position setpoint and actual position values.

Position Setpoint
Displayed value of the position demand, in percent.

Actual Position
Displayed value of the actual position, in percent.

Status Bar Indications
At the bottom of the Service Tool window is a status bar. The status bar has two sections. The bottom left section displays communication status and bottom right section displays alarm & shutdown status.

Communication Status
This section of the status bar shows the status of communication between the service tool and the L-Series Driver. For more information, see Establishing Communication.

- **Connected**—The Service Tool is connected to and communicating with the driver.
- **Not Connected**—The Service Tool is not connected to the driver.
- **Connecting**—The Service Tool is attempting to connect to the driver. This message is displayed when Connect is selected from the Communications menu or when attempting to re-establish communication to the driver. If the connection is lost it will continuously attempt to re-connect.

Alarm Status
One or more alarms on the Alarms screen is active.

Shutdown Status
One or more shutdowns on the Shutdowns or Internal Shutdowns screen is active.

Overview Parameters Screen

To monitor the overview parameters, go to the Overview page on the main window.

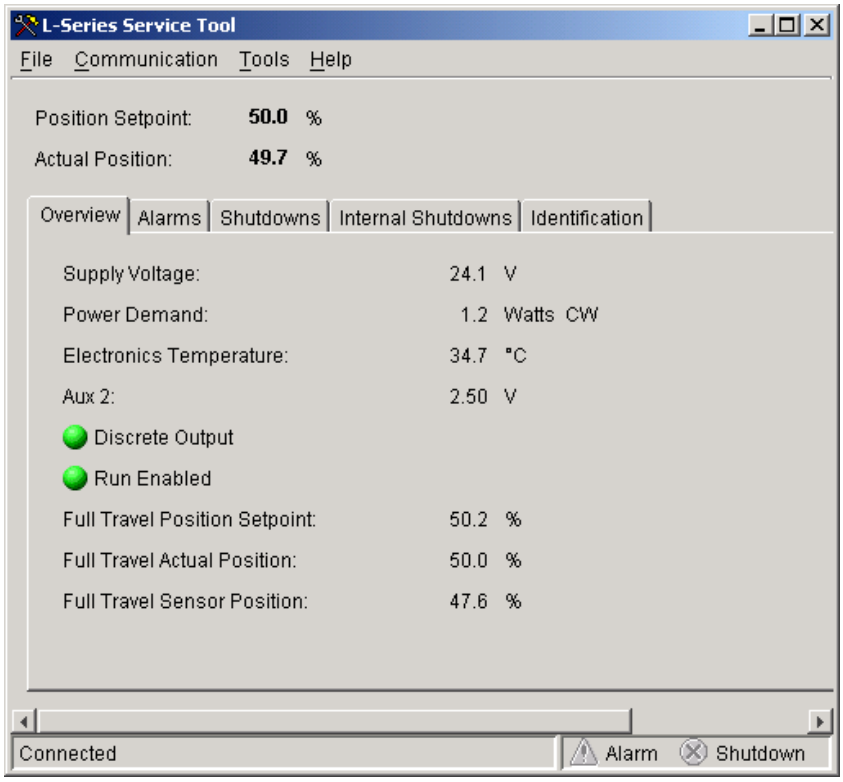


Figure 4-8. Service Tool—Overview Tab

Supply Voltage
Displayed value of the input power, in volts, as read by the processor.

Power Demand
Displayed value of the power demanded, in watts, as read by the processor. This is an indication of the work output.

Electronics Temperature
Displayed value of the electronics temperature sensor, in degrees Celsius, as read by the processor. The temperature sensor is physically located between the electronics module and the LAT motor.

PWM Input (Duty Cycle)
Displayed value of the PWM input, in percent duty cycle. This indication is displayed only when the position demand is set to ‘PWM’.

AUX2 Input
Displayed value of the analog 0–5 V input, in volts. This indication is displayed only when the position demand is set to ‘0.5 V’.

Discrete Output
On/Off status of the discrete output command. The indicator is illuminated when the channel is commanded to ON and grayed-out when the command signal is OFF.

Run Enabled
Open (off) / Closed (on) indication of the Run Enable discrete input.

Full Travel Position Setpoint
Indication of the position setpoint in terms of total overall unit travel. Useful if a less than full-travel user-calibrated range is used.

Full Travel Actual Position
Indication of the actual position in terms of total overall unit travel. Useful if a less than full-travel user-calibrated range is used.

Full Travel Sensor Position
Indication of the position in terms of total overall unit travel before linearization. This value will match the TPS output.

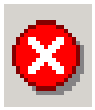
Shutdown and Alarm Indications

The Shutdown and Alarm screens display the status is both active and logged fault conditions. The logged indications provide a history of events even after the unit has been power-cycle of run again.

 Indicates a logged alarm condition.

 Indicates an active alarm condition.

 Indicates a logged shutdown condition.

 Indicates an active shutdown condition.

An active fault is one that is currently active or latched in the control. The latching/non-latching faults configuration setting factors into this indication. If the fault is latching, then an active fault could either be one that is still present or one that occurred but has not been reset. Latched faults can be cleared by cycling power on the L-Series control or by selecting the ‘Reset Alarms and Shutdowns’ button on any of the Alarm or Shutdown screens.

A logged fault is one that occurred but is no longer currently active or latched in the control. Logged faults are permanently cleared by selecting the ‘Reset Logged Alarms and Shutdowns’ button on any of the Alarm or Shutdown screens.

Alarms Screen

To monitor the alarm conditions, go to the Alarms page on the main window. The values displayed on this screen dynamically change with the fault configuration. Refer to chapter 2 for a complete listing and details of all the faults.

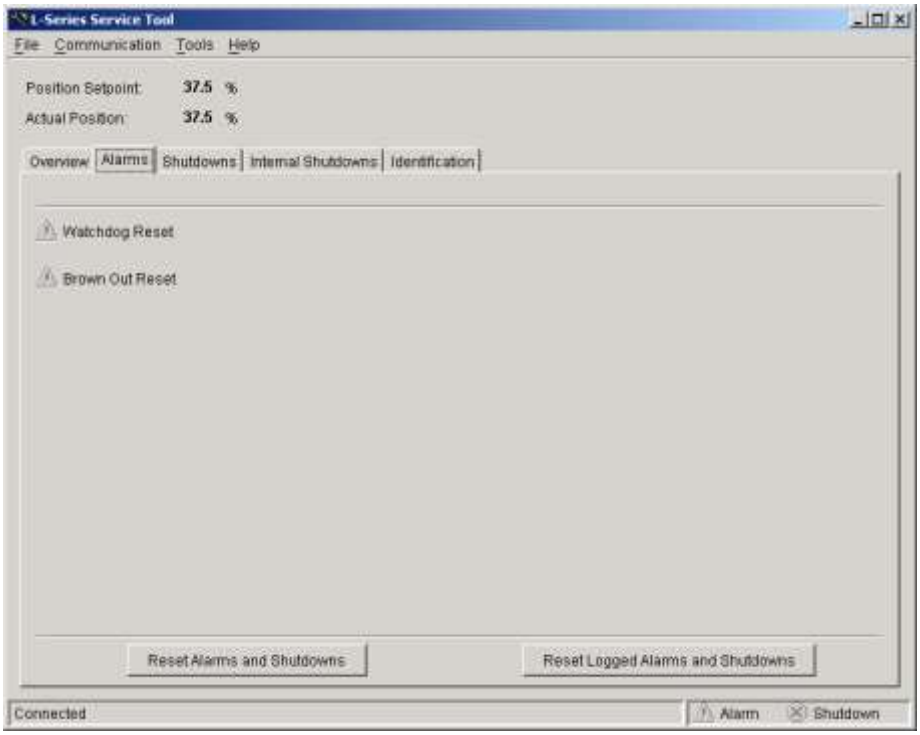


Figure 4-9. Service Tool—Alarms Tab

Shutdowns and Internal Shutdowns Screens

To monitor the shutdown conditions, go to the Shutdowns and the Internal Shutdowns pages on the main window. The values displayed on the Shutdowns screen dynamically change with the fault configuration.

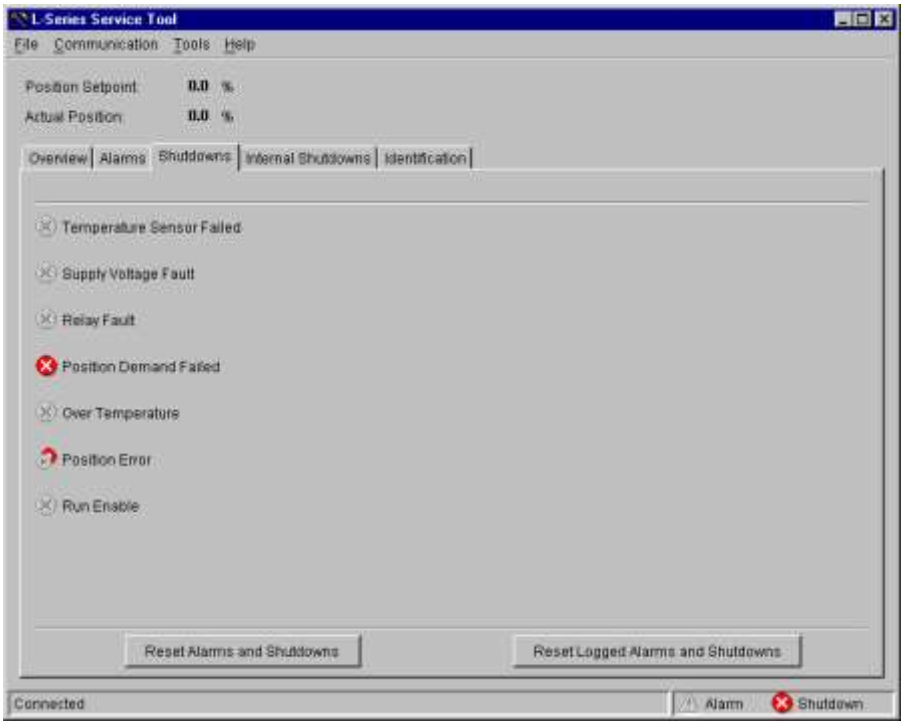


Figure 4-10. Service Tool—Shutdowns Tab

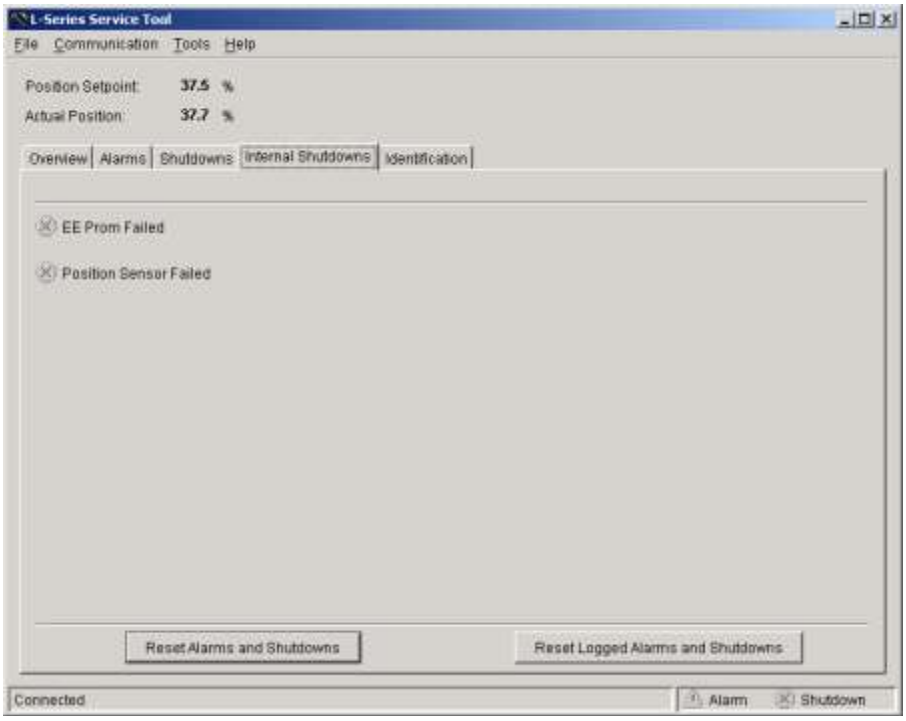


Figure 4-11. Service Tool—Internal Shutdowns Tab

Identification Screen

To monitor the L-Series product identification, go to the Identification page on the main window.

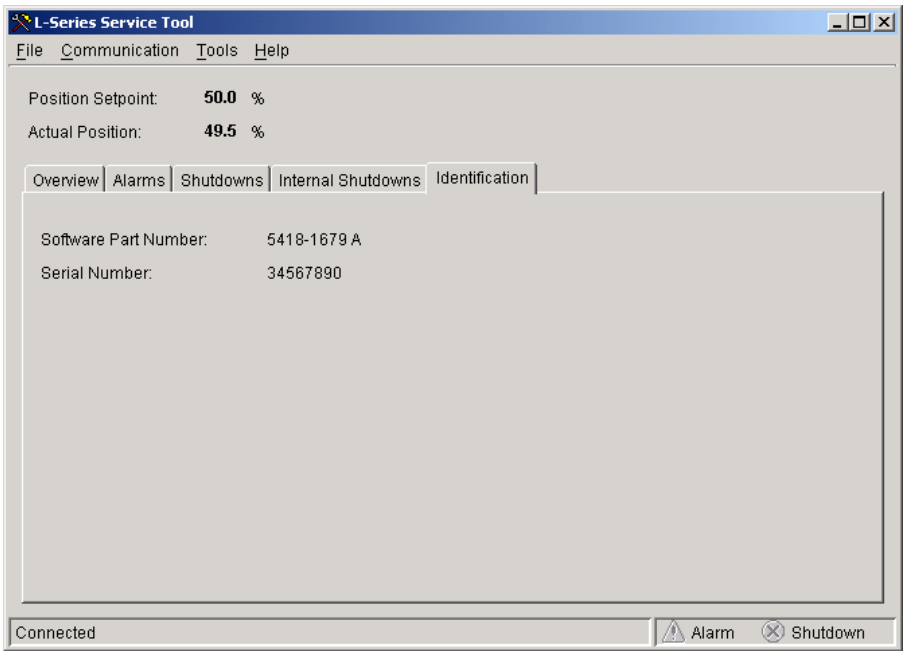
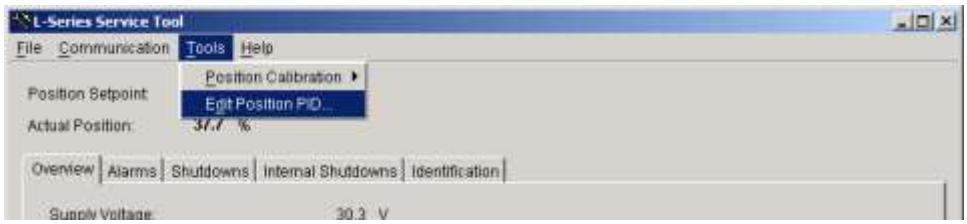


Figure 4-12. Service Tool—Identification Tab

Tuning the PID

The Service Tool can be used to tune the PID or to just trend/monitor the PID output. To get to the PID Tuning screen, select the Edit Position PID from the Tools menu selection.



The L-Series controller can be put into a manual control mode from this screen by selecting the “Enable Manual Position Tuning’ checkbox (Figure 4-13). Once in manual mode, the position setpoint box is highlighted and the value displayed is actively positioning the output. Use this command to create step changes for the PID and monitor the response using the displayed trend.

Pressing the Properties button pops open the Properties Window (Figure 4-14). From this window the user can adjust the trending window properties including the update rate and display range.

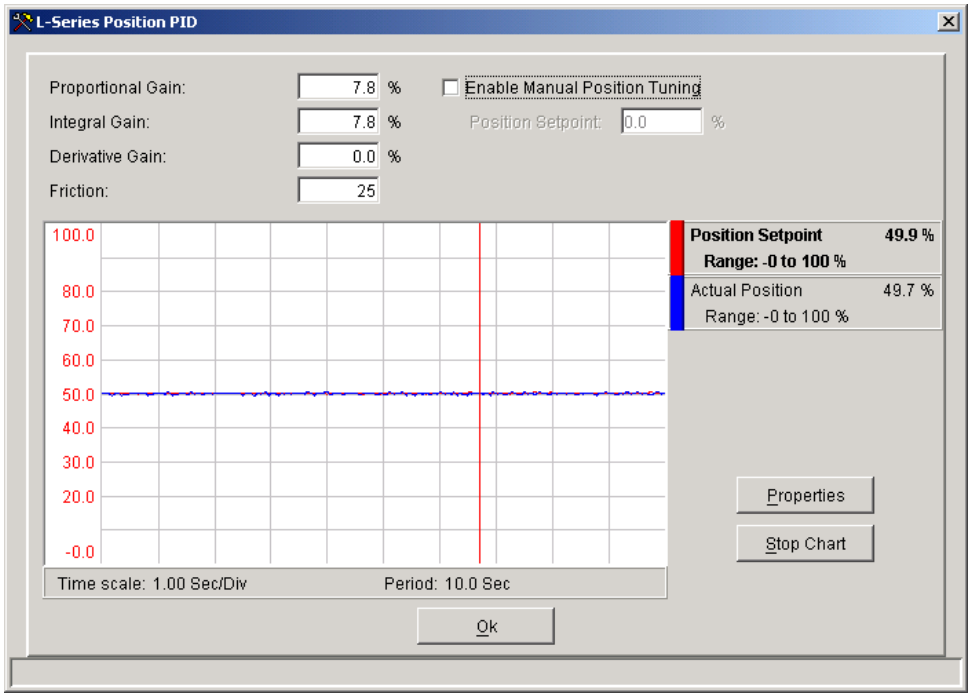


Figure 4-13. Service Tool—PID Tuning Window

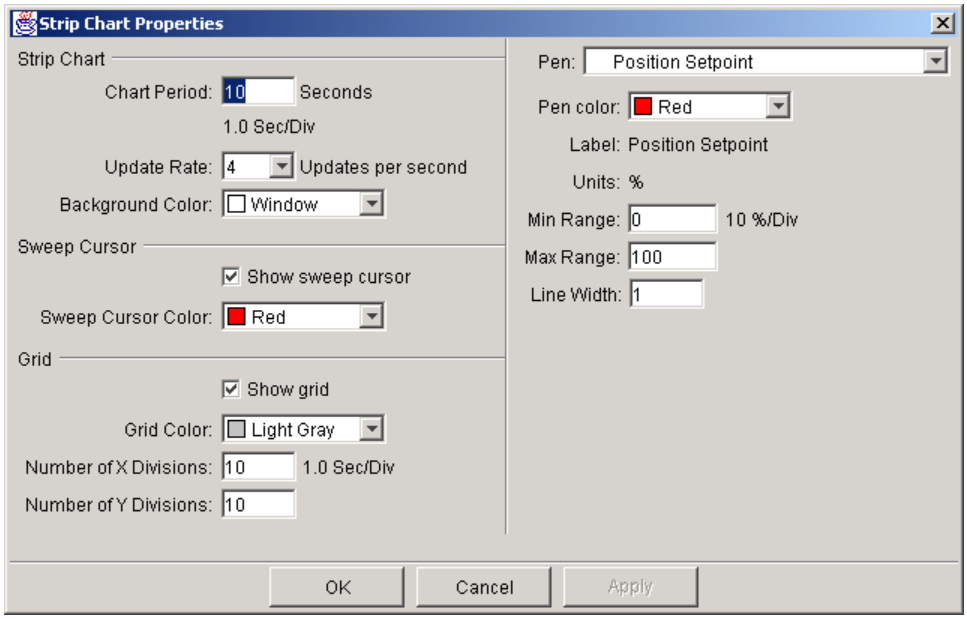


Figure 4-14. Service Tool—PID Tuning Properties Window

Position Calibration and Verification

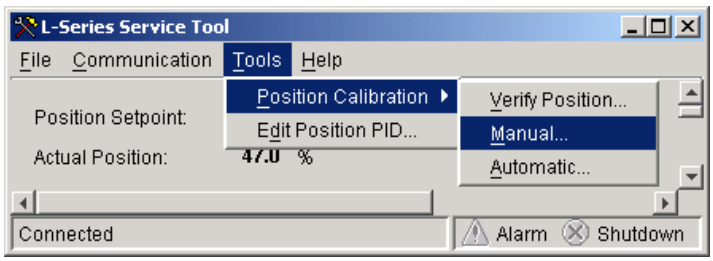
Position calibration is available to map the position command input to the actual rotational travel of the unit. It is only used when the full travel of the actuator is constrained or limited such that 0 to 60 degrees of travel is not used. For example, an application-specific position calibration could map 0–100% position command to 10–40 degrees actual rotation.

There are two methods available to perform a position calibration: Automatic or Manual. If the application has hard stops that correspond to the actual min/max travel, then either Auto or Manual methods can be used—although auto is easier. If hard stops are not available, then the auto method will give invalid results and the manual method must be followed.

The Service Tool can be used to calibrate the control to end user stops (physical or soft) or to verify the position calibration. To get to the Position Calibration screens select the desired function from Position Calibration under the Tools menu selection.

IMPORTANT

Position Calibration is only used when the full travel of the actuator is constrained or limited such that 0 to 60 degrees of travel is not used.



Calibration Sequence Overview

The following outlines the basic steps required to execute the position calibration.

Automatic Mode

1. Select Automatic Position Calibration Mode.
2. Select cw or ccw Direction.
3. L-Series automatically rotates in both cw and ccw directions until the stops are detected. The values are then captured and stored.
4. When completed, cycle the power on the L-Series.
5. It is recommended that a Position Verification be performed to confirm the calibration is correct. See Position Verification below.

Manual Mode

1. Determine to rotational travel limits. This can be done by positioning the unit to the minimum and maximum positions and recording the position settings.
2. Select Manual Position Calibration Mode.
3. Select Direction.
4. Enter the pre-determined rotational travel limits values.
5. When completed, cycle the power on the L-Series.
6. It is recommended that a Position Verification be performed to confirm the calibration is correct. See Position Verification below.

Position Verification

When the Verify Position screen is entered, the control is put into position control and the position is set to the position the control was at when the screen was entered. The screen displays the “User” Requested Position, Actual Position, Minimum Position, and Maximum Position (see figure 4-13). These User Positions are calculated from the user-calibrated stops.

The Full Travel Actual Position is the full stroke factory position without user stops after software linearization. The Full Travel Sensor Position is the full stroke factory position without user stops before software linearization. The Full Travel Sensor Position will match the TPS Output Signal.

The Verify Position screen can be used to check the calibration or to get the minimum and maximum position values for the manual calibration. If the Enable Requested Position Tuning box is checked the valve can be positioned anywhere from 0 to 100% of the user minimum and maximum stops by entering a value into the Requested Position. If the Enable Requested Position Tuning box is unchecked the valve will go limp and can be physical positioned by hand.

IMPORTANT

If the full factory position calibration range is not being used (the Manual or Automatic Calibration has been performed) and the minimum position direction is changed, the calibration must be run again for the Verify Position mode to work correctly.

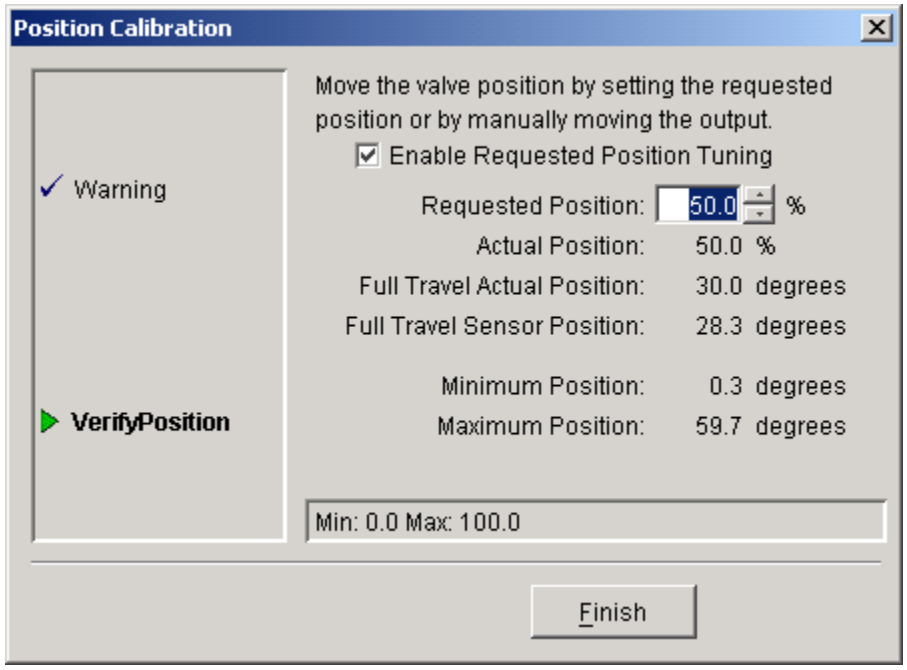


Figure 4-15. Service Tool—Verify Position Calibration

Manual Calibration

The manual calibration mode is used to set the minimum position and fail direction and to calibrate the valve to user soft stops (inside of any physical stops). The first screen to appear when entering the manual mode is used to set the minimum position and fail direction. This setting must be correct before manually calibrating the valve.

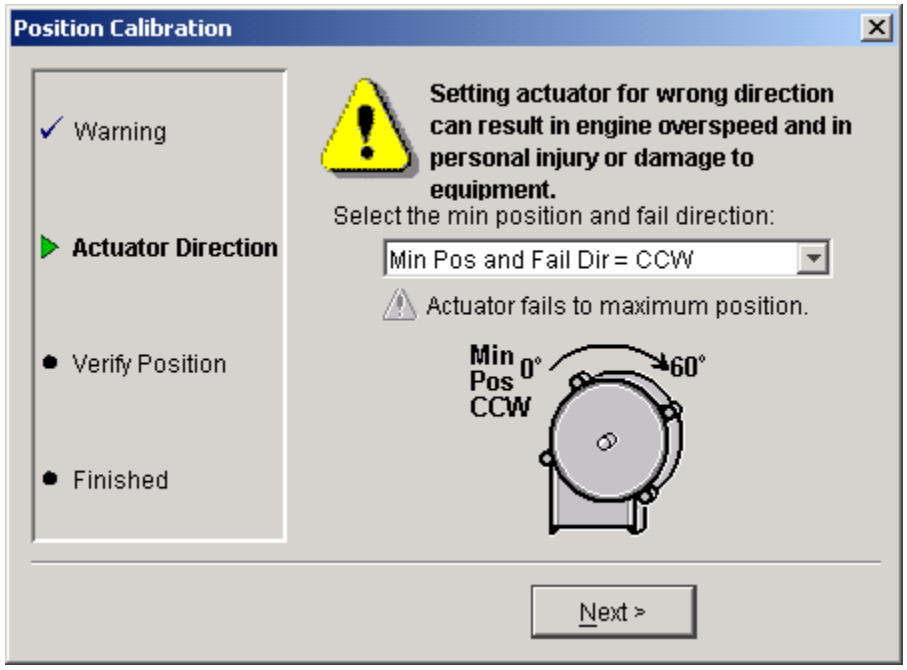


Figure 4-16. Service Tool—Manual Position Calibration

The next screen is used to set the minimum and maximum positions for the user soft stops. To find the minimum and maximum soft stops use the verify position mode described above to position the valve and use the Full Travel Actual Position reading for minimum and maximum position values.

IMPORTANT

Review ALL settings shown on ALL Configuration screens to verify that all configuration settings are correct before loading settings to the control. Configuration changes do not take effect until they are loaded to the control.

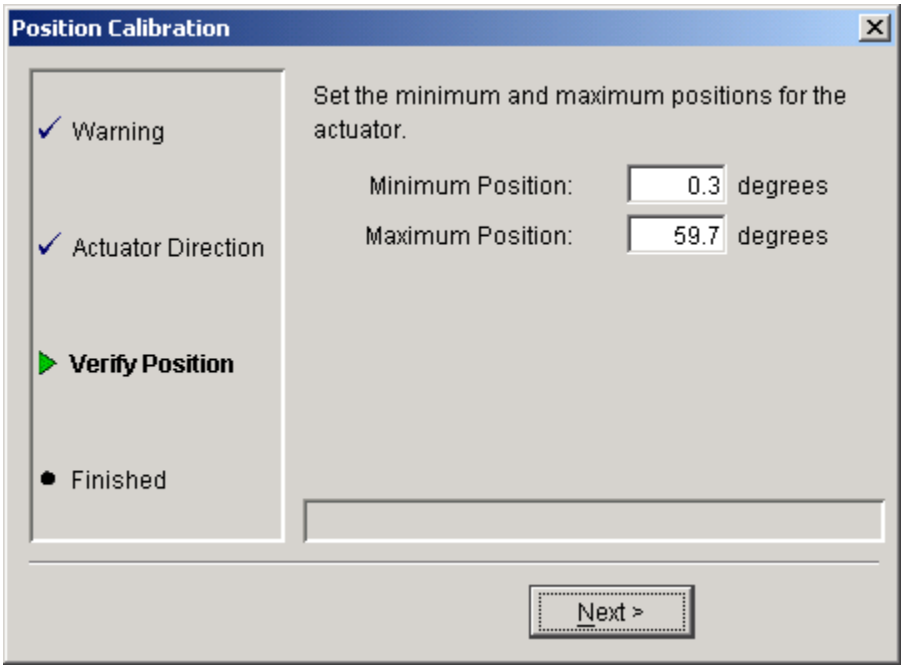


Figure 4-17. Service Tool—Manual Position Calibration Settings

Automatic Calibration

The automatic calibration mode is used to set the minimum position and fail direction and to calibrate the valve to user physical stops (mechanical hard stops). Like the manual mode, the first screen to appear is used to set the minimum position and fail direction. This setting must be correct before automatic calibration is performed.

After setting minimum position and fail direction the screen below will appear. The control is now moving first to the ccw stop and then to the cw stop to get the physical minimum and maximum positions.

IMPORTANT

Review ALL settings shown on ALL Configuration screens to verify that all configuration settings are correct before loading settings to the control. Configuration changes do not take effect until they are loaded to the control.

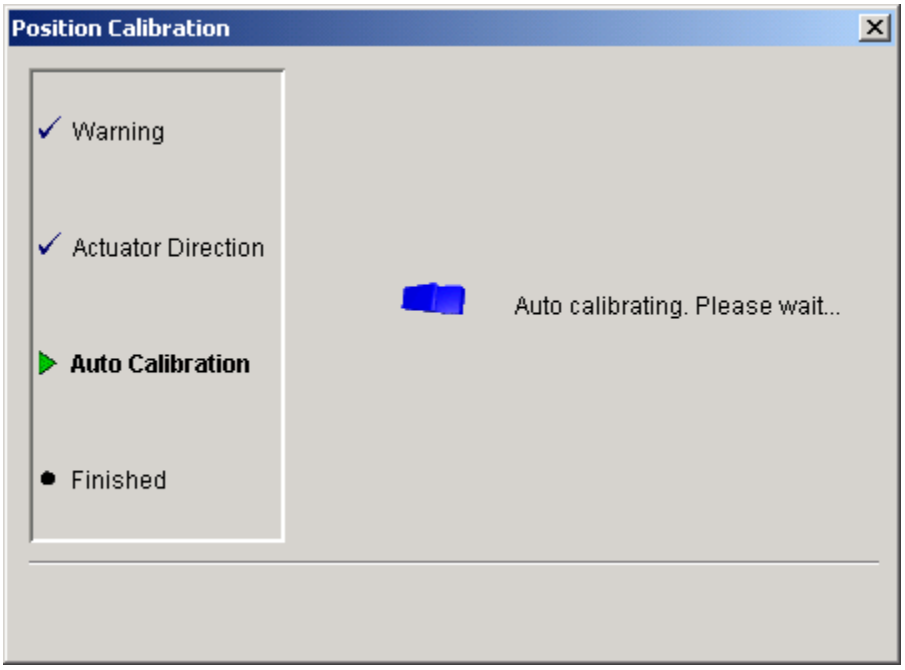


Figure 4-18. Service Tool—Auto Position Calibration

Chapter 5.
L-Series Control Specifications

	Specifications
Power Supply	12/24 V systems (10–32 Vdc) reverse polarity protection, 2.5 A max
Power Consumption	32 W maximum
Torque	Nominal: 0.34 N·m (0.25 lb-ft) at 25 °C Maximum Transient (at 105 °C): 0.20 N·m (0.15 lb-ft) Minimum Continuous (at 105 °C): 0.14 N·m (0.10 lb-ft)
Mass/Weight	425 g (15 oz)
Power-Up to Operation Time	<250 ms
	Performance
Positioning Accuracy	±2% (analog or PWM command), ±1.0% (CAN)–at 25 °C ±4% (analog), ±3.6% (PWM), ±3% (CAN)–over temperature range
Slew Time 10%–90%	33 ms
Overshoot	1%
Settling Time	10 ms
–6 db Roll-off at ±0.5% Input	32 Hz
–3 db Roll-off at ±2% Input	8 Hz
	Environment
Ambient	
Operating Temperature	–40 to +105 °C (–40 to +221 °F)
Storage Temperature	–40 to +125 °C (–40 to +257 °F)
EMC	EN61000-6-2: Immunity for Industrial Environments EN61000-6-4: Emissions for Industrial Environments SAE J1113-21: Radiated Immunity (100 V/m) SAE J1113-11: Conducted Transient Immunity – Pulse 5b, Suppressed Load Dump (45 V)
Humidity	US MIL-STD 810E, Method 507.3, Procedure III
Salt Spray	US MIL-STD 810E, Method 509.3, Procedure I
Shock	MS1-40G 11 ms sawtooth
Random Vibration	Random: 0.3 G²/Hz, 10–2000 Hz (22.1 Grms) 3 h/axis Sine: 5 G 2.5 mm peak-to-peak, 5–2000 Hz, 3 h/axis, 90 min dwells, 1 octave/min
Drop	SAE J1211, Paragraph 4.8.3 (modified)
Thermal Shock	SAE J1455, Paragraph 4.1.3.2
Ingress Protection	IP56 per EN60529

Analog Command Input

Table 5-1. Analog Command Input

Parameter	Value
Input Type	0–5 V, Single-Ended Input
Input Scaling	0.5 V = 0% and 4.5 V = 100% position
Max Input (Full Scale)	5 V ± 1%
Isolation	None
Transient Protection	According to EMC norm
Input Impedance	499 kΩ
Anti-Aliasing Filter	1 anti-aliasing pole at 0.5 ms (338 Hz)
Resolution	10 bits
Accuracy	±1.3% of full scale over the temperature range of –40 to +125 °C, including drift
I/O Latency	6.5 ms
Calibration Method	2-point linear software calibration
Out of Range Signal	< 0.2 V or > 4.8 V
Overvoltage Protection	Input protected against 32 Vdc steady state

PWM Command Input

Table 5-2. PWM Command Input

Parameter	Value
Input Magnitude	5–32 V p-p
Frequency Range	300–1500 Hz
Duty Cycle Scaling	10% = fully closed and 90% = fully open
Isolation	None
Input Impedance Push-Pull Mode	44 kΩ–113 kΩ
Input Impedance Open Collector Mode, High Side or Low Side.	15 kΩ
Resolution	16 bits at 300 Hz, 14 bits at 1.5 kHz
Accuracy	±1% of full scale (duty cycle), over the temperature range of –40 to +125 °C, including drift
I/O Latency	6.5 ms
Calibration	Duty cycle offset adjustment is available in Service Tool. This will tailor the input to the signal source
Out of Range Frequency	None
Out of Range Duty Cycle	< 3% or > 97%

Discrete Input

Table 5-3. Discrete Input

Parameter	Value
Input Current	0.5 mA @ 5 Vdc
Input Type	Ground referenced discrete input
Delay Time for Shutdown	< 200 ms for system to recognize shutdown
Delay Time for Reset Detection	< 1 s for valves to move to minimum position
Max Voltage from + Connection	32 V (power input voltage)
Isolation	None, Intended for use with external relay or other dry contact
Input Thresholds	> 3.1 Vdc = “ON” < 0.8 Vdc = “OFF”
Input Current	0.5 mA @ 5 Vdc

Discrete Output

Table 5-4. Discrete Output

Parameter	Value
Output Type	Low-side output driver
Max Contact Voltage (Open)	32 V
Max Current	0.5 A
Max Contact Voltage at 0.5 A (Closed)	1.5 V
Max Delay Time for Opening Contact	6.5 ms
Default at Power Up	Configurable in software
Error Condition	Configurable in software
OK Condition	Configurable in software
Driving Inductive Loads	Yes, internally protected low-side switch
Protection	Utilizes circuitry that will open the contact when output contacts are short-circuited. Self-resetting when fault is removed

TPS Output

Table 5-5. TPS Output

Parameter	Value
Output Type	0–5 V, single-ended
Output Scaling	0.75 V = full ccw position and 4.25 V = full cw position
Isolation	None
3 db Circuit Bandwidth	350 Hz
Transient Protection	According to EMC norm
Output Impedance	2.8 kΩ (±1%)
Accuracy	±10% of full scale, @ 25 °C
Temperature Drift	±0.4% over the full temperature range
I/O Latency	n/a–direct from position sensor
Calibration Method	Sensor-in-place factory calibration. 2-point linear
Out of Range Signal	< 0.25 V or > 4.75 V
Overvoltage Protection	Output protected against 32 Vdc, steady-state; if >28 V is applied to pin 2, a position-related error will be annunciated

RS-232 Serial Communication Service Port

Table 5-6. RS-232 Serial Communication Service Port

Parameter	Value
Isolation	None
Baud Rate	Fixed 19.2 Kbaud
Electrical Interface	Outputs are TTL level. Requires external transceiver for conversion to RS-232 levels for proper communication
Pinout	Tx = pin 4, Rx = pin 6, Gnd = pin 3
Maximum Cable Length	10 m (33 ft), not meant for permanent connection (for service only)
Cable Type	Straight-through (no crossover)

Electronics Temperature Sensor

Table 5-7. Electronics Temperature Sensor

Parameter	Value
Accuracy	±2 °C at 25 °C ambient ±3 °C over full range (–40 to +125 °C)
I/O Latency	6.5ms

Software Execution Rates

Table 5-8. Software Execution Rates

Software Routine	Nominal Software Execution Rate
Position Control Algorithms	1.6 ms
Position Demand Algorithms	6.5 ms
Analog Input Logic	6.5 ms
PWM Input Logic	6.5 ms
Serial Port	background task
Run Enable Discrete Input	6.5 ms
Discrete Output	6.5 ms
Diagnostics	6.5 ms

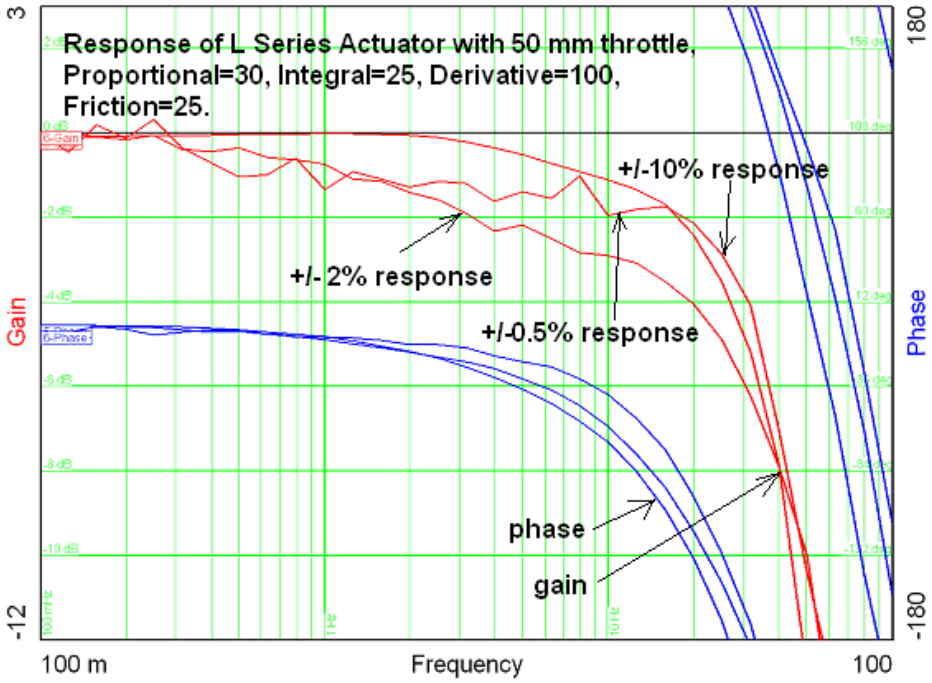


Figure 5-1. Bode Plot of L-Series Response

Chapter 6. Troubleshooting

Introduction

This chapter presents several broad categories of application failures typically experienced in the field, possible causes, and some tests used to verify the causes. Because the exact failure experienced in the field is the product of the mechanical/electrical failure combined with the configuration file resident in the control, it is left as the OEM's responsibility to create a more detailed troubleshooting chart for the end user. Ideally, this end-user troubleshooting chart will contain information about mechanical, electrical, engine, and load failures in addition to the possible governor failures. For more detailed information about governor system failure modes and effects, contact Woodward for a copy of the system DFMEA.

The troubleshooting scenarios listed below assume that the end user has a digital multimeter at his disposal for testing voltages and checking continuity, and assume that the application has been engineered and tested thoroughly.

⚠WARNING

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

⚠WARNING

Independent Fuel Shutoff Required (Overspeed / Overtemperature / Overpressure)

The engine, turbine, or other type of prime mover should be equipped with an independent fuel shut-off device to protect against fuel leakage or damage to the prime mover with possible personal injury, loss of life, or property damage. The fuel shut off 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

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

⚠CAUTION

The L-Series is used on prime movers that typically have a high noise level. Always use appropriate hearing protection while working around the L-Series.

General System Troubleshooting Guide

The following is a general troubleshooting guide for areas to check which may present potential difficulties. By making these checks appropriate to your engine/turbine before contacting Woodward for technical assistance, your system problems can be more quickly and accurately assessed.

- Valves
- Is the wiring correct?
- Is the direction of the stroke correct?
- Is the direction of the failsafe shutdown correct?
- Does the valve move through its proper stroke smoothly?
- Does the valve travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the valve fully seat (close)?
- Does the valve fully open?

Engine/Generator Troubleshooting

Table 6-1. Engine/Generator Troubleshooting Chart

Problem	Possible Cause	Suggested Test/Correction
Engine does not start	Stuck throttle/frozen shaft	Move throttle by hand. Assess smoothness, friction, and return spring force.
	Power not applied to control	Disconnect starter motor solenoid. Disconnect harness from governor. Activate application. Test for +12/24 V between +12/24 V pin and ground pin.
	Run Enable not closed	Verify status of input. Measure input. Verify input and configuration using Service Tool.
	No configuration or incorrect configuration in controller.	Using Service Tool, read configuration from controller and evaluate parameters for correction.
	Fault detected in controller.	Using Service Tool, read faults from controller. Verify/correct any shutdown conditions.
Engine unstable	Improperly tuned enabloe.	Using Service Tool, tune the position dynamics.
	Intermittent position command input signal.	Using Service Tool, verify fault indications.
	Device sending position command is sending oscillating signal.	Measure input signal. Verify signal using Service Tool.
Poor frequency control	Improperly tuned dynamics.	Using Service Tool, tune the position dynamics.
	Friction/dither improperly set.	Using Service Tool, adjust the Friction/Dither setting.
Unable to develop full power	Non-indexed linkage slipped on shaft.	Manually verify full travel of throttle plate.
	Fault detected in controller.	Using Service Tool, view status of fault codes. Take appropriate action for active faults.

Table 6-1. Engine/Generator Troubleshooting Chart (cont'd.)

Problem	Possible Cause	Suggested Test/Correction
Not controlling at desired position setpoint	PWM input signal inaccuracy.	Measure input duty cycle and convert to percentage. Verify controller signal using Service Tool. If different, adjust the PWM Offset value in the Configuration Editor.
	Wiring fault or ground loop.	Check the wiring. Look for loose connections and disconnected or misconnected cables and connections. Remove all wiring except the position command and power input and verify operation/functionality.
	Analog input signal inaccuracy.	Measure the analog command voltage arriving at pin 10 to verify that it is at the expected value in the range of 0.5 to 4.5 V. Use the service tool to verify that AUX2 is being read correctly.
	Output shaft is bound or sticking.	Manually verify full shaft movement. Use the "verify position" function of the service tool (Chapter 4).
Discrete output not working	Wiring fault.	Check the wiring leading to pin 9 for open connections or misconnections. Verify that pin 9 is not connected directly to input power or ground.
	Configuration.	Using the Service Tool, verify that the faults and shutdowns are selected properly and that the output is configured for expected operation (either normally "on" or normally "off").
Service Tool not communicating–'Not Connected' status indicated	Wiring fault.	Check AUX3 and AUX4 for loose or mis-connected connections. Verify harness setup and connections (see chapter 4) Check that Service Tool is running. Verify the port setting is correct.
Service Tool not communicating–'Error message displayed on PC when trying to connect	Old version of Service Tool or file corruption or bad install.	Re-install Service Tool, get the latest version from the Woodward web site (www.woodward.com)
Service Tool will not except password	Cap Lock is on.	Password is case sensitive, make sure you enter the password correctly using upper and lower case. If password is lost contact the OEM for retrieval.

Electrical Troubleshooting Guide

Analog Input

If the Analog Input is not functioning properly, verify the following:

- Measure the input voltage. It should be in the range of 0.5–4.5 V.
- Check the values seen by the L-Series driver using the Service Tool and verify that it matches the input signal.
- Verify that there are no or minimal ac components to the Analog Input signal. AC components can be caused by improper shielding.
- Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 V, look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly as the Demand Source.

PWM Input

If the PWM input is not functioning properly, verify the following:

- Measure the input voltage, frequency, and duty cycle.
- Check the values seen by the L-Series driver using the Service Tool and verify that is matches the input signal.
- Check the wiring. Look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly as the demand source.

Run Enable Discrete Input

If the run enable discrete input is not functioning properly, verify the following:

- Measure the input voltage on the terminal block. It should be in the range of 10–28 Vdc.
- Check the status of the input from the Overview screen of the Service Tool.
- Check the wiring, looking for loose connections or misconnected cables.
- Verify the input is properly configured.

Alarm or Shutdown Conditions

If the L-Series control has any alarm or shutdown conditions, refer to Chapter 2 for details on the exact cause of the condition. The Service Tool must be used to determine the cause of any shutdown or alarm condition.

Discrete Output

If the discrete output is not functioning properly, verify the following:

- Measure the output voltage on the terminal block. It should be in the range of 10–28 Vdc when the output is off/false. The voltage will be in this range only if all shutdowns are false. This can be verified through the Service Tool.
- Check the wiring, looking for loose connections or disconnected / misconnected cables.
- Verify the configuration of the output.

Service Tool

If the service tool is not functioning properly, review the installation information in Chapter 4. Verify the following:

- Check the wiring, looking for loose connections or disconnected / misconnected cables.
- Check that Service Tool is running. Verify the Port setting is correct.
- Follow on-screen error messages. Re-install software as needed. The latest version of software is available for download from the Woodward web site (www.woodward.com).

IMPORTANT

The L-Series actuator will not attempt to operate again, following a detected error, until power to the valve is cycled. If an error persists, the actuator must be replaced.

Chapter 7.
Product Support and Service Options

Product Support Options

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

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

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

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

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

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

Product Service Options

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

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

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

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

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

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

IMPORTANT

There are no serviceable parts on the L-Series.

Returning Equipment for Repair

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

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

- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

Contacting Woodward's Support Organization

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

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

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

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

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

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

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

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

Appendix A.
L-Series Configuration Summary

APPLICATION _____

ACTUATOR SERIAL NUMBER _____
For details on individual settings, refer to Chapter 4.

Configuration Settings – Position Controller

Setup

Position Demand Selection	PWM ____ 0..5 V ____
Fail Direction	ccw ____ cw ____
Min Position Direction	ccw ____ cw ____
Use Non-linear Actuator Curve?	Yes ____ No ____

Dynamics

Proportional Gain (%)	= _____
Integral Gain (%)	= _____
Derivative Gain (%)	= _____
Friction / Dither Setting	= _____

PWM Input

PWM Drive Select	Push-Pull ____ High Side ____ Low Side ____
PWM Offset (%)	= _____

Non-Linear Actuator Settings

Position Request (pt 0) (%)	= _____
Position Request (pt 1) (%)	= _____
Position Request (pt 2) (%)	= _____
Position Request (pt 3) (%)	= _____
Position Request (pt 4) (%)	= _____
Actuator Position (pt 0) (%)	= _____
Actuator Position (pt 1) (%)	= _____
Actuator Position (pt 2) (%)	= _____
Actuator Position (pt 3) (%)	= _____
Actuator Position (pt 4) (%)	= _____

Discrete Out

Discrete Out Normally On?	Yes ____ No ____
Indicates Watchdog Reset?	Yes ____ No ____
Indicates Brownout Reset?	Yes ____ No ____
Indicates EE Prom Failure?	Yes ____ No ____
Indicates Position Sensor Failure?	Yes ____ No ____
Indicates Temperature Sensor Failure?	Yes ____ No ____
Indicates Supply Voltage Fault?	Yes ____ No ____
Indicates Relay Fault?	Yes ____ No ____
Indicates Position Demand Failure?	Yes ____ No ____
Indicates Overtemperature?	Yes ____ No ____
Indicates Position Error?	Yes ____ No ____
Indicates Run Enable Shutdown?	Yes ____ No ____

Faults (Shutdown/Alarms)

Temp Sensor Failure Action	Shutdown ____ Alarm ____
Supply Voltage Fault Action	Shutdown ____ Alarm ____
Relay Fault Action	Shutdown ____ Alarm ____
Position Demand Failure Action	Shutdown ____ Alarm ____
Overtemperature Action	Shutdown ____ Alarm ____
Position Error Action	Shutdown ____ Alarm ____
Faults are Latched?	Yes ____ No ____
Position Error Max (%)	= _____
Position Error Delay (sec)	= _____

Revision History

New Manual—

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00240-04-EU-02-09
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	3800 Wilson Avenue Loveland, CO 80538 USA
Model Name(s)/Number(s):	L-Series ITB and LC-50
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC) Units marked for ATEX (8404-7226, 8404-7227 only): Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment Exemption in use: 6(a), 6(c), 7(a), 7(c)-I
Markings in addition to CE marking:	Ex II 3 G, Ex nA IIC T3 X Gc
Applicable Standards:	EN61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments EN61000-6-4, 2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN60079-15, (2003) Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection 'n'
Conformity Assessment:	Woodward EMC Conformity Assessment 00240-04-EU-EMC-06-03

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

MANUFACTURER

Signature

Mike Row
Full Name

Compliance Engineering Supervisor
Position

Woodward, Fort Collins, CO, USA
Place

12-July-2019
Date

Page **1** of **1**

5-09-1183 Rev 30

DECLARATION OF INCORPORATION
Of Partly Completed Machinery
2006/42/EC

File Name:	00240-04-EU-02-03
Manufacturer's Name:	WOODWARD INC
Manufacturer's Address:	3800 N. Wilson Ave. Loveland, CO, USA 80538
Model Names:	L-Series Actuator
This product complies, where applicable, with the following Essential Requirements of Annex I:	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7

The relevant technical documentation is compiled in accordance with part B of Annex VII. Woodward shall transmit relevant information if required by a reasoned request by the national authorities. The method of transmittal shall be agreed upon by the applicable parties.

The person authorized to compile the technical documentation:

Name: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate.

The undersigned hereby declares, on behalf of Woodward, Inc., of Loveland and Fort Collins, Colorado that the above referenced product is in conformity with Directive 2006/42/EC as partly completed machinery:

MANUFACTURER

Signature

Mike Row
Full Name

Engineering Supervisor
Position

Woodward, Inc, Fort Collins, CO, USA
Place

March 20th, 2019
Date

5-09-1182 (REV. 16) 00240-04-EU-02-03

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Released

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 35154.

B 3 5 1 5 4 : -

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Phone +1 (970) 482-5811

Email and Website—www.woodward.com

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.