WOODWARD

Application Note 51272
(Revision C, 2/2024)
Original Instructions

Instructions for Replacing the TQ-125™ Engine Control with an L-Series 8404-7104 Speed Controller

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. The latest version of most publications is available on the Woodward website.

http://www.woodward.com

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. The latest version of most publications is available on the Woodward website.

www.woodward.com/publications

Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

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

Manual 51272

Warnings and Notices

Important Definitions

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

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

⚠WARNING

Lockout/Tagout LOTO

Ensure that personnel are fully trained on LOTO procedures prior to attempting to replace or service equipment 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 unit.

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

WARNING

Start-up

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

WARNING

Automotive Applications

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

WARNING

IOLOCK

IOLOCK: driving I/O into a known state condition. When a control fails to have all the conditions for normal operation, watchdog logic drives it into an IOLOCK condition where all output circuits and signals will default to their de-energized state as described below. *The system MUST be applied such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.*

- **Microprocessor failures will send the module into an IOLOCK state.**
- **Discrete outputs / relay drivers will be non-active and de-energized.**
- **Analog and actuator outputs will be non-active and de-energized with zero voltage or zero current.**

Network connections like CAN stay active during IOLOCK. This is up to the application to drive actuators controlled over network into a safe state.

The IOLOCK state is asserted under various conditions, including:

- **Watchdog detected failures**
- **Microprocessor failure**
- **PowerUp and PowerDown conditions**
- **System reset and hardware/software initialization**
- **PC tool initiated**

NOTE—Additional watchdog details and any exceptions to these failure states are specified in the related section of the product manual.

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. Touch your finger to a grounded surface to discharge any potential before touching the control, smart valve, or valve driver, or installing cabling connectors. Alternatively, ESD mitigation may be used as well: ESD smocks, ankle or wrist straps and discharging to a reference grounds surface like chassis or earth are examples of ESD mitigation.
    - ESD build up can be substantial in some environments: the unit has been designed for immunity deemed to be satisfactory for most environments. ESD levels are extremely variable and, in some situations, may exceed the level of robustness designed into the control. Follow all ESD precautions when handling the unit or any electronics.
        - I/O pins within connectors have had ESD testing to a significant level of immunity to ESD, however do not touch these pins if it can be avoided.
            - Discharge yourself after picking up the cable harness before installing it as a precaution.
        - The unit is capable of not being damaged or improper operation when installed to a level of ESD immunity for most installation as described in the EMC specifications. Mitigation is needed beyond these specification levels.

IMPORTANT

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

Instructions for replacement of the TQ-125™ Engine Control with an L-Series 8404-7104 Speed Controller

Introduction

Woodward's L-Series Speed Control can be used as a functional replacement for the TQ-125™ Speed Control. The L-Series 8404-7104 speed control was designed with many new features and functions that are not built into the TQ-125.

The Woodward L-Series combines the L-Series electric actuator with integrated speed control software to control the speed of a diesel or gaseous engine. The L-Series is a microprocessor-based control that is incorporated into the actuator, creating a single integrated package. This eliminates the need for an additional driver box and speed control box.

Refer to Woodward manual 26250 for details on the L-Series additional features, operation, adjustment, and troubleshooting.

Required Items to Complete Replacement

Installation Kit	8923-1163 (Includes the following): 8404-7104 L-Series Speed Control 3600-1274 Adapter Plate and Mounting Hardware 02-0004-171 Lever for .25-inch Shaft 5404-1049 Electrical Harness
Programming Harness	8923-1061 (Used for configuring and tuning the L-Series)
9-Pin Straight-through Serial Cable	(not provided)
L-Series Service Tool Software	9927-1222 (free download from www.woodward.com)
L-Series Speed Control Manual	26250 (free download from www.woodward.com)

Overview

The following pages will describe the TQ-125 replacement in detail. The general replacement will require the removal of the TQ-125 control and lever arm but not the linkage. The L-Series control will be mounted on an adapter plate which is designed to mount to the same bracket that held the TQ-125. A new lever arm is installed to the L-Series assembly and connected to the linkage. The L-Series electrical harness is installed using the existing wiring for the TQ-125.

Using the programming harness and a laptop computer, configure the control for the proper speed signal (number of teeth when using an MPU or number of cylinders when using ignition), speed setpoints (including the overspeed setpoint), and any necessary options such as second dynamics. The default PID speed dynamics should be sufficient for the initial start-up. Once the engine is running, you can use the service tool software to adjust the speed dynamics for best performance in your application.

Mechanical Installation

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

1. The TQ-125 control should be rigidly mounted to the engine with a bracket. At the minimum fuel position, remove the linkage from the TQ-125 by loosening the lever-retaining bolt. Remove the four 0.250-28 screws which attach the TQ-125 to the bracket and remove the control.

2. Mount the L-series control (8404-7104) to the adapter plate (3600-1274) using the four M5 mounting screws contained in the installation kit. 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.

3. Install the L-Series and adapter plate assembly onto the TQ-125 mounting bracket using the four 0.250-28 screws.

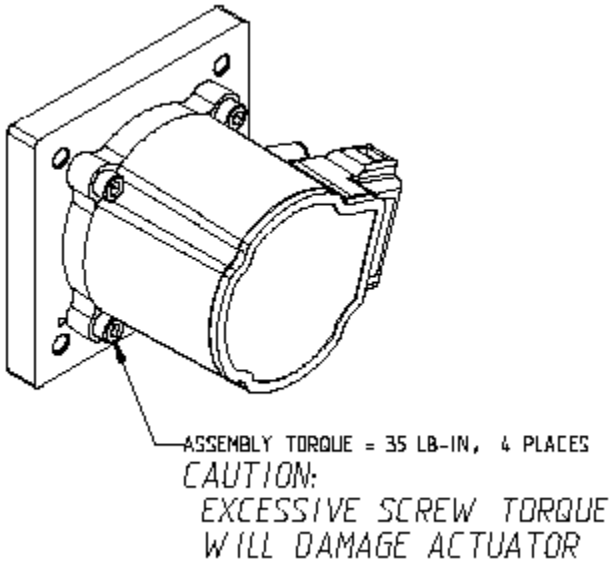


Figure 1. L-Series Adapter Plate Assembly

4. The linkage for diesel engine applications should be linear, and for carbureted engines non-linear. The linkage should not bind or have play in it.

5. Install the new L-Series lever (02-0004-171) included in the installation kit to the shaft of the L-Series and re-connect the linkage.

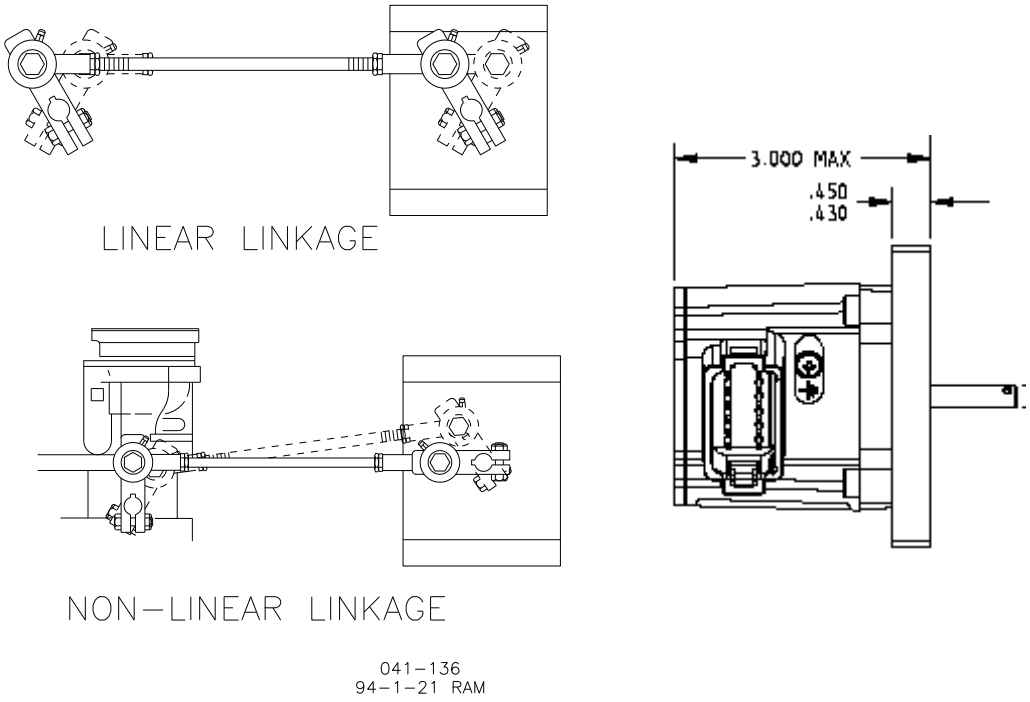


Figure 2. Linkage

6. Once installed, manually stroke the fuel-control linkage from stop to stop as if the actuator were moving it. The linkage must move freely, without friction and backlash. Lubricate or replace worn linkage or fuel control parts as required. Always make sure the fuel delivery device (fuel pump or throttle body) has a return spring that pulls toward minimum fuel when no power is applied to the control. Size the return spring so that the actuator output shaft sees no more than 0.07 N·m (0.05 lb-ft) of torque at maximum loading conditions.

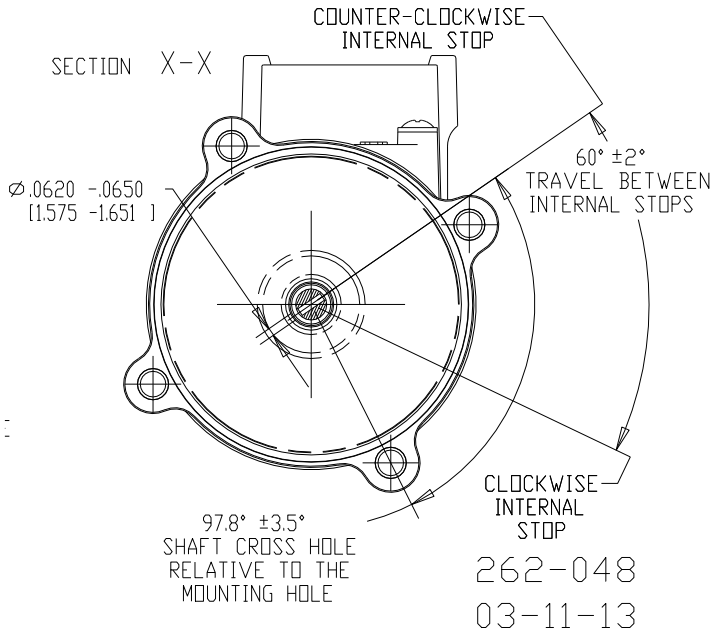


Figure 3. Travel

Electrical Installation

Figure 4 shows a wiring pinout of the L-Series control, as viewed by looking into the control's connector. The control system should be protected with a 6 A 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. The use of cable with individually shielded-twisted pairs should be used with the speed signal input.

1. Using the harness provided in the installation kit (8923-1163), replace the TQ-125 connector by wiring in the L-Series connector into the TQ-125 portion of the engine harness as shown in the diagrams.

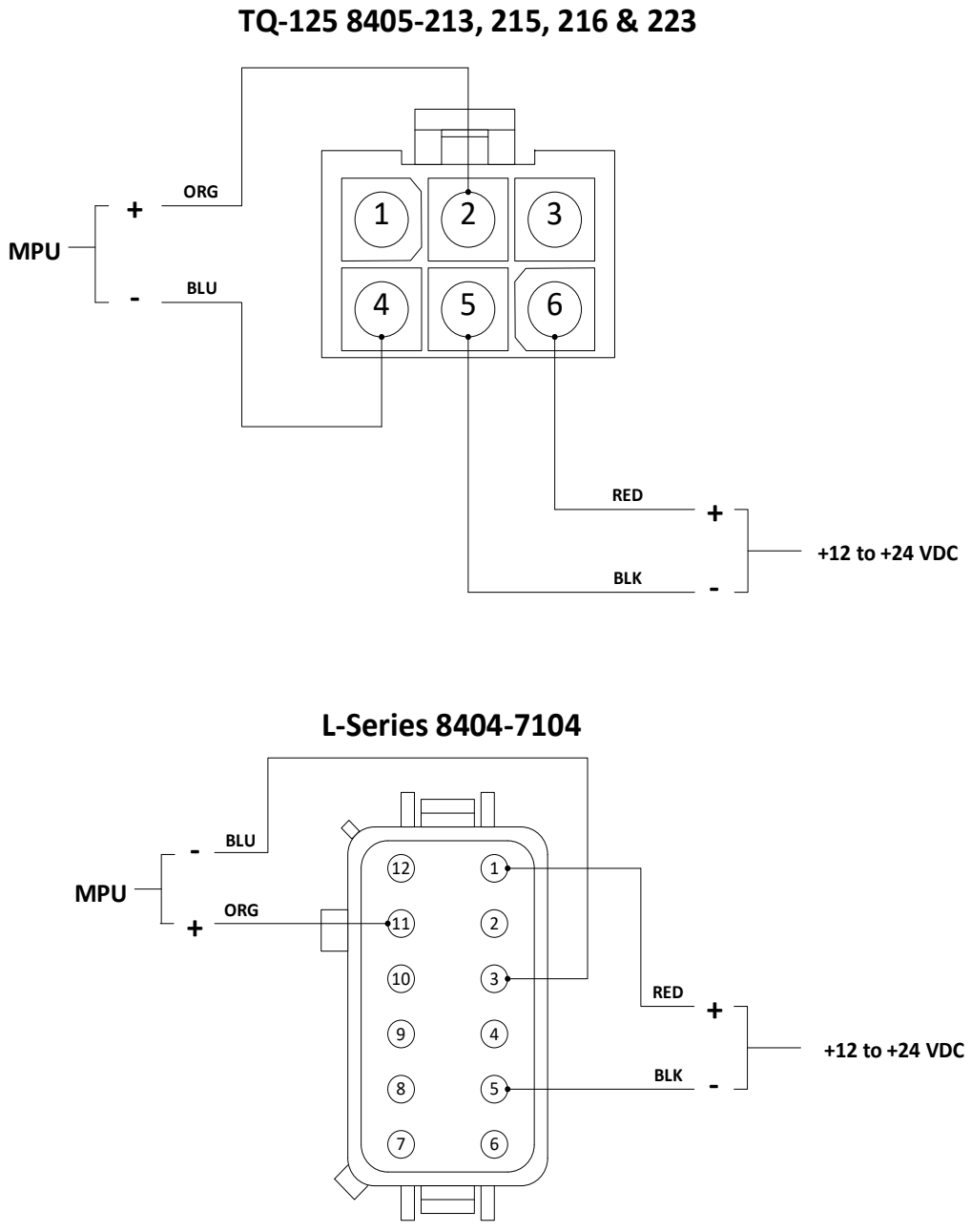
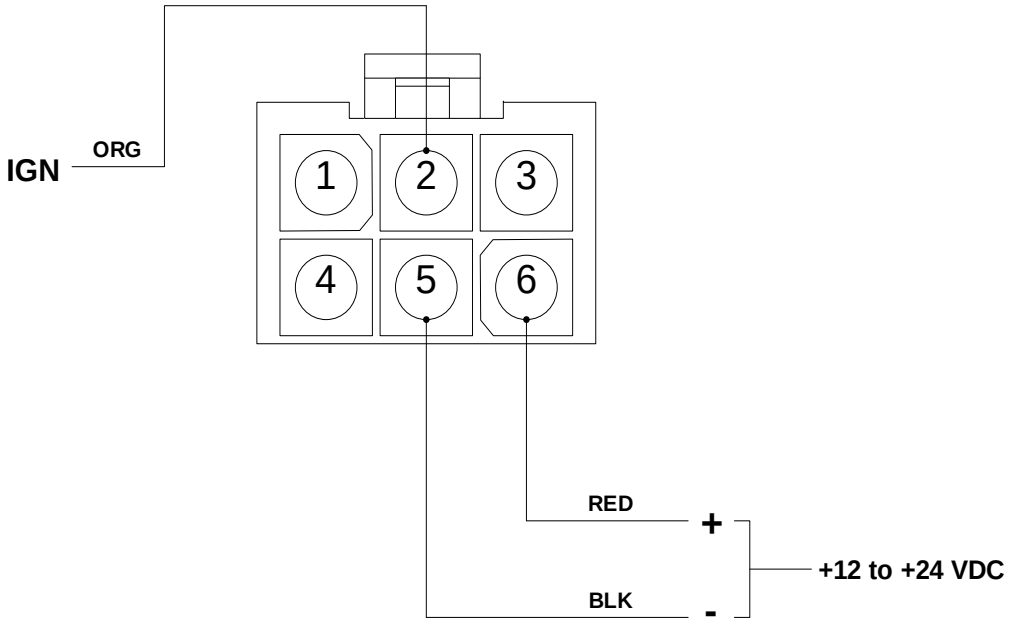


Figure 4. Wiring Pinout (TQ 8405-213, 215, 216, 223)

If replacing a TQ-125 8405-214 using an ignition input from the coil (–) for a speed signal, it will be necessary to relocate the orange wire from PIN 11 on the L-Series connector, to PIN 12 as shown below.

TQ-125 8405-214



L-Series 8404-7104

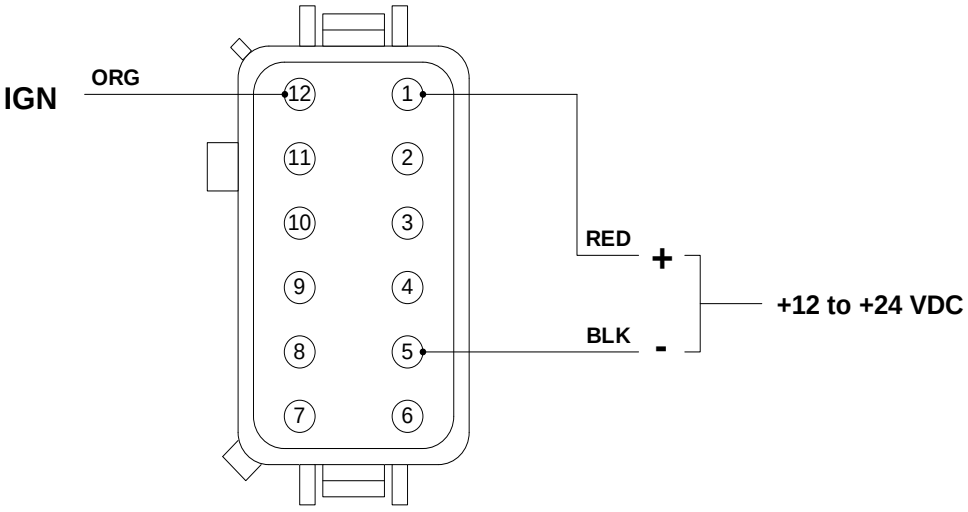
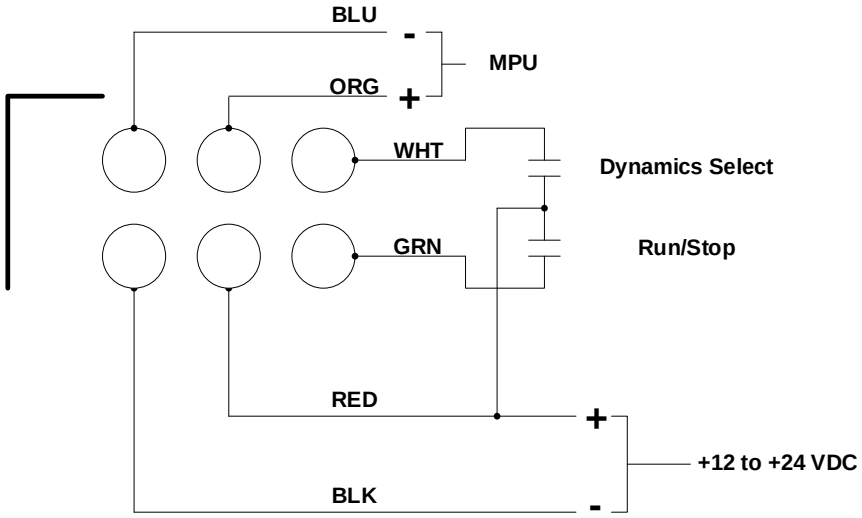


Figure 5. Wiring Pinout (TQ 8405-214)

TQ-125 8405-206, 207, 208 & 212



L-Series 8404-7104

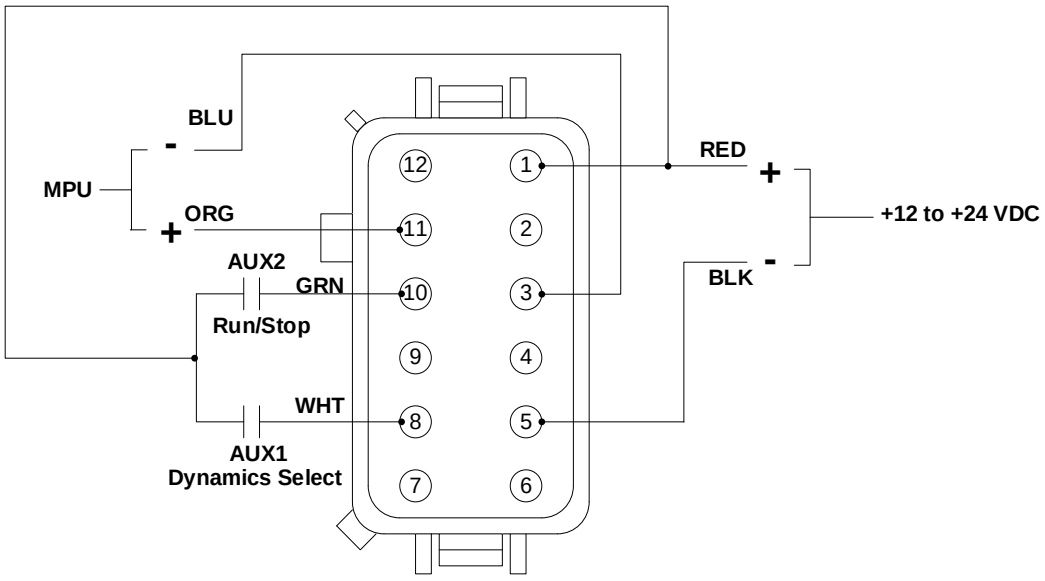


Figure 6. Wiring Pinout (TQ 8405-206, 207, 208, 212)

IMPORTANT **If using an ignition input for the speed signal input, relocate the ORANGE wire from PIN 11 (MPU) to PIN 12 (IGN).**

Configuring the L-Series

You must configure the L-Series using the Software Service Tool. Parameters such as Speed Input, Rated Setpoint, and Overspeed Threshold will need to be configured before starting the engine. Refer to L-series Speed Control Manual 26250 for a complete description of all L-Series features and programming examples.

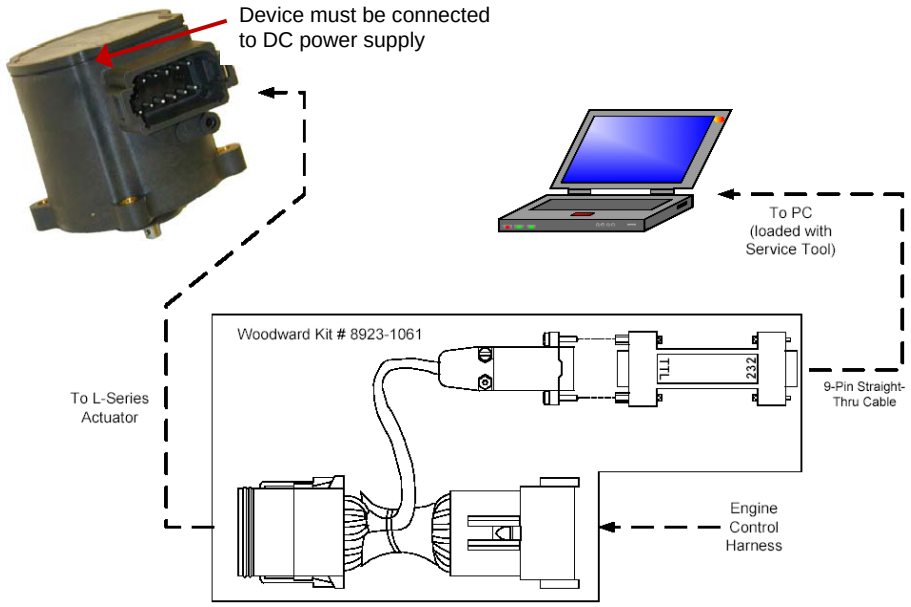


Figure 7. Connecting the Control

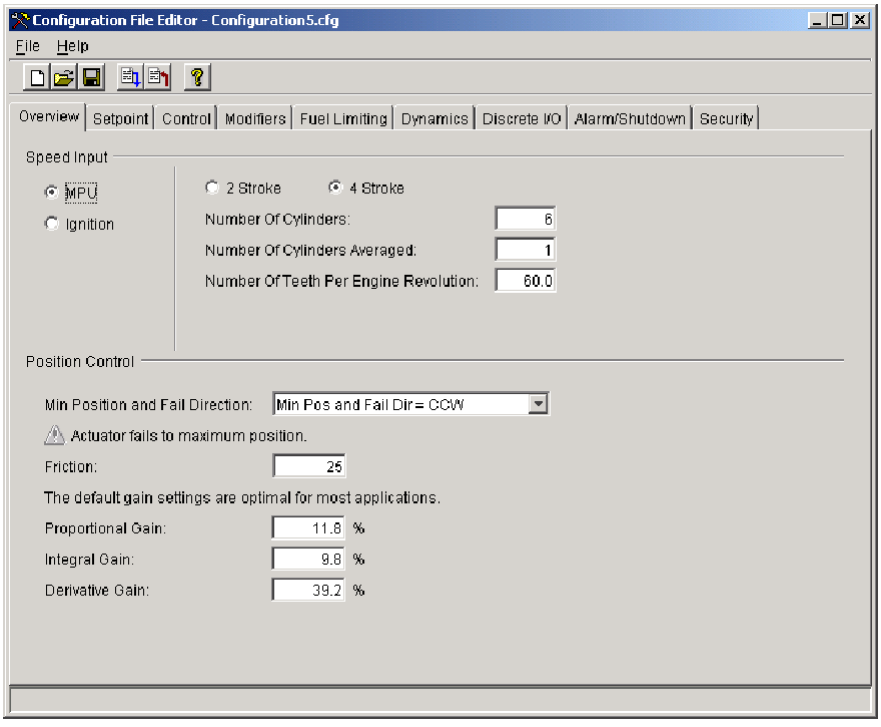


Figure 8. Example Service Tool Screen

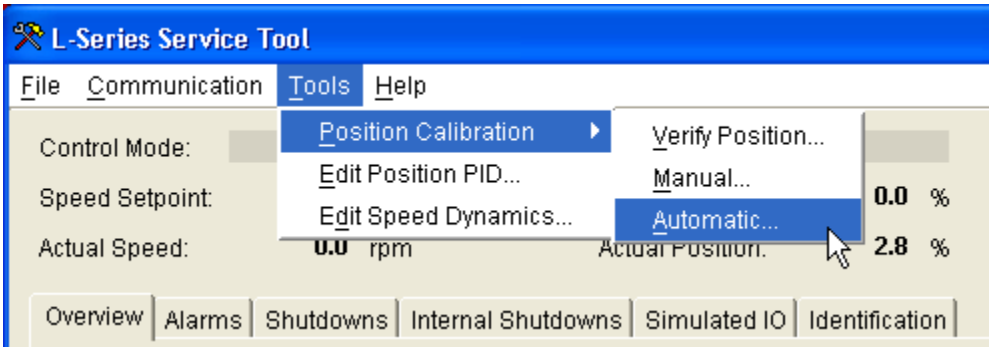
Position Calibration and Verification

Position calibration is normally used when full travel of the actuator is constrained or limited such that 0 to 60 degrees of travel is not used. **When replacing a TQ-125 with an L-Series, the linkage travel is usually less than 60 degrees, and a position calibration must be performed for proper operation**. The Service Tool is used to calibrate the control to end user (linkage) stops and to verify the position calibration. The L-Series will be driven from min position to max position, and the values will be saved. Refer to L-series Speed Control manual 26250 for complete description of calibration and position verification.

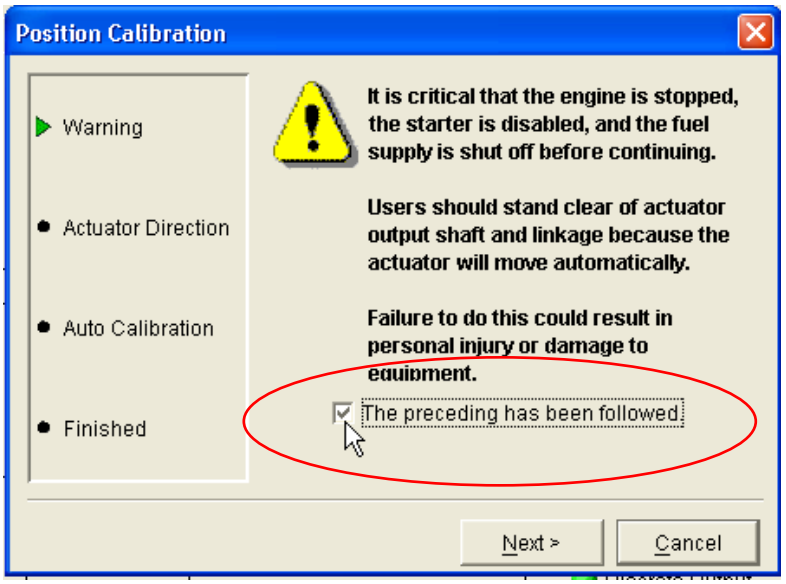
1. Verify the L-Series is at minimum position when the throttle or fuel rack is at minimum position. If unsure, simply loosen the L-Series lever and rotate the L-Series shaft to full minimum position and re-tighten the lever.

2. Using the L-Series Service Tool, select the Automatic Position Calibration from the Tools option at the top of the screen.

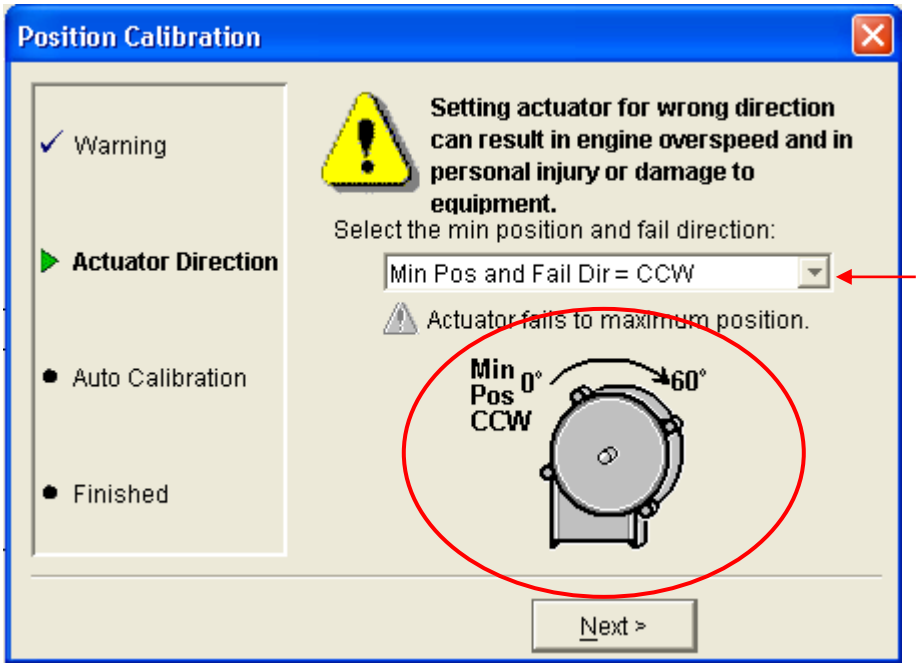
Example of Calibration Menu



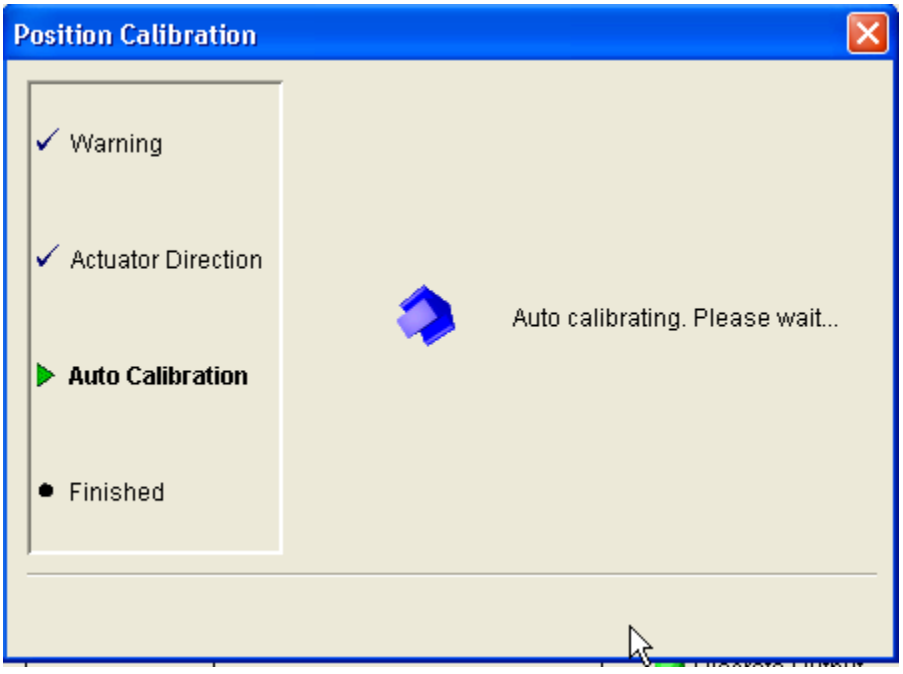
3. After reading the warning message, select the checkbox and then click the Next button using your mouse.



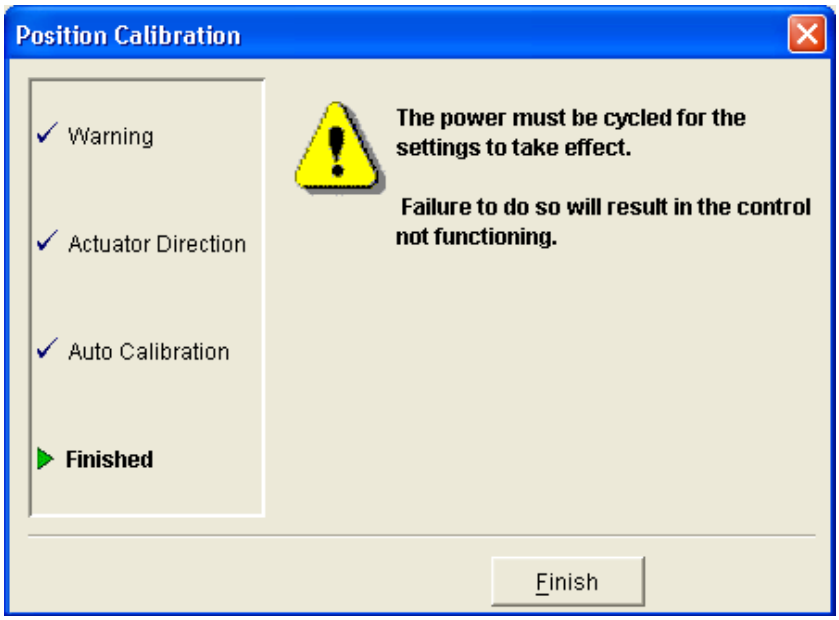
4. The minimum position and the failed direction are listed here and graphically shown from the shaft end of the L-Series. If this is not correct, use the pulldown arrow the change the direction of rotation and the failed direction to the correct orientation for your installation.



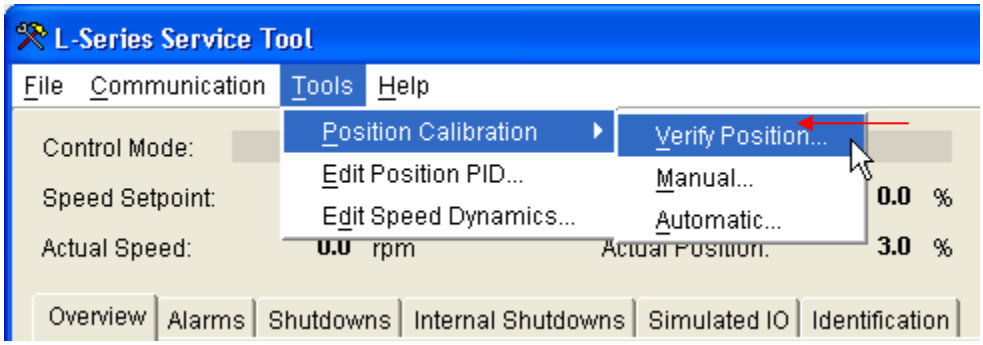
5. The blue programming arrow will rotate during calibration and the L-Series will move from minimum to maximum position.



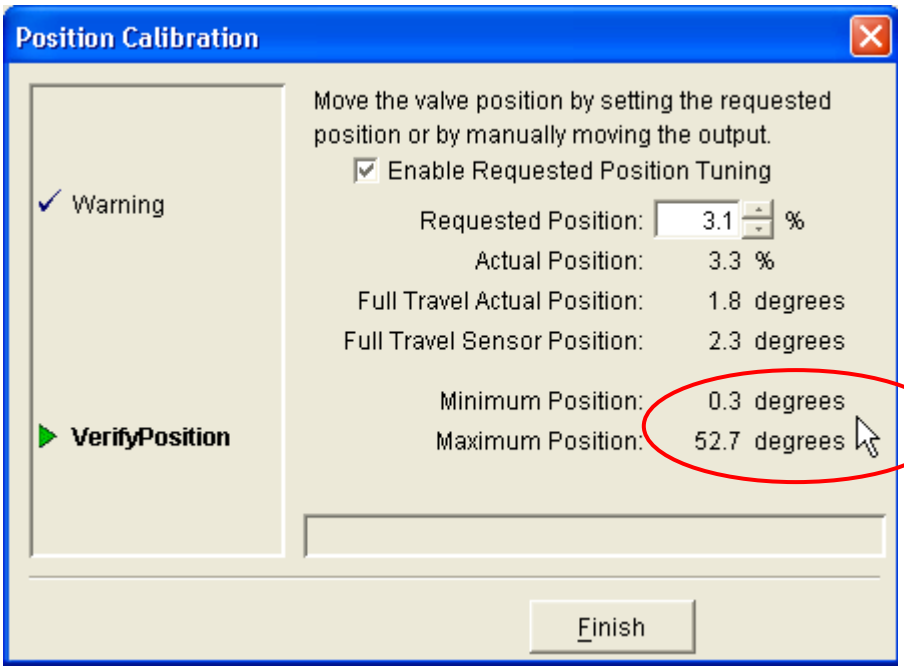
6. When complete, the following screen will appear. You must cycle power in order to save the new min/max stop positions. Select the Finish button and immediately remove power from the L-Series for approximately 5 seconds, then re-apply power. The Service Tool will re-connect. Now verify the position using the same Tools menu option.



7. From the Tools option, select Position Calibration and then Verify Position. Once again, after reading the warning message, select the checkbox and then click the Next button using your mouse.



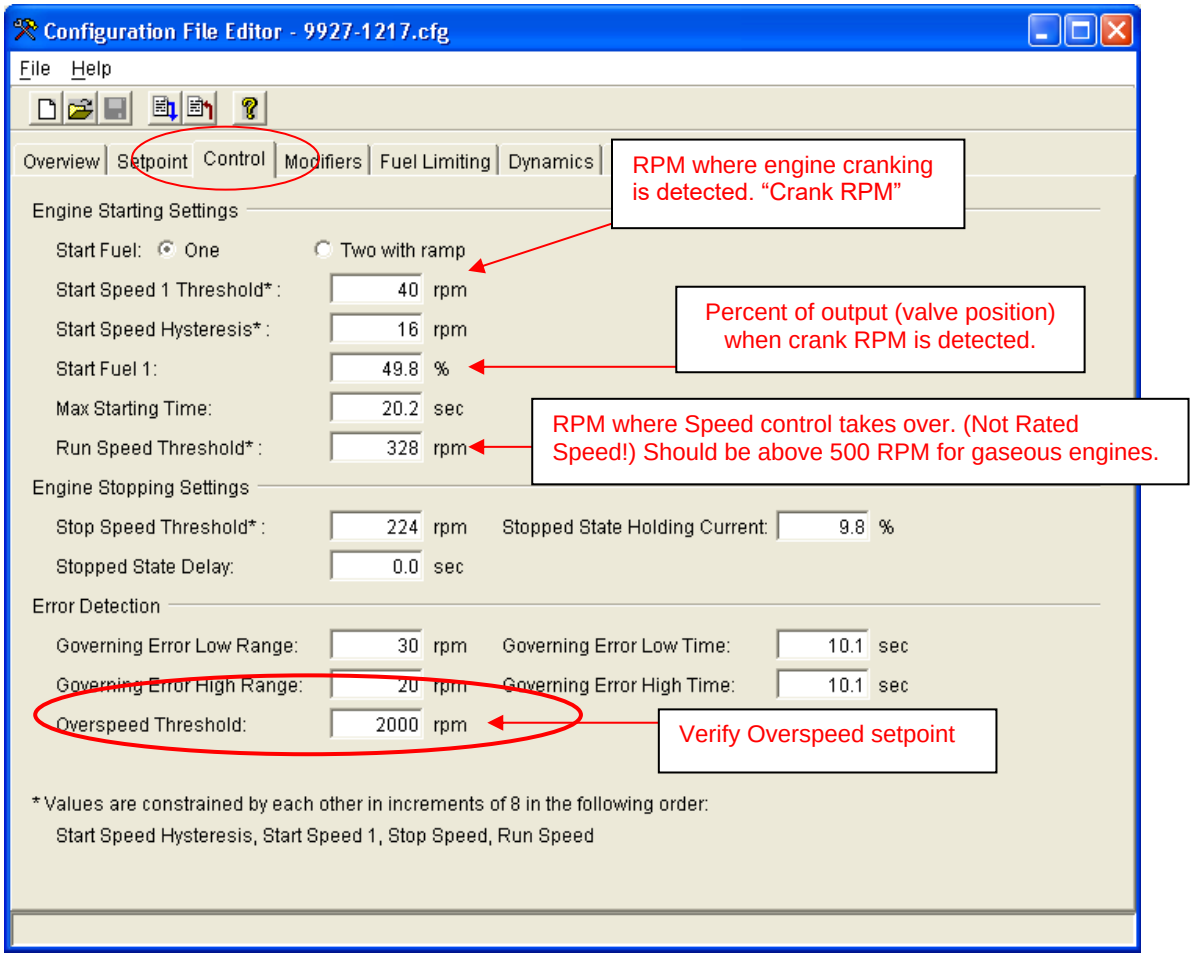
8. Select the checkbox to enable manual position tuning. Note the minimum and maximum positions at the bottom of the screen—these are the saved minimum and maximum positions from your calibration. **For best results, you should have a minimum 30 degrees of travel—anything less than 30 degrees may cause instability or difficulty in tuning the dynamic settings due to excessive gain in the mechanical linkage.** If you do not have 30 degrees of travel from minimum to maximum position, re-adjust your linkage to obtain additional travel and repeat the calibration procedure (steps 1–8).



9. With the checkbox enabled, enter a value for requested position of 50% and press the “Enter” key on your PC. Do not select the Finish button until you are ready to exit. A requested position of 50% is 50% of full travel. If your full travel is 30 degrees, 50% will be 15 degrees or 50% of full travel. If the L-series does not move in the desired direction, repeat the calibration procedure and correct the direction of rotation. If the normal movement is verified, select the Finish button to exit. You can now proceed with normal start-up and dynamic configuration.

The following page gives an example of the Control Tab configuration settings of the L-Series. We recommend that you check this example and compare the settings of your control before starting.

Configuration File Control Tab Settings



Revision History

Changes in Revision C—

- Updated Part Number of L-Series Speed Controller to 8401-7104

Released

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 51272.

PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

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.