MLS300 Series
User's Guide

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Warranty

Watlow Anafaze, Incorporated warrants that the products furnished under this Agreement will be free from defects in material and workmanship for a period of three years from the date of shipment. The Customer shall provide notice of any defect to Watlow Anafaze, Incorporated within one week after the Customer's discovery of such defect. The sole obligation and liability of Watlow Anafaze, Incorporated under this warranty shall be to repair or replace, at its option and without cost to the Customer, the defective product or part.

Upon request by Watlow Anafaze, Incorporated, the product or part claimed to be defective shall immediately be returned at the Customer's expense to Watlow Anafaze, Incorporated. Replaced or repaired products or parts will be shipped to the Customer at the expense of Watlow Anafaze, Incorporated.

There shall be no warranty or liability for any products or parts that have been subject to misuse, accident, negligence, failure of electric power or modification by the Customer without the written approval of Watlow Anafaze, Incorporated. Final determination of warranty eligibility shall be made by Watlow Anafaze, Incorporated. If a warranty claim is considered invalid for any reason, the Customer will be charged for services performed and expenses incurred by Watlow Anafaze, Incorporated in handling and shipping the returned unit.

If replacement parts are supplied or repairs made during the original warranty period, the warranty period for the replacement or repaired part shall terminate with the termination of the warranty period of the original product or part.

The foregoing warranty constitutes the sole liability of Watlow Anafaze, Incorporated and the Customer's sole remedy with respect to the products. It is in lieu of all other warranties, liabilities, and remedies. Except as thus provided, Watlow Anafaze, Inc. disclaims all warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose.

Please Note: External safety devices must be used with this equipment.

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1

System Overview

Manual Contents

This manual describes how to install, setup, and operate a MLS316 or MLS332 controller. Each chapter covers a different aspect of your control system and may apply to different users. The following describes each chapter's purpose.

- **Chapter 1: System Overview.** Provides a component list and summary of features for the MLS300 controllers.
- **Chapter 2: Installation.** Provides detailed instructions on installing the MLS300 controller and its peripherals.
- **Chapter 3: Using the MLS300.** Provides an overview of operator displays used for system monitoring and job selection.
- **Chapter 4: Setup.** Provides detailed descriptions of all menus and menu options for controller setup.
- **Chapter 5: Extruder Options.** Explains the additional features on an MLS300 controller equipped with Extruder Control Firmware.
- **Chapter 6: Enhanced Features.** Describes process variable retransmit, ratio, differential and cascade control features available with the enhanced features option.
- **Chapter 7: Ramp/Soak.** Explains how to setup and use the features of the ramp/soak option.
- **Chapter 8: Tuning and Control.** Describes available control algorithms and provides suggestions for applications.
- **Chapter 9: Troubleshooting and Reconfiguring.** Includes troubleshooting, upgrading and reconfiguring procedures for technical personnel.

- **Chapter 10: Linear Scaling Examples.** Provides an example configuring a pressure sensor, a flow sensor, and an encoder using linear scaling.
- **Chapter 11: Specifications.** Lists detailed specifications of the controller and optional components.

Getting Started

The following sections provide information regarding product features, technical descriptions, safety requirements, and preparation for operation.

These symbols are used throughout this manual:

DANGER! ***Indicates potential for serious injury or loss of human life.***

WARNING! ***Indicates possible damage to property or equipment.***

NOTE! ***Indicates pertinent information in order to proceed.***

Initial Inspection

Accessories may or may not be shipped in the same container as the MLS300, depending upon their size. Check the shipping invoice carefully against the contents received in all boxes.

Product Features

The MLS300 series controllers provide 16 or 32 fully independent loops of PID control. When used as a stand-alone controller, you may operate the MLS300 via the two-line 16-character display and touch keypad. You can also use it as the key element in a computer-supervised data acquisition and control system; the MLS300 can be locally or remotely controlled via an EIA/RS-232 or EIA/RS-485 serial communications interface.

The MLS300 features include:

- **Direct Connection of Mixed Thermocouple Sensors**: Connect most thermocouples to the controller with no hardware modifications. Thermocouple inputs feature reference junction compensation, linearization, process variable offset calibration to correct for sensor inaccuracies, detection of broken, shorted or reversed thermocouples, and a choice of Fahrenheit or Celsius display.
- **CIM300 Input Option:** The CIM300 input module provides high density sensor termination with a smaller installation footprint and faster installation.
- **Accepts Resistive Temperature Detectors (RTDs):** Use 3-wire, 100 ohm, platinum, DIN-curve sensors with two choices for range and precision of measurements. (To use this input, order a MLS316 or MLS332 controller with scaling resistors.)
- **Automatic Scaling for Linear Analog Inputs:** The MLS300 series automatically scales linear inputs used with other industrial process sensors. Enter two points, and all input values are automatically scaled in your units. Scaling resistors must be installed.
- **Dual Outputs:** The MLS300 series includes both heat and cool outputs for up to 16 loops. Independent control parameters are provided for each output.
- **Independently Selectable Control and Output Modes:** You can set each control output to ON/OFF, Time Proportioning, Serial DAC, or Distributed Zero Crossing mode. Set up to two outputs per loop for ON/OFF, P, PI, or PID control with reverse or direct action.
- **Control Outputs:** Set high/low deviation and high/low process limits to operate digital outputs as on/off control functions or alarms.

- **Flexible Alarm Outputs:** Independently set high/low process alarms and a high/low deviation band alarm for each loop. Alarms can activate a digital output by themselves, or they can be grouped with other alarms to activate an output.
- **Global Alarm Output:** When any alarm is triggered, the Global Alarm Output is also triggered, and it stays on until you acknowledge it.
- **CPU Watchdog:** The MLS300 series CPU watchdog timer output notifies you of system failure. You can use it to hold a relay closed while the controller is running, so you are notified if the microprocessor shuts down.
- **Front Panel or Computer Operation:** Set up and run the controller from the front panel or from a local or remote computer. WatView software is available to configure and monitor the MLS300 from a PC.
- **Modbus RTU Protocol, EIA/TIA-232 and 485 Communications:** Connect to PLCs, operator interface terminals and third-party software packages using the widely supported Modbus RTU protocol.
- **Multiple Job Storage:** Store up to 8 jobs in memory, and access them locally by entering a single job number or remotely via digital inputs. Each job is a set of operating conditions, including set points and alarms.
- **Non-Linear Output Curves:** Select either of two non-linear output curves for each control output.
- **Autotuning Makes Setup Simple:** Use the Autotune feature to set up your system quickly and easily. The MLS300 internal expert system table finds the correct PID parameters for your process.
- **Pulse Counter Input:** Use the pulse counter input for precise control of motor or belt speed.
- **Low Power Shutdown:** The controller shuts down and turns off all outputs when it detects the input voltage drop below the minimum safe operating level.

System Diagram

The illustration below shows how the parts of the MLS300 are connected. When unpacking your system, use the diagram and parts list below to ensure all parts have been shipped. Please don't hesitate to call Watlow Anafaze's Customer Service Department if you have problems with your shipment, or if the MLS300's components are missing or damaged.

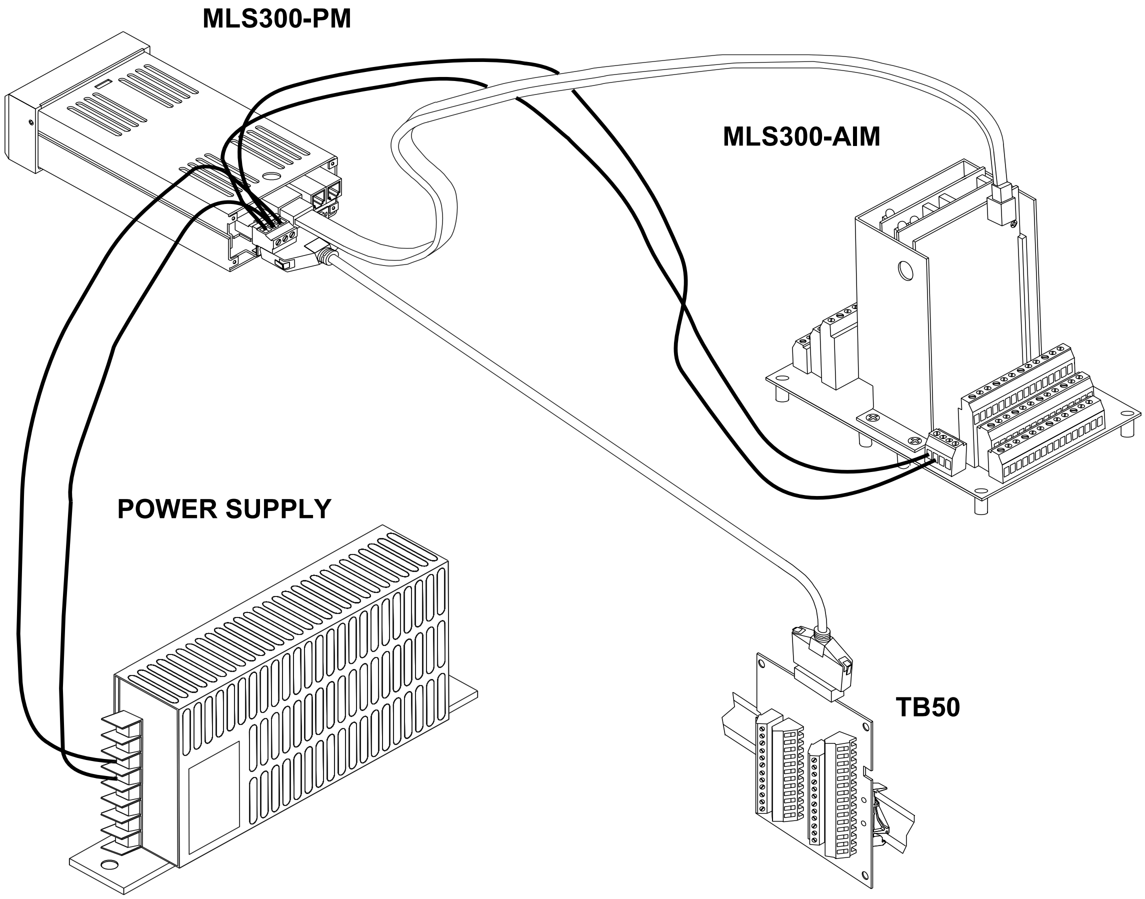


Figure 1.1 System Diagram

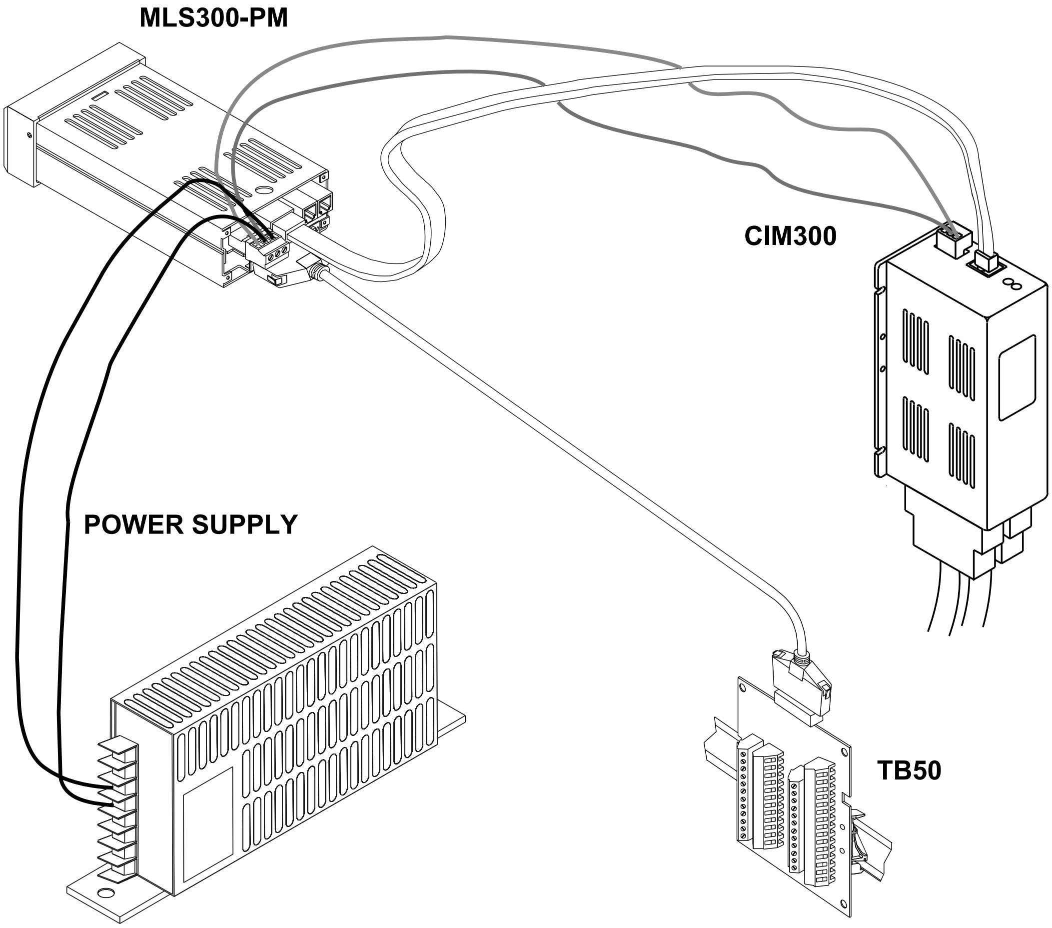


Figure 1.2 System Diagram with CIM300

Parts List MLS316/MLS332

You may have received one or more of the following components. Refer to *Figure 1.1 on page 5* and *Figure 1.2 on page 6* for MLS300 configuration information.

- MLS300 Processor Module (PM)
- Controller Mounting Kit
- 16- or 32-Channel MLS300-AIM Module with 4-foot AIM cable
- 16- or 32-Channel CIM300 Module with 4-foot AIM cable.
- EIA/RS-232 or EIA/RS-485 Communication Cable
- TB50 with 50-pin SCSI Cable
- Power Supply with Mounting Bracket and Screws
- SDAC (Serial Digital-to-Analog Converter)
- Special Input Resistors (installed in MLS300 AIM)
- User Manual

To order, complete the model number to the right with the information below: **3** _ _ - _ _ _ _ _ _ _ _ _

Input Module
16 = 16-channel Analog Input Module (AIM316)
32 = 32-channel Analog Input Module (AIM332)
C1 = 16-channel Compact Input Module (CIM316)
C2 = 32-channel Compact Input Module (CIM332)

Processor Module and Firmware
0 = Input module only (no MLS300-PM)
1 = Standard firmware option
2 = Extruder firmware option
3 = Enhanced features option (includes cascade, PV retransmit, ratio, remote set point)
4 = Ramp and soak firmware option

Terminal Board
0 = No terminal board accessory
1 = 50-pin terminal board, includes 3 foot SCSI cable

Power Supply
0 = None
2 = 120/240V~(ac) 50/60Hz power supply adapter (5V⎓[dc] @ 4A, 15V⎓[dc] @ 1.2A) CE approved

SCSI Cables (For use with 50-pin terminal board)
0 = No special SCSI cable (3-foot cable is included with 50-pin terminal board)
1 = 6-foot SCSI cable
2 = 3-foot right angle SCSI cable
3 = 6-foot right angle SCSI cable

Serial Communication Cables (For communications with computer)
0 = No serial communications cable
1 = 10-foot EIA/TIA-232 communications cable, DB-9/RJ-12 phone plug
2 = 25-foot EIA/TIA-232 communications cable, DB-9/RJ-12 phone plug
3 = 50-foot EIA/TIA-232 communications cable, DB-9/RJ-12 phone plug
7 = EIA/TIA-485 terminal block with 2-foot cable
8 = EIA/TIA-485 terminal block with 4-foot cable

Module Interconnect Cables
0 = No special cable (4 foot cable comes with input module)
1 = 10-foot MLS AIM cable, RJ45/RJ45
2 = 25-foot MLS AIM cable, RJ45/RJ45

Serial Communications Jumper Settings
0 = EIA/TIA-232
1 = EIA/TIA-485
2 = EIA/TIA-485 terminated

Special Inputs
(Standard unit is configured for thermocouples and -10 to 60 mV linear inputs. For other sensors, order special inputs.)
00 = Thermocouples and -10 to 60 mV inputs only
XX = Number of current, voltage, and RTD inputs. Include leading zero as needed.

Figure 1.3 MLS300 Part Numbering

If special inputs are ordered in the controller part number, specify the following information in the part description:

MLS300SI __ __ __ __ __ __

Special Input Type
(Not required for thermocouple sensor inputs)
20 = RTD1: 0.1° Platinum, -100.0 to 300.0°C (-148.0 to 572.0°F)
21 = RTD2: 1° Platinum, -120.0 to 840.0°C (-184.0 to 1544.0°F)
43 = 0 to 10mA⎓(dc)
44 = 0 to 20mA⎓(dc)/4 to 20mA⎓(dc)
50 = 0 to 100mV⎓(dc)
52 = 0 to 500mV⎓(dc)
53 = 0 to 1V⎓(dc)
55 = 0 to 5V⎓(dc)
56 = 0 to 10V⎓(dc)
57 = 0 to 12V⎓(dc)

Start Channel
XX = Channel number XX

End Channel
XX = Channel number XX

Note:
Make sure the number of special inputs specified is equal to the number of special inputs in the controller part number.
Uninstalled kits are available upon request.

Figure 1.4 Special Input Description

Technical Description

This section contains a technical description of each component of your MLS300 Controller.

Processor Module

The MLS300 Processor Module (MLS300-PM) is housed in an eighth-DIN panel mount package. It contains the CPU, RAM with a built-in battery, EPROM, serial communications, digital I/O, the screen and touch keypad.

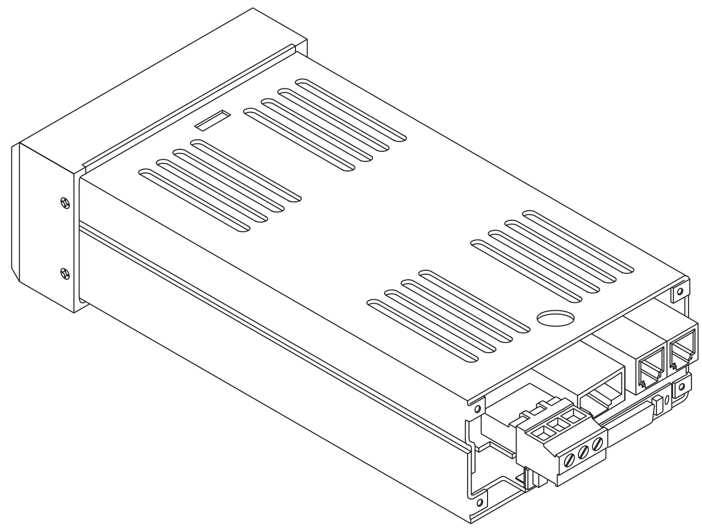


Figure 1.5 MLS300-PM Rear View

The MLS300-PM has the following features:

- Keypad and 2-line, 16-character display.
- Screw terminals for the power inputs and outputs.
- Input power is 12 to 24 Vdc at 1 amp.
- The +5 Vdc output power supply of the processor module powers the MLS300-AIM.
- The MLS300-PM interfaces with the MLS300-AIM with an 8-pin RJ-45 style connector.
- A 50-pin SCSI cable connects the digital inputs and outputs to the 50-pin terminal block (TB50).
- The MLS300 uses 6-pin, telephone-style connectors for EIA/RS-232 and EIA/RS-485 external communications.

The program that operates the MLS300 is stored in a socketed, flash, static-RAM chip, so it is easy to update or change the firmware. The MLS300 stores its operating parameters in battery-backed RAM, so if there's a power loss the operating parameters are unchanged. The battery has a ten year shelf life, and it is not used when the unit is on.

The microprocessor performs all calculations for input signal linearization, PID control, alarms, and communications.

Front Panel Description

The MLS300-PM's display and touch keypad provide an intelligent way to operate the MLS300. The display has 16 alphanumeric or graphic characters per line. The 8-key keypad allows you to change the MLS300's operating parameters, controller functions, and displays.

The MLS300's information-packed displays show process variables, set points, and output levels for each loop. A bar graph display, single loop display, scanning display and an alarm display offer a real-time view of process conditions. Two access levels allow operator changes and supervisor changes.

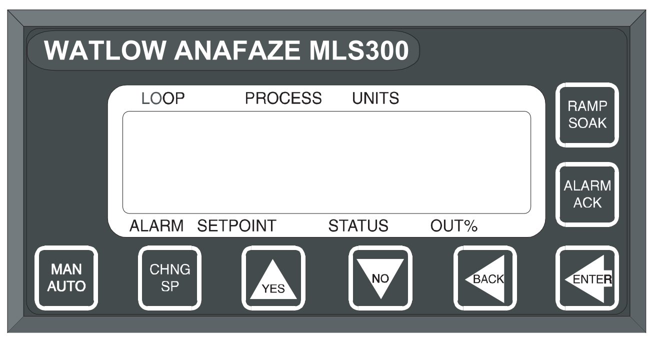


Figure 1.6 MLS300 Front Panel

TB50

The TB50 is a screw terminal interface for control wiring which allows you to connect relays, encoders and discrete I/O devices to the MLS300. The screw terminal blocks accept wires as large as 18 AWG. A 50-pin SCSI cable connects the TB50 to the MLS300-PM.

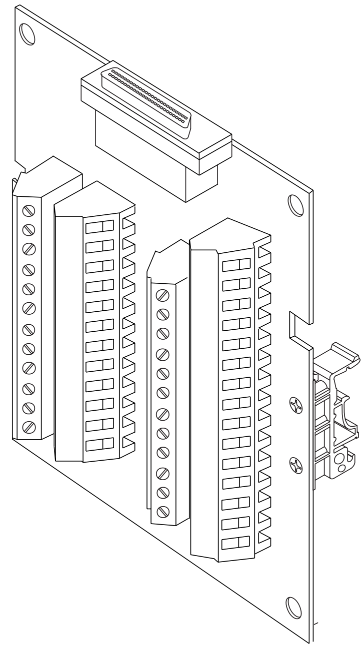


Figure 1.7 TB50

MLS300-AIM and AIM-TB

The MLS300 Analog Input Module (MLS300-AIM), consists of the AIM-TB (AIM Terminal Board) and the AIM's plug-in cards. The MLS300-AIM receives input signals from sensors and transmits this information to the MLS300-PM through the AIM cable.

The AIM-TB includes power supply terminals, input signal wiring screw terminals, input signal conditioning circuits, and terminal connections for the AIM's plug-in cards. It also includes a cold junction temperature sensor and room for the input scaling resistors, if required. (RTDs, inputs greater than 60 mVdc, and mAdc current inputs require input scaling resistors.) The AIM-TB has three slots for the plug-in AIM cards.

There are two versions of the MLS300-AIM: the AIM-16 and AIM-32. The AIM-16 has one multiplexer (MUX) card, and the AIM-32 has two MUX cards. These cards multiplex the 16 inputs each card receives. Each -10 to 60 mVdc input is converted to a voltage that is transmitted to the Voltage/ Frequency (V/F) card. (The MUX cards also automatically calibrate the zero and span of the analog amplifier and measure the cold junction compensation temperature for thermocouple inputs.) Both the AIM-16 and AIM-32 have a V/F card, which converts the input signal voltage to a frequency. The converted signal is then transmitted via the AIM cable to the MLS300-PM for processing.

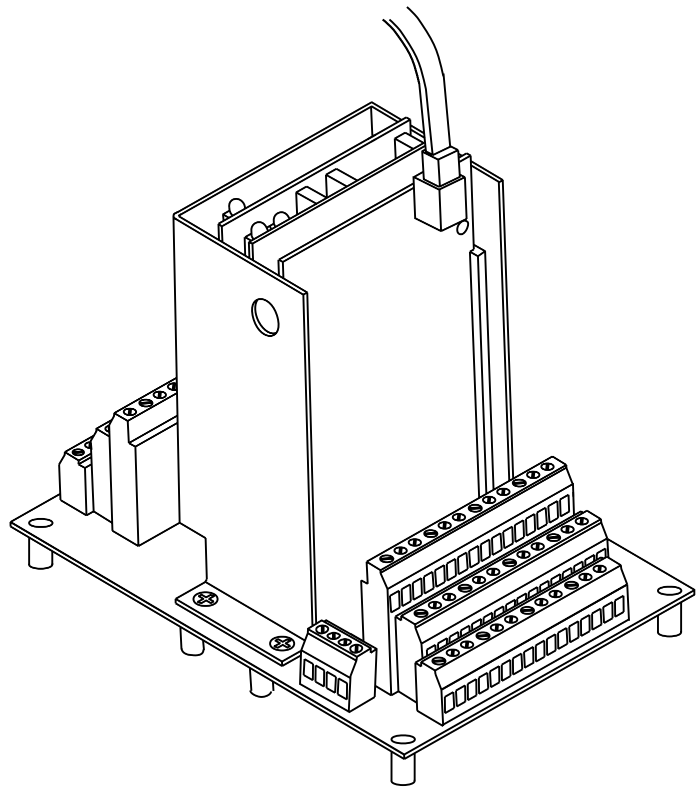


Figure 1.8 MLS300-AIM-32 and Terminal Block

CIM300

The MLS300 Compact Input Module (CIM300) consists of two circuit boards that perform analog-to-digital conversion and data communications to the processor module. The CIM300 receives input signals from sensors and transmits this information to the MLS300-PM through the AIM cable.

The CIM300 includes power supply terminals, input signal connectors, a communications connector and input signal conditioning circuits. It also includes a cold-junction temperature sensor and room for the input scaling resistors, if required. (RTDs, inputs greater than 60 mV dc, and mA dc current inputs require input scaling resistors.)

There are two versions of the CIM300: the CIM316 and CIM332. The CIM316 supports 16 inputs through a D-Sub 50 female connector and the CIM332 supports 32 inputs through 2 D-Sub 50 connectors (inputs 1 to 16 female, inputs 17 to 32 male). The user supplies the mating D-Sub 50 connectors. The CIM300 has one or two multiplexer circuits that multiplex the 16 inputs each card receives. Each -10 to 60 mV dc input is converted to a voltage that is transmitted to the Voltage/ Frequency (V/F) card. (The mulitplexer circuits also automatically calibrate the zero and span of the analog amplifier and measure the cold-junction compensation temperature for thermocouple (T/C) inputs.) A V/F circuit converts the input signal voltage to a frequency. The converted signal is then transmitted via the AIM cable to the MLS300-PM for processing.

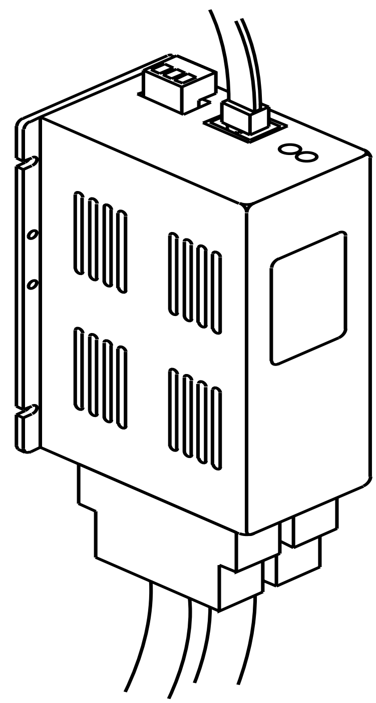


Figure 1.9 CIM300

MLS300 Cabling

Watlow Anafaze provides cables required to install your MLS300.

A 50-pin SCSI cable connects the TB50 to the MLS300-PM.

The cable connecting the MLS300-PM to the AIM-TB is an 8-conductor, shielded cable with RJ-45 connectors.

The cables used to connect the MLS300 to EIA/RS-232 or EIA/RS-485 communications are 6-conductor, shielded cable with RJ-12 connectors on one end and a DB-9 connector or bare wires on the other end.

WARNING! ***The pin numbering convention used for communications cables varies between suppliers. See Serial Communications, Cable Connector Pin Outs on page 62.***

Safety

Watlow Anafaze has made every effort to ensure the reliability and safety of this product. In addition, we have provided recommendations that will allow you to safely install and maintain this controller.

DANGER! ***Ensure that power has been shut off to your entire process before you begin installation of the controller.***

WARNING! ***In any application, failures can occur. These failures can result in full control output (100% power), or the occurrence of other output failures which can cause damage to the controller, or to the equipment or process connected to the controller. Therefore, always follow good engineering practices, electrical codes, and insurance regulations when installing and operating this equipment.***

External Safety Devices

External safety devices should be used to prevent potentially dangerous and unsafe conditions upon equipment failure. Always assume that this device can fail with outputs full-on, or full-off, by the occurrence of an unexpected external condition.

DANGER! ***Always install high or low temperature protection in installations where an over-temperature or under-temperature fault will present a potential hazard. Failure to install external protection devices where hazards exist can result in damage to equipment and property as well as loss of human life.***

Power-Fail Protection

In the occurrence of a sudden loss of power, this controller can be programmed to reset the control outputs to OFF (this is the default). Typically, when power is re-started, the controller restarts to data stored in memory. If you have programmed the controller to restart with control outputs ON, the memory-based restart might create an unsafe process condition for some installations. Therefore, you should only set the restart with outputs ON if you are certain your system will safely restart. (See *Process Power Digital Input on page 98*).

When using a computer or host device, you can program the software to automatically reload desired operating constants or process values on power-up. Keep in mind that these convenience features do not eliminate the need for independent safety devices.

Contact Watlow Anafaze immediately if you have any questions about system safety or system operation.

2

Installation

This chapter describes how to install the MLS300 series controller and its peripherals. Installation of the controller involves the following procedures:

- Determining the best location for the controller
- Mounting the controller, the AIM and the TB50
- Power connection
- Testing the system
- Input wiring
- Output wiring
- Communications wiring (EIA/TIA-232 or EIA/TIA-485)

Typical Installation

Figure 2.1 on page 18 illustrates a typical installation of the MLS300-PM (controller) with the MLS300-AIM (analog input module), TB50 terminal block, and power supply.

Refer to *Figure 2.15 on page 36* for a more detailed view of the power connections.

Read this entire chapter before beginning the installation procedure.

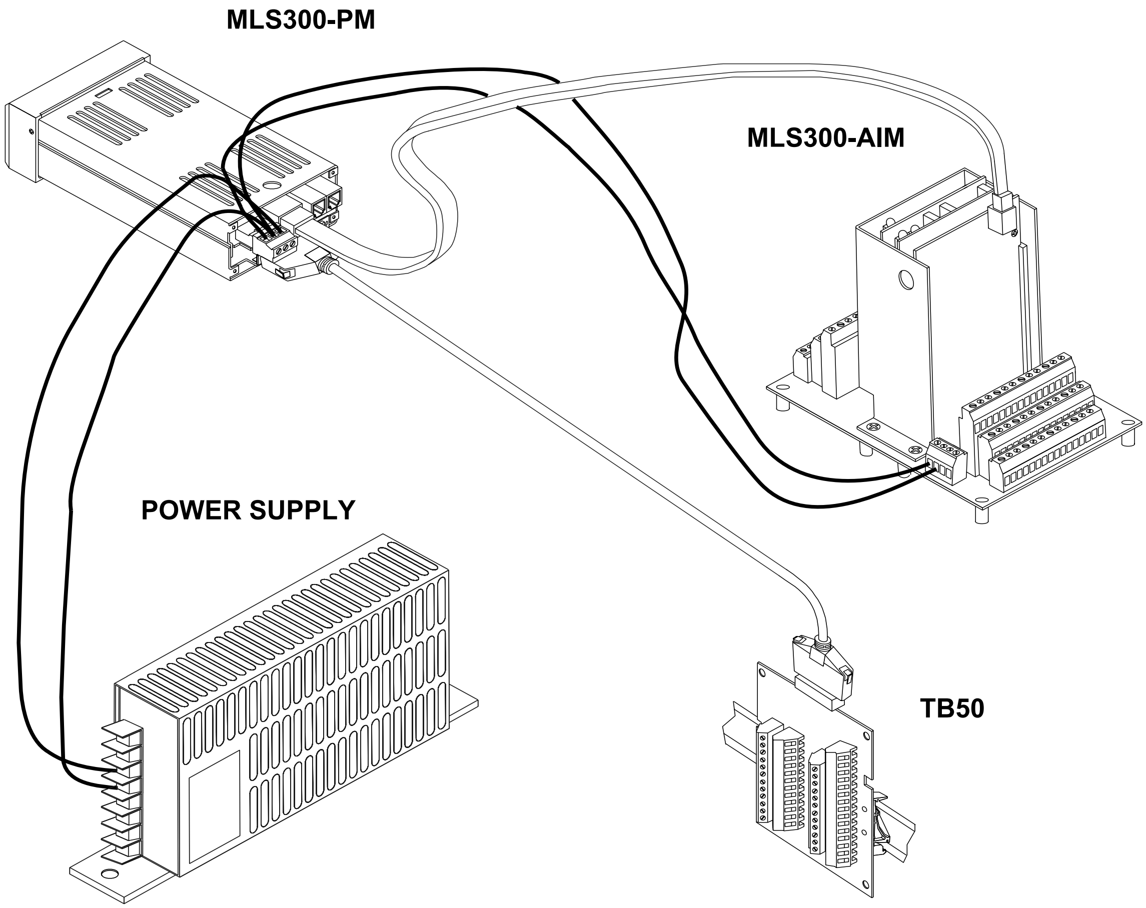


Figure 2.1 MLS300 System Components with AIM

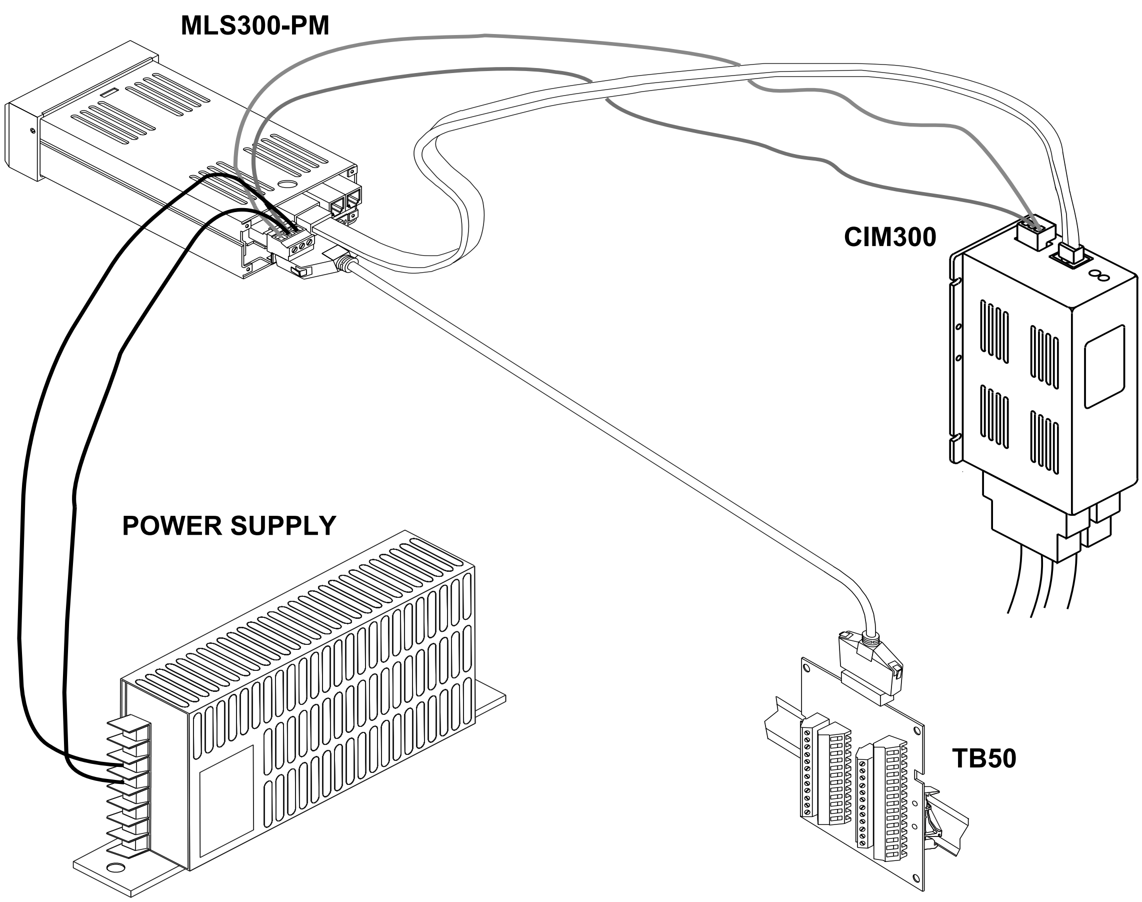


Figure 2.2 MLS300 System Components with CIM300

Mounting Controller Components

Install the controller in a location free from excessive heat (more than 50°C), dust and unauthorized handling. Electromagnetic and radio frequency interference can induce noise on sensor wiring. Select locations for the MLS300-PM and MLS300-AIM and CIM300 such that wiring can be routed clear of sources of interference such as high voltage wires, power switching devices and motors.

DANGER! ***The MLS300 system is for indoor use only. Install it in a controlled environment to reduce the risk of fire or electric shock.***

Recommended Tools

Use these tools to install the MLS300 series controller.

Panel Hole Cutters

Use any of the following tools to cut a hole of the appropriate size in the panel.

- Jigsaw and metal file, for stainless steel and heavyweight panel doors.
- Greenlee 1/8 DIN rectangular punch (Greenlee part # 600-68), for most panel materials and thicknesses.
- Nibbler and metal file, for aluminum and lightweight panel doors.

Other Tools

You will also need these tools:

- Phillips head screwdriver
- Flathead screwdriver for wiring
- Multimeter
- A metal phone connector crimping tool (optional).

Watlow Anafaze provides all the cabling for the Modular Loop System. If you have special cabling requirements and you make your own RJ-12 communications cable, use a metal crimping tool for the connectors. (A metal tool makes better connections than a plastic tool.)

Mounting the Processor Module

Mount the processor module before you mount the terminal block or do any wiring. The controller's placement affects placement and wiring considerations for the other components of your system.

Ensure there is enough clearance for mounting brackets, terminal blocks, and cable and wire connections; the controller extends up to 9.0 in. (219 mm) behind the panel face and the collar and brackets extend 9/32 in. (7 mm) on the sides and 15/32 in. (12 mm) above and below it.

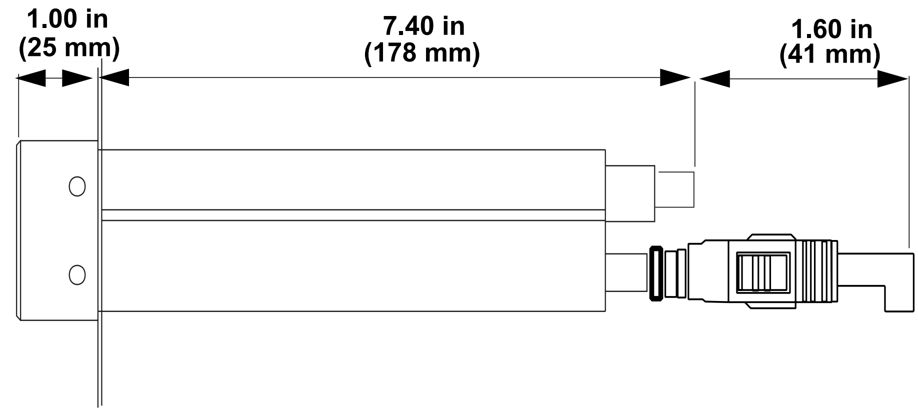


Figure 2.3 Clearance with Straight SCSI Cable

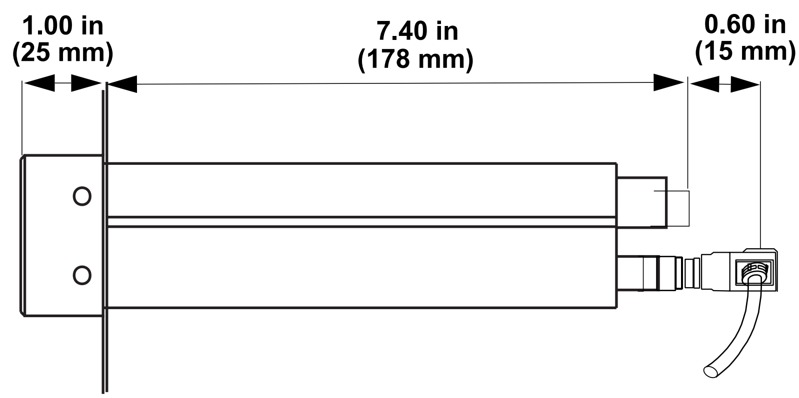


Figure 2.4 Clearance with Right-Angle SCSI Cable

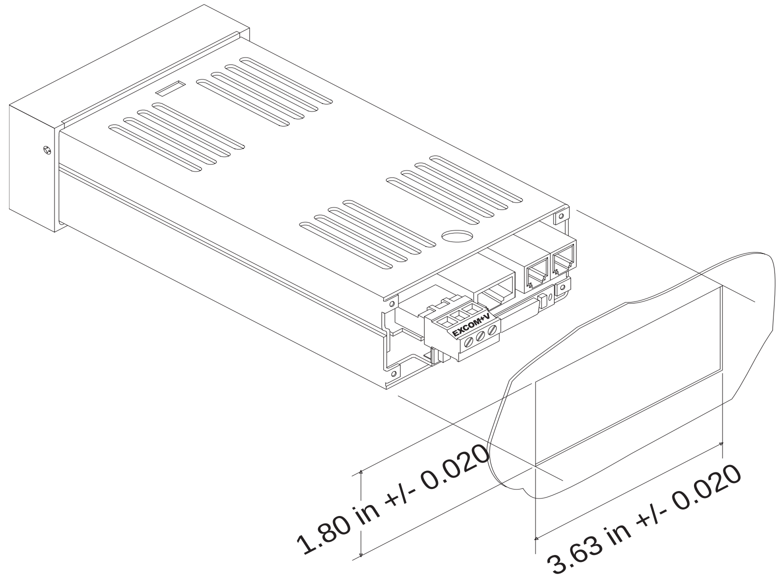


Figure 2.5 Wiring Clearances

We recommend you mount the controller in a panel not more than 0.2 in. (5 mm) thick.

1. Choose a panel location free from excessive heat (more than 50°C), dust, and unauthorized handling. (Make sure there is adequate clearance for the mounting hardware, terminal blocks, and cables. The controller extends 7.40 in. (178 mm) behind the panel. Allow for an additional 0.60 to 1.60 in. (15 to 41 mm) beyond the connectors.
2. Temporarily cover any slots in the metal housing so that dirt, metal filings, and pieces of wire do not enter the housing and lodge in the electronics.
3. Cut a hole in the panel 1.80 in. (46 mm) by 3.63 in. (92 mm) as shown below. (This picture is NOT a template; it is for illustration only.) Use caution; the dimensions given here have 0.02 in. (1 mm) tolerances.
4. Remove the brackets and collar from the processor module, if they are already in place.
5. Slide the processor module into the panel cutout.

6. Slide the mounting collar over the back of the processor module, making sure the mounting screw indentations face toward the back of the processor module.

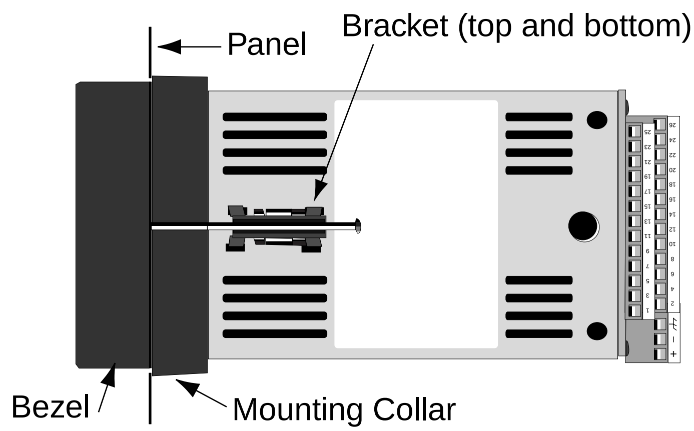


Figure 2.6 Mounting Bracket

7. Loosen the mounting bracket screws enough to allow for the mounting collar and panel thickness. Place each mounting bracket into the mounting slots (head of the screw facing the back of the processor module). Push each bracket backward then to the side to secure it to the processor module case.

Make sure the case is seated properly. Tighten the installation screws firmly against the mounting collar to secure the unit. Ensure that the end of the mounting screws fit into the indentations on the mounting collar.

Mounting the MLS300-AIM

NOTE!

If you plan to install scaling resistors, mount them on the AIM-TB before mounting the AIM-TB in the panel. See Chapter 9, Trouble-shooting and Reconfiguring.

If you ordered an MLS300-AIM-TB with scal-ing inputs from Watlow Anafaze, the scaling resistors are already installed.

Install the MLS300-AIM in a location free from excessive (more than 50°C) heat, dust, and unauthorized handling.

The MLS300-AIM measures 6.5 L x 5 W x 7 in. H. Leave 6 in. of clearance above the MLS300-AIM, so you can remove the entire unit (or just the AIM cards) if necessary.

1. Choose an appropriate place to install the MLS300-AIM.
2. Use the template shown in *Figure 2.7* as a reference for clearance and dimensions.

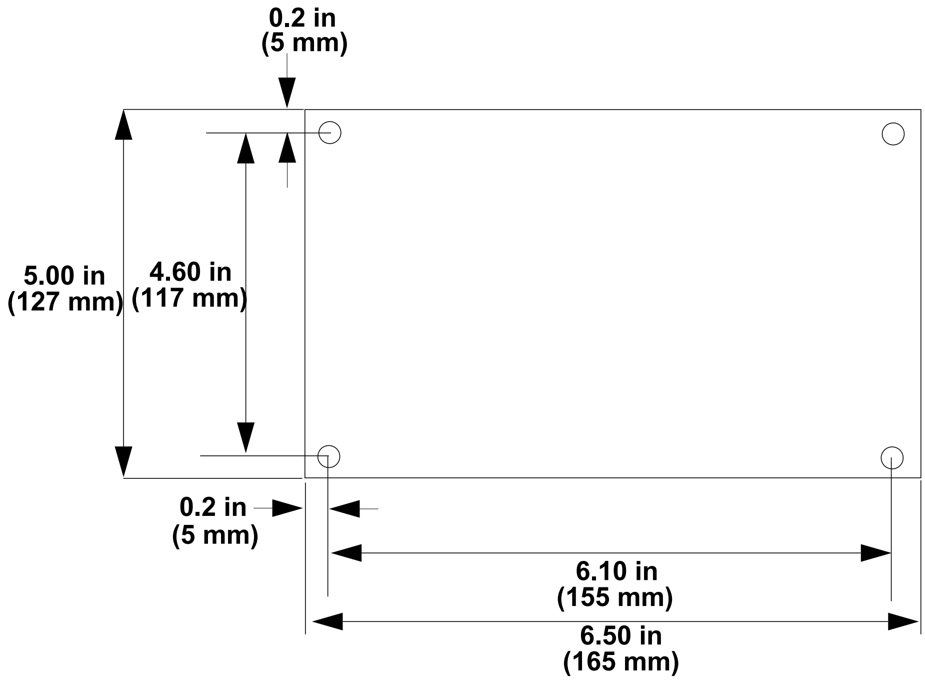


Figure 2.7 MLS300-AIM Template

3. Drill four holes for #6 or #8 screws in the chosen location.
4. Place the MLS300-AIM where you will mount it. Use screws with internal star lock washers to ensure a good Frame Ground connection. You may use self-tapping screws. Insert the screws through the standoffs and tighten them.
5. Be sure to remove any loose metal filings after you are finished mounting the MLS300-AIM.

Mounting the CIM300

NOTE! ***If you plan to install scaling resistors, mount them on the CIM300 before mounting the CIM300 in the panel. See Chapter 9, Trouble-shooting and Reconfiguring.***

If you ordered a CIM300 with scaling inputs from Watlow Anafaze, the scaling resistors are already installed.

Install the CIM300 in a location free from excessive (more than 50ºC) heat, dust and unauthorized handling. The CIM300 measures 7.5 L x 2.75 W x 3.75 inches D. Leave 1.5 inches of clearance above the CIM300, so that there will be enough space for power and communications wires.

DIN Mounting

1. Choose an appropriate place to install the CIM300.

2. Snap the CIM300 on to the DIN rail by placing the hook side on the rail first, then pushing the snap latch side in place. (To remove the CIM300 from the rail, use a flat-head screw driver to unsnap the bracket from the rail.)

Direct Mounting

1. Choose an appropriate place to install the CIM300.

2. Use the dimensions shown in Figure 2.8 as a reference for clearance and dimensions

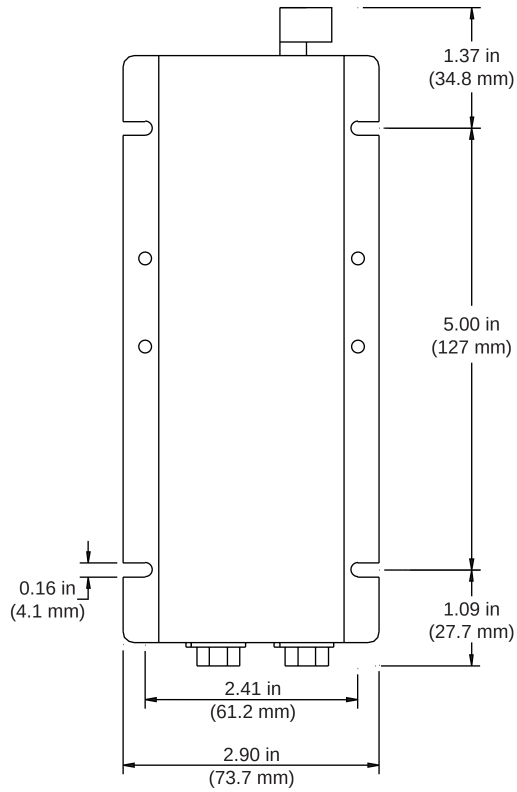


Figure 2.8 CIM300 Template

3. Drill four holes for #6 or #8 screws in the chosen location.

4. Place the CIM300 where you will mount it. Use screws with internal star lock washers to ensure a good frame ground connection. You may use self-tapping screws. Insert the screws through the standoffs and tighten them.

5. Be sure to remove any loose metal filings after you are finished mounting the CIM300.

NOTE! ***Do not connect power or sensors to the MLS300 now. Test the unit first, as explained in the Power Wiring and Controller Test section.***

Mounting the TB50

There are two ways you can mount the TB50: use the pre-installed DIN rail mounting brackets provided or use the plastic standoffs. Follow the corresponding procedures to mount the board.

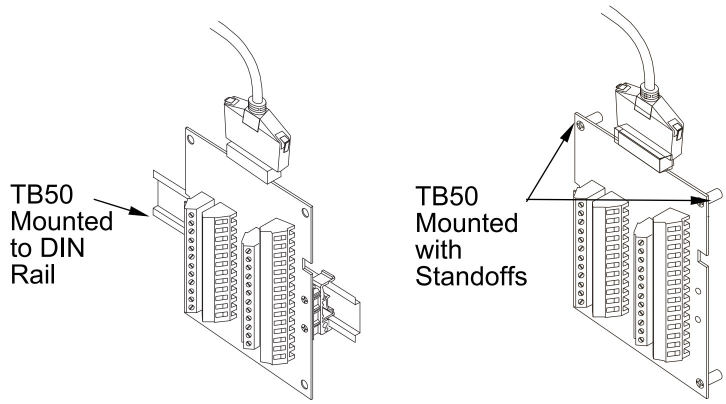


Figure 2.9 Mounting the TB50

DIN Rail Mounting

Snap the TB50 on to the DIN rail by placing the hook side on the rail first, then pushing the snap latch side in place. Refer to *Figure 2.10.*

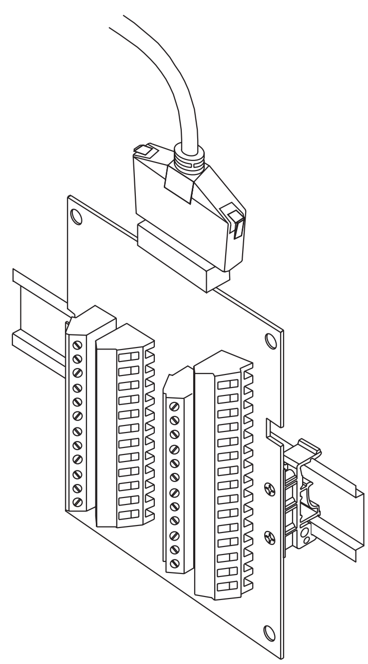


Figure 2.10 TB50 Mounted on a DIN Rail (Front)

To remove the TB50 from the rail, use a flat-head screw driver to unsnap the bracket from the rail. See *Figure 2.11.*

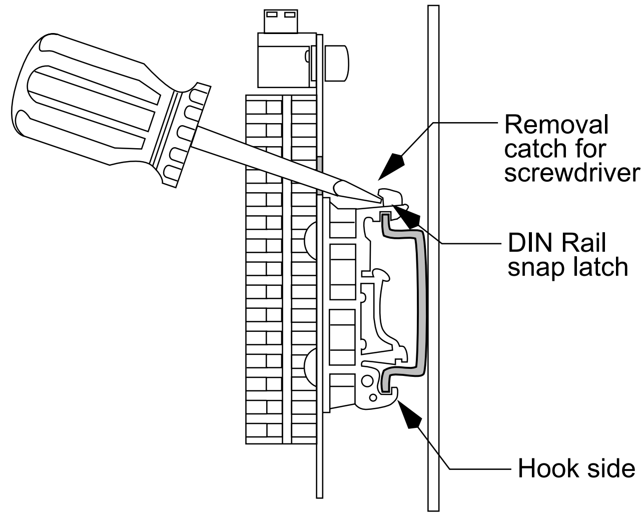


Figure 2.11 TB50 Mounted on DIN Rail (Side)

Mounting with Standoffs

1. Remove the DIN rail mounting brackets from the TB50.
2. Select a location with enough clearance to remove the TB50, its SCSI cable, and the controller itself.
3. Mark the four mounting holes.
4. Drill and tap the 4, #6 (3.5 mm) mounting holes.
5. Mount the TB50 with 4 screws.

There are four smaller holes on the terminal board. Use these holes to secure wiring to the terminal block with tie wraps.

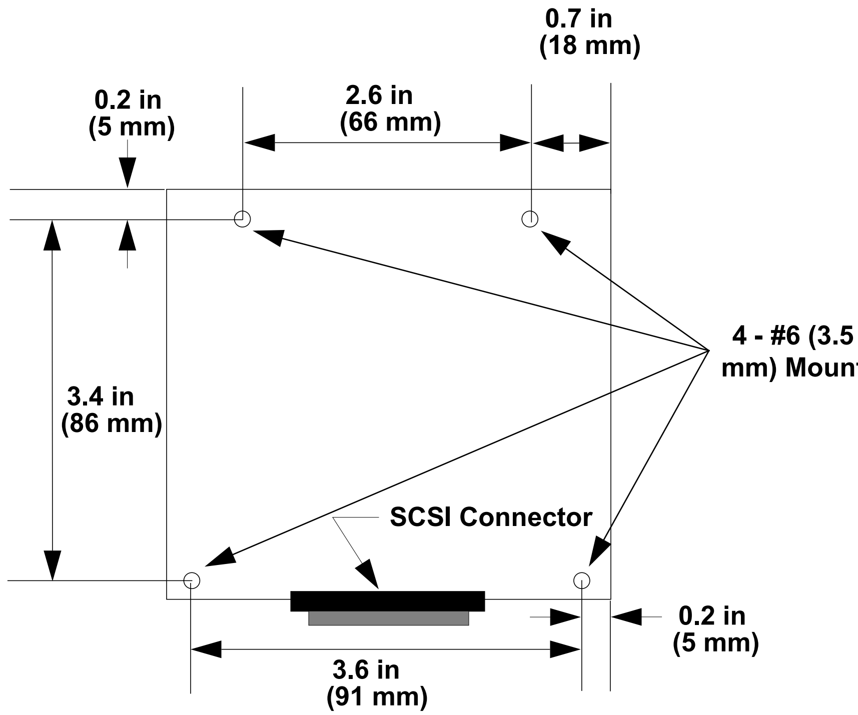


Figure 2.12 Mounting a TB50 with Standoffs

Mounting the Power Supply

If you use your own power supply for the MLS300, please refer to the power supply manufacturer's instructions for mounting information. Choose a power supply that supplies an isolated regulated 12 to 24 Vdc at 1 A.

Mounting Environment

Leave enough clearance around the power supply so that it can be removed.

Mounting DAC or SDAC Module

This section describes how to install the optional DAC and SDAC Digital-to-Analog Converters for use with a MLS300 series controller.

Installation

Installation of the DAC and SDAC is essentially the same. The main differences are in the dimensions and the wiring. Follow this procedure to correctly install these devices.

Jumpers

The output signal range of the DAC and SDAC modules is configured with jumpers. See *Configuring DAC Outputs on page 210* and *Configuring SDAC Outputs on page 212* for information on setting these jumpers.

Mounting

1. Select a location for installation. The unit is designed for wall mounting and should be installed as close to the controller as possible.
2. Mark and drill four holes for screw mounting. Holes accommodate #6 size screws. Use the diagrams in *Figure 2.14 on page 32* for the correct locations.
3. Install the unit with the four screws.

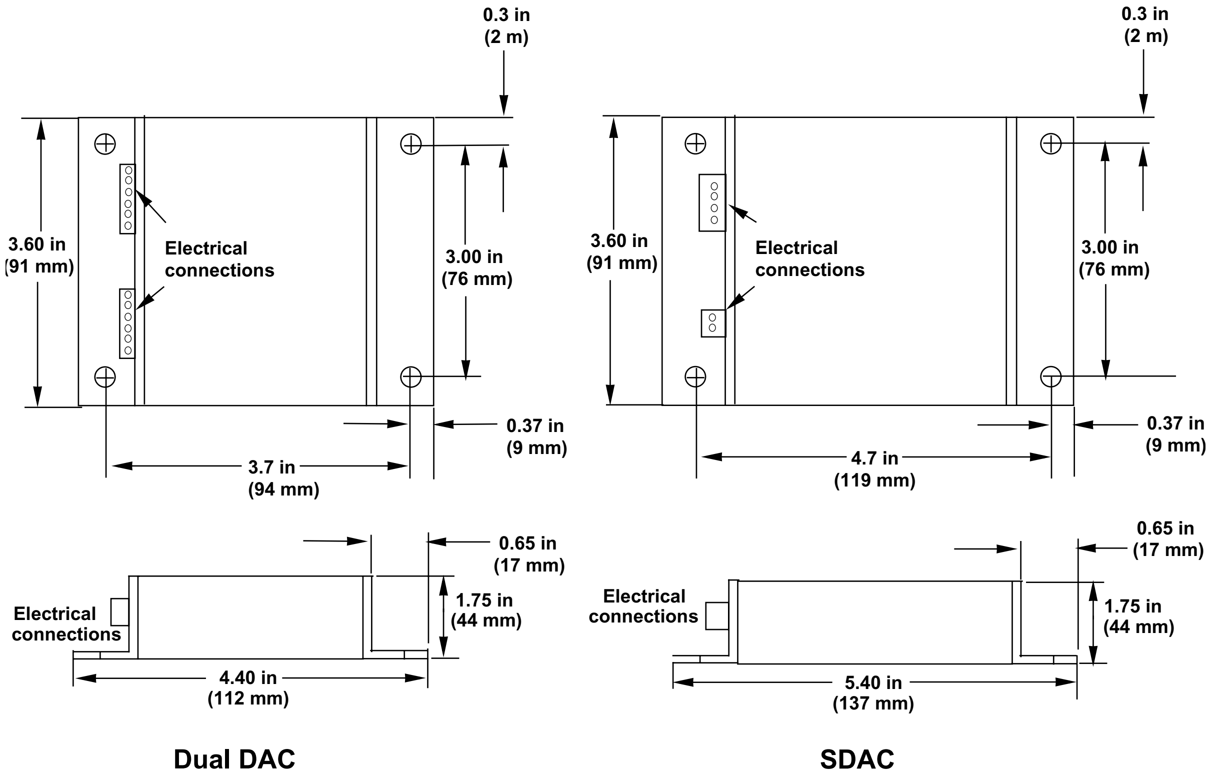


Figure 2.14 Dual DAC and SDAC Dimensions

System Wiring

Successful installation and operation of the control system can depend on placement of the components and on selection of the proper cables, sensors, and peripheral components.

Routing and shielding of sensor wires and proper grounding of components can insure a robust control system. This section includes wiring recommendations, instructions for proper grounding and noise suppression, and considerations for avoiding ground loops.

WARNING! ***Never wire bundles of low power Watlow Anafaze circuits next to bundles of high power ac wiring. Instead, physically separate high power circuits from the controller. If possible, install high voltage ac power circuits in a separate panel.***

Wiring Recommendations

Keep the following guidelines in mind when selecting wires and cables:

- Use stranded wire. (Solid wire can be used for fixed service; it makes intermittent connections when you move it for maintenance.)
- Use #20 AWG thermocouple extension wire. Larger or smaller sizes may be difficult to install, may break easily, or may cause intermittent connections.
- Use shielded wire. (The electrical shield protects the signals and the MLS300 from electrical noise.) Connect one end of the input and output wiring shield to earth ground.
- Use copper wire for all connections other than thermocouple sensor inputs.

See *Table 2.1 on page 33* for cable recommendations.

Table 2.1 Cable Recommendations

Function	Mfr. P/N	No. of Wires	AWG Gauge	Max. Length
Analog Inputs	Belden #9154 Belden #8451	2 2	20 22	
RTD Inputs	Belden #8772 Belden #9770	3 3	20 22	
Thermocouple Inputs	Thermocouple Ext. Wire	2	20	
Control Outputs and Digital I/O	Belden #9539 Belden #9542	9 20	24 24	
Analog Outputs	Belden #9154 Belden #8451	2 2	20 22	
Computer Communication: EIA/TIA-232, RS422, EIA/TIA-485, or 20 mA	Belden #9729 Belden #9730 Belden #9842 Belden #9843 Belden #9184	4 6 4 6 4	24 24 24 24 22	4000 ft. 4000 ft. 6000 ft.

Noise Suppression

The MLS300's outputs are typically used to drive solid state relays. These relays may in turn operate more inductive types of loads such as electromechanical relays, alarm horns and motor starters. Such devices may generate electromagnetic interference (EMI or noise). If the controller is placed close to sources of EMI, it may not function correctly. Below are some tips on how to recognize and avoid problems with EMI.

For the AIM or CIM300 earth ground wire, use a large gauge and keep the length as short as possible. Additional shielding may be achieved by connecting a chassis ground strap from the panel to the case of the processor module.

Symptoms of RFI/EMI

If your controller displays the following symptoms, suspect EMI:

- The controller's display blanks out and then re-energizes as if power had been turned off for a moment.
- The process variable does not display correctly.

EMI may also damage the digital output circuit—so digital outputs will not turn on. If the digital output circuit is damaged, return the controller to Watlow Anafaze for repair.

Avoiding Noise Problems

To avoid RFI/EMI noise problems:

- The MLS300 system includes noise suppression circuitry. Some of which is only effective when the components are properly grounded. Be sure the processor module and AIM (or CIM300) are connected to earth ground.
- Separate the 120 or 240 Vac power leads from the low level input and output leads connected to the MLS300 series controller. Don't run the digital I/O or control output leads in bundles with 120 Vac wires.
- Where possible, use solid-state relays (SSRs) instead of electromechanical (EM) relays. If you must use EM relays, try to avoid mounting them in the same panel as the MLS300 series equipment.
- If you must use EM relays and you must place them in a panel with MLS300 series equipment, use a 0.01 microfarad capacitor rated at 1000 Vac (or higher) in series with a 47 Ω, 1/2 watt resistor across the NO contacts of the relay load. This is known as a snubber network and can reduce the amount of electrical noise.
- You can use other voltage suppression devices, but they are not usually required. For instance, you can place a metal oxide varistor (MOV) rated at 130 Vac for 120 Vac control circuits across the load, which limits the peak AC voltage to about 180 Vac (Watlow Anafaze P/N 0802-0826-0000). You can also place a transorb (back to back zener diodes) across the digital output, which limits the digital output voltage.

The above steps will eliminate most EMI/RFI noise problems. If you have further problems or questions, please contact Application Engineering.

Avoiding Ground Loops

Ground loops occur when current passes from the process through the controller to ground. This can cause instrument errors or malfunctions.

A ground loop may follow one of these paths, among others:

- From one sensor to another.
- From a sensor to the communications port.
- From a sensor to the dc power supply.

The best way to avoid ground loops is to minimize unnecessary connections to ground. Do not connect any of the following terminals to each other or to earth ground:

- MLS300 PM: TB1, pin 2 (COM)
- MLS300-AIM: TB3, pin 1 to (PWR COM)
- All A COM terminals on the MLS300-AIM or CIM300
- Power Supply: (COM)
- Pin 3 on the RJ connector

Watlow Anafaze strongly recommends that you:

- Isolate outputs through solid state relays, where possible.
- Isolate RTDs or "bridge" type inputs from ground.
- Isolate digital inputs from ground through solid state relays. If you can't do that, then make sure the digital input is the only place that one of the above pins connects to earth ground.
- If you are using EIA/TIA-232 from an un-isolated host, don't connect any other power common point to earth ground, or use an optical isolator in the communications line.

Personal Computers and Ground Loops

Many PC communications ports connect the communications common to chassis ground. When such a PC is connected to the controller, this can provide a path to ground for current from the process that can enter the controller through a sensor (such as a thermocouple). This creates a ground loop that can affect communications and other controller functions. To eliminate a ground loop, either use an optically isolated communications adapter or take measures to ensure that sensors and all other connections to the controller are isolated and not conducting current into the unit.

Power Connections

This section covers making the power connections between the MLS300 components and testing those connections before completing sensor and controller wiring in the following sections.

Figure 2.15 on page 36 and *Figure 2.16 on page 36* illustrates the power connections.

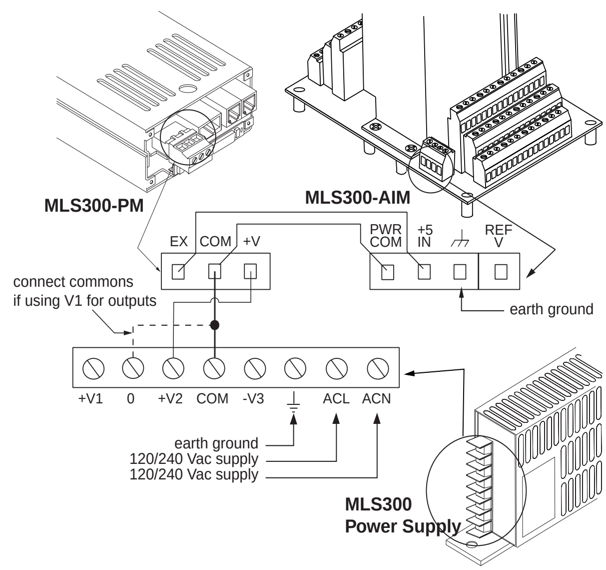


Figure 2.15 Power Connections with MLS300-AIM

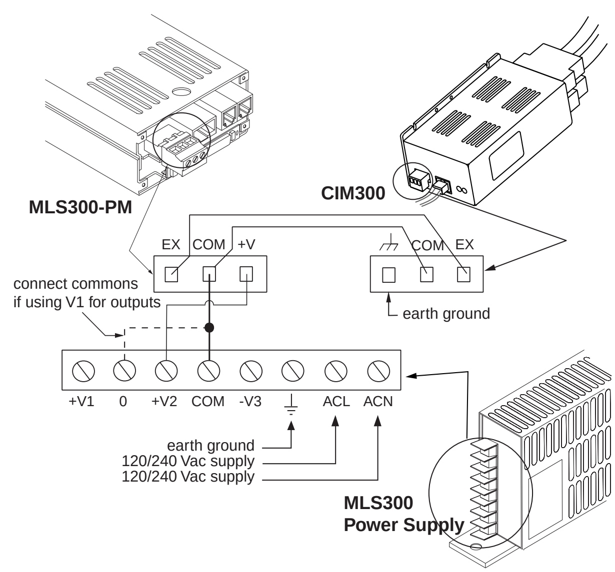


Figure 2.16 Power Connections with CIM300

Connecting Power and TB50 to MLS300-PM

WARNING! ***Use a power supply with a Class 2 rating only.***

1. Connect the power supply terminal labeled **COM** to MLS300-PM TB1 **COM** terminal.
2. Connect the power supply terminal labeled **+V2** to MLS300 PM TB1 **+V**.
3. If using the 5 Vdc output on the power supply to power SSR or other outputs, connect **0** to **COM** on the power supply.

NOTE! ***When making screw terminal connections, tighten to 0.5 to 0.6 Nm, or 4.5 to 5.4 inch-pound.***

WARNING! ***Do not turn on the ac power before testing the connections as explained in Testing Power Connections to PM and AIM on page 39.***

4. Connect ac power wires to the power supply.
5. Connect the 50-pin SCSI cable to the Processor Module.
6. Connect the SCSI to the TB50.

WARNING! ***Do not connect COM to earth ground .***

Connecting Power to AIM-TB

WARNING! ***The MLS300 can be damaged by reversed power connections or incorrect voltage.***

1. On the MLS300-PM: Connect TB1 **EX** to MLS300-AIM TB3 **+5 IN**.
2. On the MLS300-PM: Connect TB1 **COM** to MLS300-AIM TB3 **PWR COM**.
3. Plug the AIM communications cable into the connector on the MLS300-PM labeled **To AIM**.
4. Plug the other end of the AIM communications cable into the connector on the MLS300-AIM labeled **Tel 1**. (The connector is on top of the V/F card.)
5. Connect ground terminal on MLS300-AIM to ac earth ground.

NOTE! ***When making screw terminal connections, tighten to 0.5 to 0.6 Nm, or 4.5 to 5.4 inch-pounds.***

Connecting Power to CIM300-TB

WARNING! ***The MLS300 can be damaged by reversed power connections or incorrect voltage***

1. On the MLS300-PM: Connect TB1 **EX** to CIM300 TB2 **EX**.
2. On the MLS300-PM: Connect TB1 **COM** to CIM300 TB2 **COM**.

3. Plug the AIM communications cable into the connector on the MLS300-PM labeled "To AIM".
4. Plug the other end of the AIM communications cable into the connector on CIM300 labeled J3.
5. Connect ground ⏚ terminal on CIM300 to ac earth ground.

NOTE! ***When making screw terminal connections, tighten to 0.5 to 0.6 Nm, or 4.5 to 5.4 inch-pounds.***

Testing Power Connections to PM and AIM

To prevent damage to the MLS300, it is important to verify the correct power connections. The following procedure describes how to test MLS300 power connections without risking damage to the system.

WARNING! ***The MLS300 can be damaged by reversed power connections or incorrect voltage. Read this section completely and follow the steps below before applying power to the MLS300.***

1. Unplug TB1 (the green block that contains the **EX**, **COM**, and **+V** terminals) from the MLS300-PM.
2. Unplug the AIM cable from the PM and AIM modules.
3. Unplug the AIM cards from the MLS300-AIM-TB.
   (a) Carefully insert a screwdriver in the hole on the side of the AIM's metal jacket.
   (b) Gently press the screwdriver blade against the metal standoffs that separate the AIM cards. Continue pressing gently until the AIM cards pop loose from the plastic bracket that holds them in place.

(c) Carefully grasp the AIM cards by the edges and remove them from the metal bracket.

NOTE! ***At this point you have isolated the parts of the MLS300 that can be damaged by excess voltage.***

4. With ac power on, use a voltmeter to measure the following:

    (a) The voltage between the **COM** and **+V** terminals on TB 1 should be +12 to 24 Vdc

    (b) The voltage between **COM** and **EX** should be 0 Vdc

5. If the voltages are not as described in *Step 4*, check the installation of the power supply, troubleshoot or replace the power supply. If the voltages are within the limits described in *Step 4*, continue to *Step 6*.

6. Turn off the power and plug TB1 back into the MLS300-PM.

7. Turn the power back on. The Processor Module's display should light up, and after about a second the Bar Graph display should appear, followed by the message **AIM COMM FAIL**.

8. Verify power to the MLS300-AIM. With a voltmeter, measure the following:

    (a) The voltage between **+5 IN** and **PWR COM** terminals on TB-3 on the MLS300-AIM should be +4.75 to +5.25 Vdc.

9. If the voltage is not as described in *Step 8*, check the wiring from the MLS300-PM to the MLS300-AIM. If the voltage is within the limit described in *Step 8*, continue to *Step 10*.

10. Turn off the power and carefully insert the AIM cards back into the AIM Terminal Block.

11. Reconnect the AIM communications cable.

Testing Power Connections to PM and CIM300

To prevent damage to the MLS300, it is important to verify the correct power connections. The following procedure describes how to test MLS300 power connections without risking damage to the system.

WARNING! ***The MLS300 can be damaged by reversed power connections or incorrect voltage.***

1. Unplug TB1 (containing the **EX**, **COM**, and **+V** terminals) from the MLS300-PM.
2. Unplug the AIM cable from the PM and CIM300 modules.
3. Unplug TB2 (containing the ⏚, **COM** and **EX** terminals) from the CIM300.

NOTE! ***At this point you have isolated the parts of the MLS300 that can be damaged by excess voltage.***

4. With ac power on, use a voltmeter to measure the following:
   (a) The voltage between the **COM** and **+V** terminals on TB 1 should be +12 to 24 Vdc
   (b) The voltage between **COM** and **EX** should be 0 Vdc
5. If the voltages are not as described in *Step 4*, check the installation of the power supply, troubleshoot or replace the power supply. If the voltages are within the limits described in *Step 4*, continue to *Step 6*.
6. Turn off the power and plug TB1 back into the MLS300-PM.
7. Turn the power back on. The Processor Module's display should light up, and after about a second the Bar Graph

display should appear, followed by the message AIM COMM FAIL.

8. Verify power to the CIM300 TB2. With a voltmeter, measure the following:

   (a) The voltage between the **COM** and **EX** terminals on TB2 should be +4.75 to +5.25 Vdc.

9. If the voltage is not as described in *Step 8*, check the wiring from the MLS300-PM to the CIM300. If the voltage is within the limit described in *Step 8*, continue to *Step 10*.

10. Turn off the power and reconnect TB2 to the CIM300.

11. Reconnect the AIM communications cable.

Sensor Wiring

This section describes how to properly connect thermocouples, RTDs, current and voltage inputs to your controller. The controller can accept any mix of available input types. Some input types require that special scaling resistors be installed (generally done by Watlow Anafaze before the controller is delivered).

NOTE! ***Never run input leads in bundles with high power wires or near other sources of EMI.***

AIM Connections

Sensors are connected to the terminal blocks on the MLS300-AIM. The MLS300-AIM in an MLS316 system has terminal blocks on one side. The MLS300-AIM in an MLS332 system has terminal blocks on both sides.

Figure 2.17 on page 43 shows the MLS300-AIM cards with the sensor terminal blocks, AIM-TB and AIM communications connection.

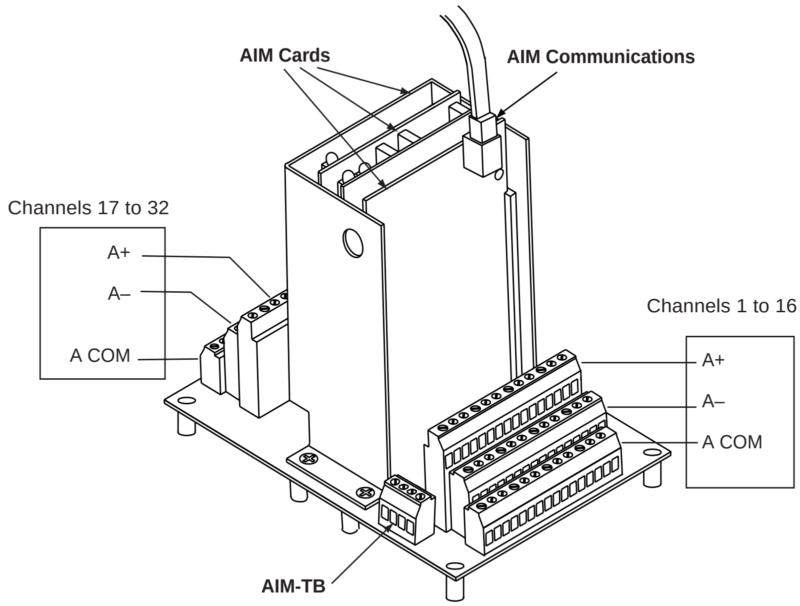


Figure 2.17 MLS300-AIM Cards, TB and Communications Port

The input signal terminal blocks are labeled with numbers and function designations. *Table 2.2 on page 44* describes the relationship between AIM terminals and their function.

Table 2.2 AIM Connections

Channel	Analog Input +	Analog Input –	Analog Input Common
1	A+ 1	A- 1	A COM 1
2	A+ 2	A- 2	A COM 2
3	A+ 3	A- 3	A COM 3
4	A+ 4	A- 4	A COM 4
5	A+ 5	A- 5	A COM 5
6	A+ 6	A- 6	A COM 6
7	A+ 7	A- 7	A COM 7
8	A+ 8	A- 8	A COM 8
9	A+ 9	A- 9	A COM 9
10	A+ 10	A- 10	A COM 10
11	A+ 11	A- 11	A COM 11
12	A+ 12	A- 12	A COM 12
13	A+ 13	A- 13	A COM 13
14	A+ 14	A- 14	A COM 14
15	A+ 15	A- 15	A COM 15
16	A+ 16	A- 16	A COM 16
17	A+ 17	A- 17	A COM 17
18	A+ 18	A- 18	A COM 18
19	A+ 19	A- 19	A COM 19
20	A+ 20	A- 20	A COM 20
21	A+ 21	A- 21	A COM 21
22	A+ 22	A- 22	A COM 22
23	A+ 23	A- 23	A COM 23
24	A+ 24	A- 24	A COM 24
25	A+ 25	A- 25	A COM 25
26	A+ 26	A- 26	A COM 26
27	A+ 27	A- 27	A COM 27
28	A+ 28	A- 28	A COM 28
29	A+ 29	A- 29	A COM 29

Channel	Analog Input +	Analog Input –	Analog Input Common
30	A+ 30	A- 30	A COM 30
31	A+ 31	A- 31	A COM 31
32	A+ 32	A- 32	A COM 32

WARNING! ***Do not exceed 10 Vdc between loops. Excess voltage may damage the Analog Input Module (AIM).***

NOTE! ***The REF V voltage is supplied for sensors requiring an external bridge circuit only. Do not use this voltage to power any other type of device.***

CIM300 Connections

Sensors to the CIM300 are terminated on D-Sub 50 connectors which mate to connections J1 (channels 1 to 16) and J2 (channels 17 to 32, CIM332 only). J1 and J2 have different genders to prevent reversed connections. Sensor connectors are located on the bottom of the CIM300. *Figure 2.18 on page 46* shows the CIM300 with D-Sub 50 connectors installed.

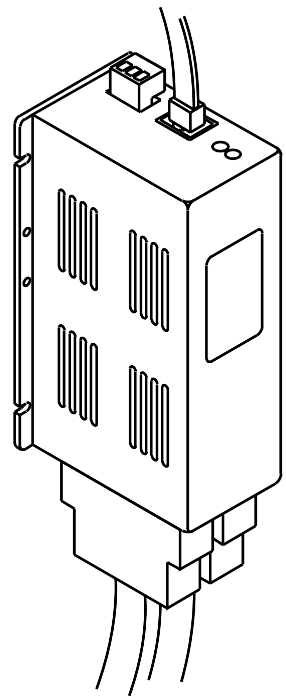


Figure 2.18   CIM300 with D-Sub 50 Connectors

Pins and sockets are labeled as follows:

- J1 sockets 1 to 50
- J2 pins 1 to 50 (CIM332 only)

Table 2.3 on page 47 describes the relationship between CIM316/32 J1 socket numbers and their function. Use a male D-Sub 50 connector to mate with J1.

Table 2.3 CIM316/32 J1 Connections

Channel	Analog Input + Socket	Analog Input – Socket	Analog Input Common Socket
1	1	18	34
2	2	19	35
3	3	20	36
4	4	21	37
5	5	22	38
6	6	23	39
7	7	24	40
8	8	25	41
9	9	26	42
10	10	27	43
11	11	28	44
12	12	29	45
13	13	30	46
14	14	31	47
15	15	32	48
16	16	33	49
			50

Table 2.4 on page 48 describes the relationship between CIM332 pin numbers and their function. Use a female D-Sub 50 connector to mate with J2.

Table 2.4 CIM332 J2 Connections

Channel	Analog Input + Pin	Analog Input – Pin	Analog Input Common Pin
17	1	18	34
18	2	19	35
19	3	20	36
20	4	21	37
21	5	22	38
22	6	23	39
23	7	24	40
24	8	25	41
25	9	26	42
26	10	27	43
27	11	28	44
28	12	29	45
29	13	30	46
30	14	31	47
31	15	32	48
32	16	33	49
			50

WARNING! ***Do not exceed 10 Vdc between loops. Excess voltage may damage the CIM300.***

Selecting Compatible D-Sub Connectors

D-Sub connectors are not supplied with the CIM300. Use the following guidelines when selecting and wiring connectors for the CIM300:

- Connection J1 requires a male D-Sub 50 connector.

- Connection J2 (CIM332 only) requires a female D-Sub 50 connector.
- Pins and sockets should be gold flashed.
- Wire connections to pins and sockets may be crimp or solder cup type.
- Wire connections consisting of stranded wire with crimped connectors offer the most reliable connection.
- If using solid wires with crimp type connections, apply solder to the connection after crimping.
- Use solder and soldering temperature that is appropriate for the alloy you are working with.

Table 2.5 on page 49 lists compatible third-party connector components.

Table 2.5 CIM300 J1- and J2-Compatible D-Sub 50 Connectors

J1-Compatible D-Sub 50 Solder Cup Connector		
Description	*Vendor*	*Part Number*
Solder cup male connector	Norcomp	171-050-102-001
Connector hood	Amp	748676-5
J2-Compatible D-Sub 50 Solder Cup Connector		
Description	*Vendor*	*Part Number*
Solder cup female connector	Norcomp	171-050-202-001
Connector hood	Amp	748676-5
J1-Compatible D-Sub 50 Crimp Connector		
Description	*Vendor*	*Part Number*
Metal shell male	Amp	205212-3
Crimp type pins; 24-20 AWG wire (50 pcs. required)	Amp	66506-9
Connector hood	Amp	748676-5
J2-Compatible D-Sub 50 Crimp Connector		
Description	*Vendor*	*Part Number*
Metal shell female	Amp	205211-2
Crimp type sockets; 24 to 20 AWG wire (50 pcs. required)	Amp	66504-9
Connector hood	Amp	748676-5

Input Wiring Recommendations

Use multicolored stranded shielded cable for analog inputs. Watlow Anafaze recommends that you use #20 AWG wire. (If the sensor manufacturer requires it, you can also use #22 or #24 AWG wiring.) Most inputs use a shielded twisted pair; some require a three-wire input.

Follow the instructions pertaining to the type(s) of input(s) you are installing.

The controller accepts the following inputs without any special scaling resistors:

- J, K, T, S, R, and B thermocouples.
- Linear inputs with ranges between -10 and 60 mV.

Any unused inputs should be set to SKIP or jumpered to avoid thermocouple break alarms.

Connect signal inputs to TB1 and TB2 of the MLS300-AIM as described in the following sections. Note that some inputs require scaling resistors that are generally factory installed.

Thermocouple Connections

Connect the positive lead of any of the supported thermocouple types to the A+ terminal for one of the loops and the negative lead to the corresponding A– terminal.

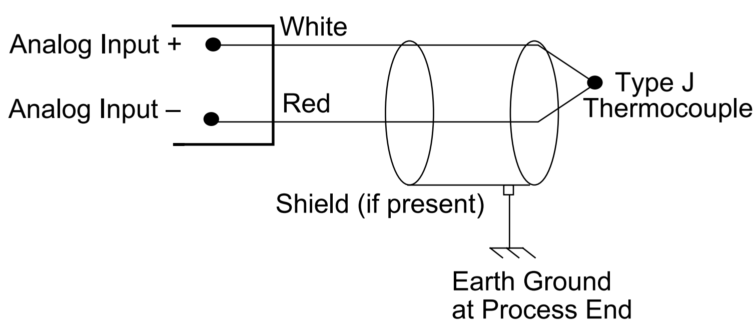
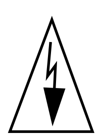


Figure 2.19 Thermocouple Connections

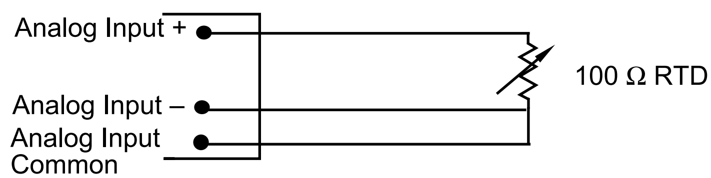


WARNING! ***The controller's analog common floats. To minimize the chance of ground loops, use ungrounded thermocouples with the thermocouple sheath electrically connected to earth ground.***

When you use grounded thermocouples, tie the thermocouple sheaths to earth ground in one place. Otherwise any common mode voltages that exceed 10 volts may cause incorrect readings or damage to the controller.

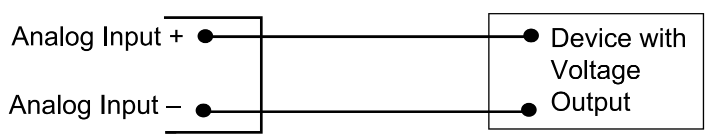
RTD Input Connections

This input type requires scaling resistors. Watlow Anafaze recommends that you use a 100 Ω, three-wire platinum RTD (RTD1 or 2) to prevent reading errors due to cable resistance. If you use a two-wire RTD, jumper Ch. A- to Ch. A COM. If you must use a four-wire RTD, leave the fourth wire unconnected.



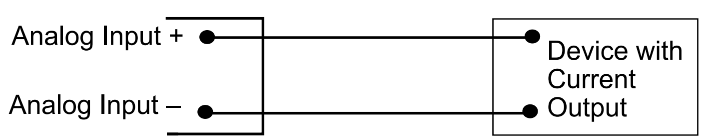
Voltage Input Connections

This input type requires scaling resistors. Special input resistors installed at Watlow Anafaze divide analog input voltages such that the controller sees a -10 to 60 mV signal on the channel.



Current Input Connections

This input type requires special input resistors. Resistors installed at Watlow Anafaze for analog current signals are such that the controller sees a -10 to 60 mV signal across its inputs for the channel.



Pulse Input Connections

The MLS300 can accept a pulse input from a device such as an encoder. The frequency of this input is scaled with user-set parameters. See *Setup Loop Input Menu on page 102* and *Chapter 10, Linear Scaling ExamplesLinear Scaling Examples*. This scaled value is the process variable for loop 17 on an MLS316 or loop 33 on an MLS332.

The MLS300 can accommodate encoder signals up to 24 Vdc using a voltage divider or you can power encoders with the 5 Vdc from the MLS300-PS or TB50. The following figures illustrate connecting encoders. A pull-up resistor in the MLS300 PM allows open collector inputs to be used.

WARNING! ***If the pulse input signal exceeds 10 kHz, the controller's operation may be disrupted. Do not connect the pulse input to a signal source that may exceed 10 kHz.***

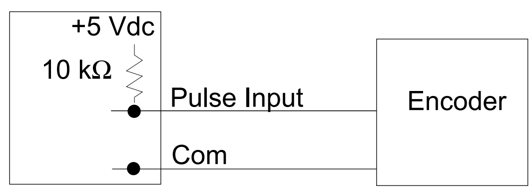


Figure 2.20 Encoder with 5 Vdc TTL Signal

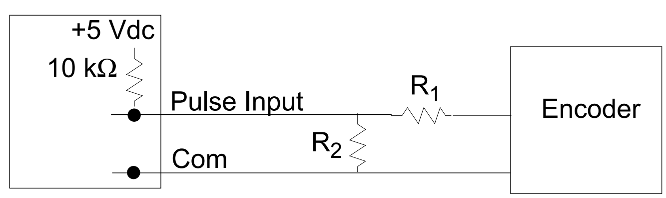


Figure 2.21 Encoder Input with Voltage Divider

For encoders with signals greater than 5 Vdc, use a voltage divider to drop the voltage to 5 volts at the input. Use appropriate values for R_1 and R_2 depending on the encoder excitation voltage. Be sure not to exceed the specific current load on the encoder.

Wiring Control and Digital I/O

This section describes how to wire and configure the control outputs for the MLS300 series controller.

NOTE! ***Control outputs are connected to the MLS300's common when the control output is ON (Low). Be careful when you connect external devices that may have a low side at a voltage other than controller ground, since you may create ground loops.***

If you expect grounding problems, use isolated solid-state relays and isolate the control device inputs.

The MLS300 provides dual PID control outputs for each loop. These outputs can be enabled or disabled, and are on the TB50.

Output Wiring Recommendations

When wiring output devices to the TB50, use multicolored, stranded, shielded cable for analog outputs and PID digital outputs connected to panel mounted SSRs.

- Analog outputs usually use a twisted pair.
- Digital outputs usually have 9 to 20 conductors, depending on wiring technique.

Cable Tie Wraps

When you have wired outputs to the TB50, install the cable tie wraps to reduce strain on the connectors.

Each row of terminals has a cable tie wrap hole at one end. Thread the cable tie wrap through the cable tie wrap hole. Then wrap the cable tie wrap around the wires attached to that terminal block.

Digital Outputs

The MLS300 series provides dual control outputs for up to 16 loops. the controller's default configuration has all heat outputs enabled and all cool outputs disabled. Disabling a heat output makes that output available to be used as a control or an alarm output. See *Enable/Disable Heat or Cool Outputs on* *page 114*. The CPU Watchdog Timer output can be used to monitor the state of the controller with an external circuit or device. See *CPU Watchdog Timer on page 56*.

The digital outputs sink current from a load connected to the 5 Vdc supplied by the controller via the TB50. Alternately, an external power supply may be used to drive loads.

Keep in mind the following points when using an external power supply:

- The MLS300-PS available from Watlow Anafaze includes a 5 Vdc supply. When using it to supply output loads, connect the 5 Vdc common to the 15 Vdc common at the power supply.
- Do not exceed +24 volts.
- If you tie the external load to earth ground, or if you cannot connect it as shown on the following page, then use a solid-state relay.

All digital outputs are sink outputs referenced to the MLS300 controller common supply. These outputs are low (pulled to common) when they are on.

The outputs conduct current when they are low or on. The maximum current sink capability is 60 mA at 24 Vdc. They cannot "source" current to a load.

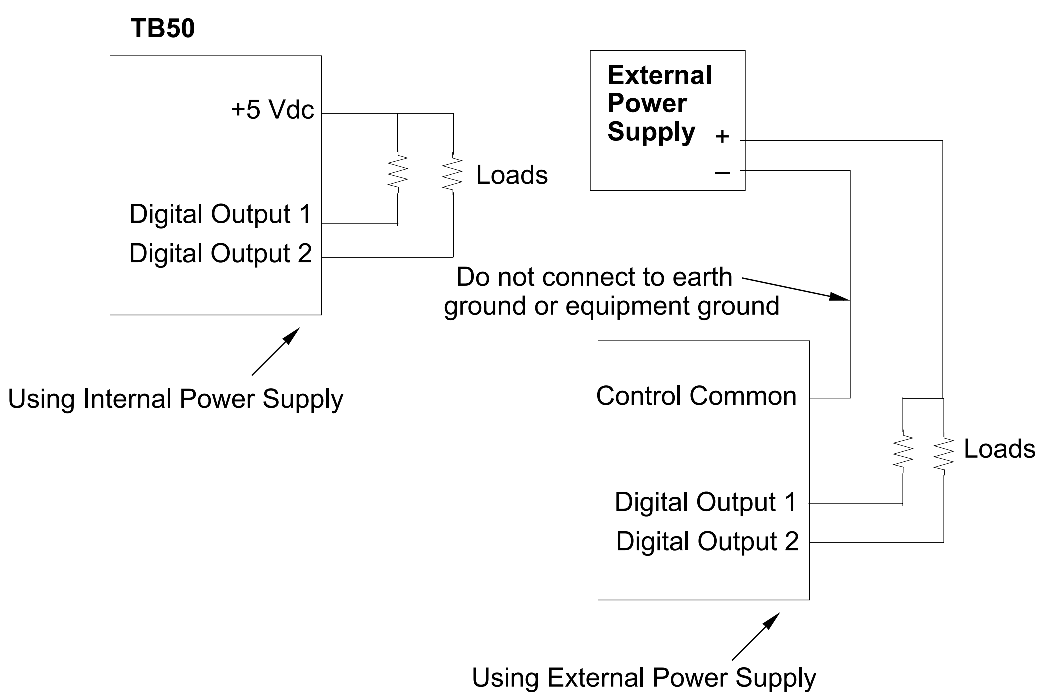


Figure 2.22 Digital Output Wiring

Configuring Outputs

Keep in mind the following points as you choose outputs for control and alarms:

- You can enable or disable the control outputs. The default setting is heat outputs enabled, cool outputs disabled.
- You can program each control output individually for On/Off, TP, DZC, or SDAC control.
- You can individually program each control output for direct or reverse action.
- Alarm outputs other than the global alarm are non-latching.
- Alarms can be suppressed during process start up and for preprogrammed durations. See *Alarm Delay on page 124*.
- Alarm outputs can be configured as a group as normally on (low) or normally off (high). See *Digital Output Polarity on Alarm on page 101*.

Control and Alarm Output Connections

Typically control and alarm outputs use external optically isolated solid-state relays (SSRs). SSRs accept a 3 to 32 Vdc input for control, and some can switch up to 100 amps at 480 Vac. For larger currents, use Silicon Control Rectifier (SCR) power controls up to 1000 amps at 120 to 600 Vac. You can also use SCRs and an SDAC for phase-angle fired control.

The 34 control and alarm outputs are open collector outputs referenced in the MLS300's common. They are low when the output is on. Do not exceed the rated current sinking capability of 60 mA dc.

NOTE! ***Control outputs are SINK outputs. They are Low when the output is on. Connect them to the negative side of solid-state relays.***

Figure 2.23 shows sample heat, cool and alarm output connections.

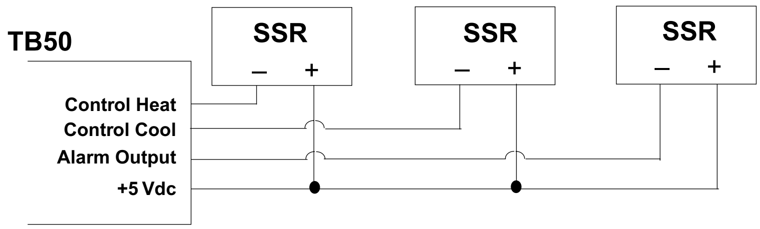


Figure 2.23 Sample Heat, Cool and Alarm Output Connections

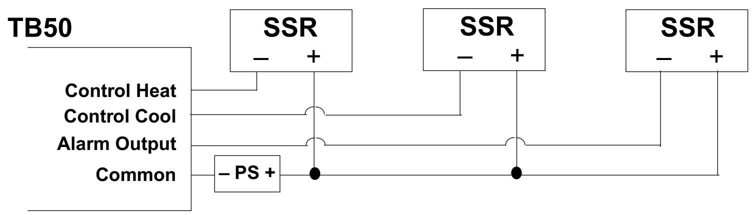


Figure 2.24 Output Connections Using External Power Supply

CPU Watchdog Timer

The CPU watchdog timer constantly monitors the microprocessor. It is a sink output located on TB50 terminal 6. The output can be connected to an external circuit or device in order to determine if the controller is powered and operational. Do not exceed the 5 Vdc, 10 mAdc rating for the watchdog output. The output is Low (on) when the microprocessor is operating; when it stops operating, the output goes High (off).

Figure 2.25 shows the recommended circuit for the watchdog timer output.

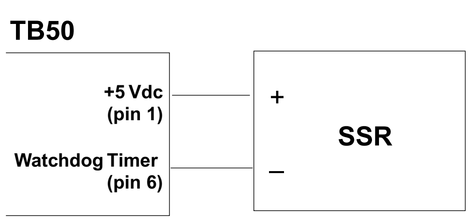


Figure 2.25 Watchdog Timer Output

Digital Inputs

All digital inputs are Transistor-Transistor Logic (TTL) level inputs referenced to control common and the internal +5 V power supply of the MLS300-PM.

The eight digital inputs are pulled up to 5 Vdc with respect to the controller common by internal 10 kΩ resistors when not pulled low by an external device. In this high state, the input is considered off. When an input is connected to the controller common, the input is pulled low and considered on. Features that use the digital inputs can be user configured to activate when an input is either high or low.

To insure the inputs are reliably switched, use a switching device with the appropriate impedances in the on and off states and do not connect the inputs to external power sources. When off, the switching device must provide an impedance of at least 11 kΩ in order to ensure the voltage will rise to greater than 3.7 Vdc. When on the switch must provide not more than 1 kΩ impedance in order to insure the voltage drops below 1.3 Vdc.

To install a switch as a digital input, connect one lead to the common terminal on the TB50 (pins 3 and 4). Connect the other lead to the desired digital input terminal on the TB50 (pins 43 to 50).

Digital inputs are used to activate various functions. See *Chapter 4, Setup.*

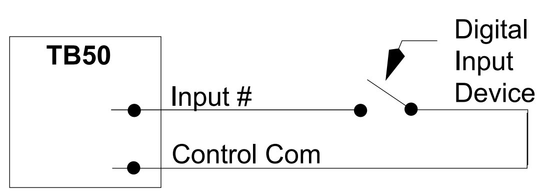


Figure 2.26 Wiring Digital Inputs

TB50 Connections

The following table describes the pinout of the TB50:

Table 2.6 TB50 Connections MLS316 and MLS332

		Control Output[1]				Control Output[1]	
Terminal	Function	MLS316	MLS332	Terminal	Function	MLS316	MLS332
1	+5 Vdc			2	+5 Vdc		
3	CTRL COM			4	CTRL COM		
5	Not Used			6	Watchdog Timer		
7	Pulse Input			8	Global Alarm		
9	Output 1	Loop 1 heat	Loop 1 heat	10	Output 34[2]		
11	Output 2	Loop 2 heat	Loop 2 heat	12	Output 33	Pulse loop heat	Pulse loop heat
13	Output 3	Loop 3 heat	Loop 3 heat	14	Output 32	Loop 16 cool	Loop 32 heat
15	Output 4	Loop 4 heat	Loop 4 heat	16	Output 31	Loop 15 cool	Loop 31 heat
17	Output 5	Loop 5 heat	Loop 5 heat	18	Output 30	Loop 14 cool	Loop 30 heat
19	Output 6	Loop 6 heat	Loop 6 heat	20	Output 29	Loop 13 cool	Loop 29 heat
21	Output 7	Loop 7 heat	Loop 7 heat	22	Output 28	Loop 12 cool	Loop 28 heat
23	Output 8	Loop 8 heat	Loop 8 heat	24	Output 27	Loop 11 cool	Loop 27 heat
25	Output 9	Loop 9 heat	Loop 9 heat	26	Output 26	Loop 10 cool	Loop 26 heat
27	Output 10	Loop 10 heat	Loop 10 heat	28	Output 25	Loop 9 cool	Loop 25 heat
29	Output 11	Loop 11 heat	Loop 11 heat	30	Output 24	Loop 8 cool	Loop 24 heat
31	Output 12	Loop 12 heat	Loop 12 heat	32	Output 23	Loop 7 cool	Loop 23 heat
33	Output 13	Loop 13 heat	Loop 13 heat	34	Output 22	Loop 6 cool	Loop 22 heat
35	Output 14	Loop 14 heat	Loop 14 heat	36	Output 21	Loop 5 cool	Loop 21 heat
37	Output 15	Loop 15 heat	Loop 15 heat	38	Output 20	Loop 4 cool	Loop 20 heat
39	Output 16	Loop 16 heat	Loop 16 heat	40	Output 19	Loop 3 cool	Loop 19 heat
41	Output 17	Loop 1 cool	Loop 17 heat	42	Output 18	Loop 2 cool	Loop 18 heat
43	Input 1			44	Input 2		
45	Input 3			46	Input 4		
47	Input 5			48	Input 6		
49	Input 7			50	Input 8		

[1] The indicated outputs are dedicated for control when enabled in the loop setup. If one or both of a loop's outputs are disabled, the corresponding digital outputs become available.

[2] If you install a Watlow Anafaze Serial Digital-to-Analog Converter (SDAC), the controller uses digital output 34 for a clock line. You cannot use output 34 for anything else when you have an SDAC installed.

Analog Outputs

Analog outputs can be provided by using a DAC or SDAC module to convert the open collector outputs from the controller. Use multicolored stranded shielded cable for analog outputs. Analog outputs generally use a twisted pair wiring. The following sections describe how to connect the DAC and SDAC modules to power the controller outputs and the load.

Wiring the DAC

A DAC module includes two identical circuits. Each can convert a DZC signal from the controller to a voltage or current signal. Watlow Anafaze strongly recommends using a power supply separate from the controller supply to power the DAC. Using a separate power supply isolates the controller's digital logic circuits and analog measurement circuits from the frequently noisy devices that take the analog signal from the DAC.

Several DAC modules may be powered by one power supply. *Chapter 11, Specifications* for the DAC's power requirements. Also note in the specifications that the DAC does not carry the same industry approvals as the SDAC.

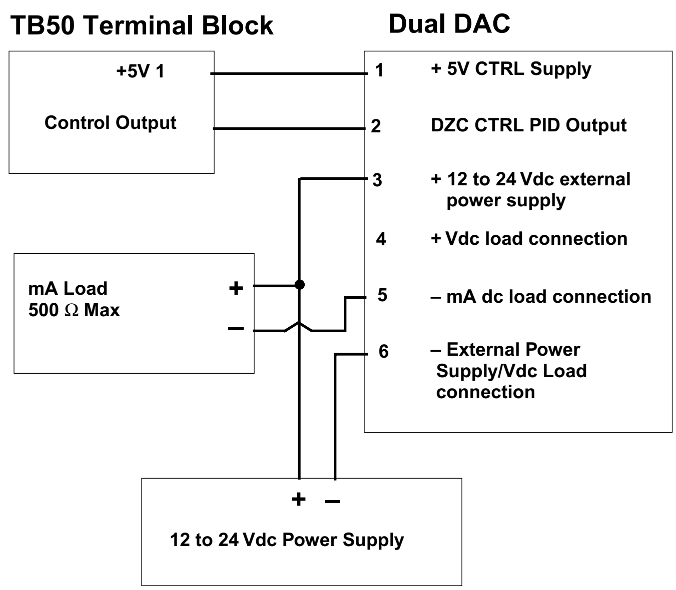


Figure 2.27 DAC with Current Output

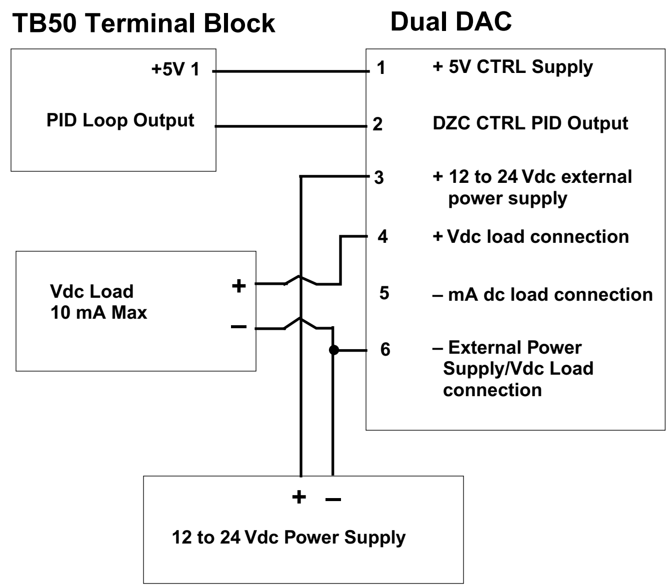


Figure 2.28 DAC with Voltage Output

Wiring the SDAC

The SDAC provides a robust analog output signal. The module converts the proprietary SDAC signal from the controller's open collector output in conjunction with the clock signal to an analog current or voltage. See *Figure 2.27* for wiring. The SDAC is user-configurable for voltage or current output through firmware configuration. Refer to *Configuring SDAC Outputs on page 212*.

The SDAC optically isolates the controller's control output from the load. When a single SDAC is used, it may be powered by the 5 Vdc found on the TB50. When using multiple SDACs, the controller cannot provide sufficient current; use an external power supply. See *SDAC Specifications on page 237* for power requirements.

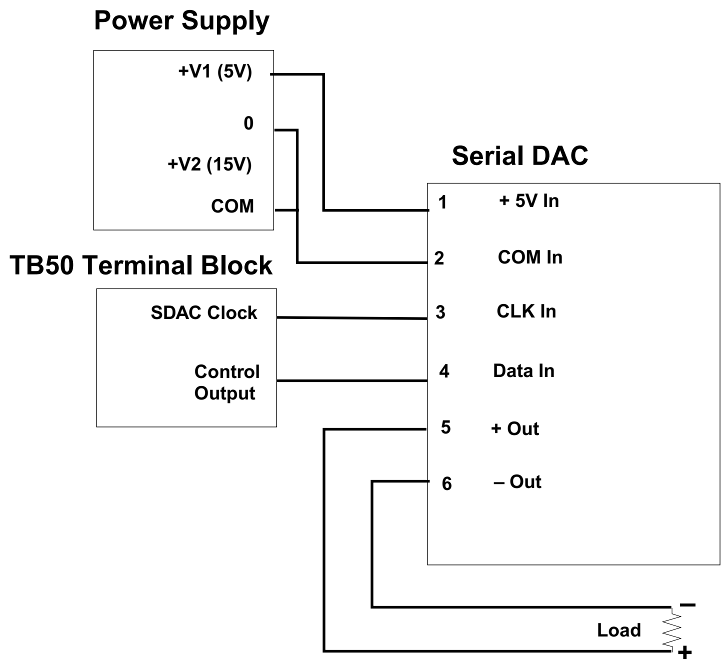


Figure 2.29 Single SDAC Systems

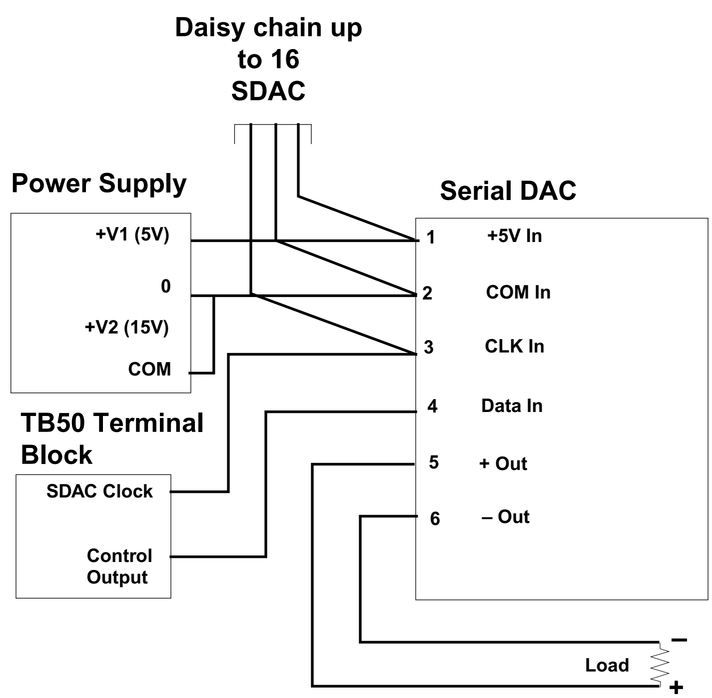


Figure 2.30 Single/Multiple SDACs with External Power

Serial Communications

The MLS300 series controllers are factory-configured for EIA/TIA-232 communications unless otherwise specified when purchased. However, the communications are jumper-selectable, so you can switch between EIA/TIA-232 and EIA/TIA-485. See *Changing Communications on page 206*.

The MLS300 is equipped with two RJ-12 serial communications connectors.

Communication Cables

Watlow Anafaze supplies flat, oval cables with RJ-type and DB-9 connectors for EIA/TIA-232. For EIA/TIA-485 communications, Watlow Anafaze supplies a RJ12 cable that interfaces the EIA/TIA-485 terminal block. Use one EIA/TIA-485 terminal block for each MLS300 on a EIA/TIA-485 communications network. Pins on the terminal block are designated 1 to 6. The function and number of each pin corresponds to the function and pin numbers of the MLS300 EIA/TIA-485 connector. See *Table 2.9 on page 66* for a description of each pin function.

Cable Shield

RJ-12 connectors connected to an MLS300 serial port must have the bare, shield drain wire in the proper position. Do not use cables from sources other than Watlow Anafaze unless the shield wire is in the proper position in the connector.

Cable Connector Pin Outs

Cable connectors must have the correct pin outs.

Refer to *Figure 2.31 on page 63* to determine the location of pin 1 in the connector. Refer to *Table 2.7 on page 64* for EIA/TIA-232 cable pin outs. Refer to *Table 2.9 on page 66* for the EIA/TIA-485 pin out and connections. The colors in the table are for Watlow Anafaze cables.

EIA/TIA-232 Interface

EIA/TIA-232 provides communication to the serial port of an IBM-PC or compatible computer. It is primarily used for single-controller installations where the cable length does not exceed 50 feet.

The EIA/TIA-232 interface is a standard three-wire interface. See *Table 2.7 on page 64* for connection information. (Some computers reverse transmit (TX) and receive (RX), so check your computer manual to verify your connections.)

If you are using EIA/TIA-232 communications with grounded thermocouples, use an optical isolator between the controller and the computer to prevent ground loops.

The EIA/TIA-232 interface is a standard phone cable with a 6-pin, RJ-12 connector on one end and a DB-9 or DB-25 female connector on the computer end. The RJ-12 connector may be plugged in to either RJ-12 socket on the MLS300. (You can order MLS300 EIA/TIA-232 COM cable from Watlow Anafaze. Specify cable length and the type of D-sub miniature connector.)

EIA/TIA-232 may be used to connect a computer through a 232/485 converter, to an EIA/TIA-485 communications network with up to 32 MLS300 controllers.

NOTE! ***The MLS, the MLS300's predecessor, used a different pin numbering convention for the RJ-12 connector. The cable construction and actual pinout remains unchanged. Refer only to this manual for MLS300 communications connections.***

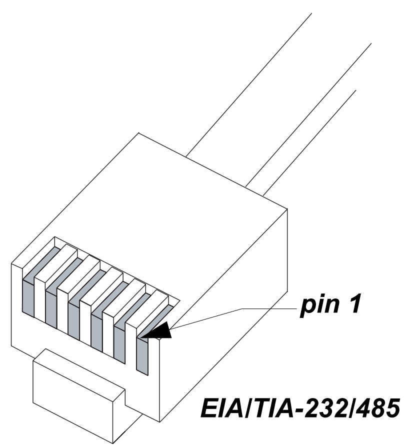


Figure 2.31 RJ-12 Connector

Table 2.7 EIA/TIA-232 Connector Pinout

RJ Pin #	Wire Color	MLS300 Function	DB-9 Pin #	DB-25 Pin #	PC Function
1	bare	n/c	n/c	n/c	n/c
2	yellow	TX	2	3	RX
3	green	GND	5	7	GND
4	red	n/c	n/c	n/c	n/c
5	black	n/c	n/c	n/c	n/c
6	white/ blue	RX	3	2	TX

Jumpers in EIA/TIA-232 Connectors

Some software programs and some operator interface terminals require a Clear to Send (CTS) signal in response to their Request to Send (RTS) signal, or a Data Set Ready (DSR) in response to their Data Terminal Ready (DTR). The MLS300 is not configured to receive or transmit these signals. To use such software with the MLS300, jumper the RTS to the CTS and the DTR to the DSR in the DB connector. *Table 2.8* lists the standard pin assignments for DB-9 and DB-25 connectors.

Table 2.8 RTS/CTS Pins in DB-9 and DB-25 Connectors

	DB-9	DB-25
RTS	7	4
CTS	8	5
DTR	4	20
DSR	6	6

Cables manufactured by Watlow Anafaze for EIA/TIA-232 communications include these jumpers. Neither ANAWIN nor WatView requires these jumpers.

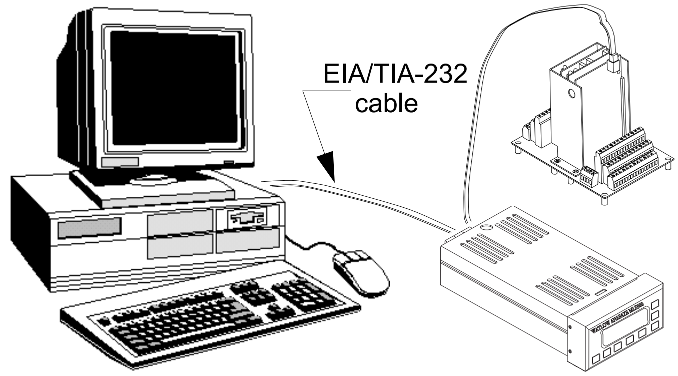


Figure 2.32 Connecting One MLS300 and MLS300-AIM to a Computer Using EIA/TIA-232

EIA/TIA-485 Interface

If you communicate with more than one MLS300 series controller on a controller network, or you require communication cable lengths greater than 50 feet (from PC to controller), you must use EIA/TIA-485 communications.

When using EIA/TIA-485 communications, you must attach an optically isolated EIA/TIA-232 to EIA/TIA-485 converter to the computer.

Figure 2.33 on page 66 shows the recommended system hookup. To avoid ground loops, it uses an optically isolated EIA/TIA-232 to EIA/TIA-485 converter at the host computer. The system is powered by an isolated supply.

Table 2.9 EIA/TIA-485 Connector Pinouts

RJ Pin #	Wire Color	MLS300 Function	Converter/Host Connection
1	bare	n/c	earth ground
2	yellow	TX+	RXB
3	green	common	common
4	red	RX-	TXA
5	black	TX-	RXA
6	blue/white	RX+	TXB

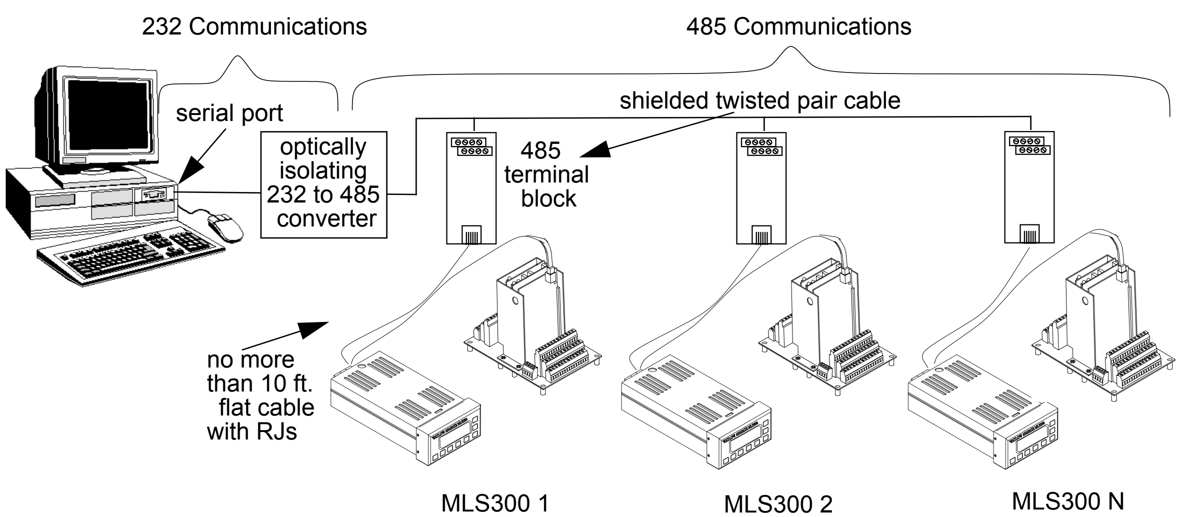


Figure 2.33 Recommended System Connections

The transmitter from the host computer connects in parallel to the controller receivers, and the host computer receiver connects in parallel to the controller transmitters. Watlow Anafaze recommends that you use a single "daisy chain" rather than "octopus connections" or "spurs."

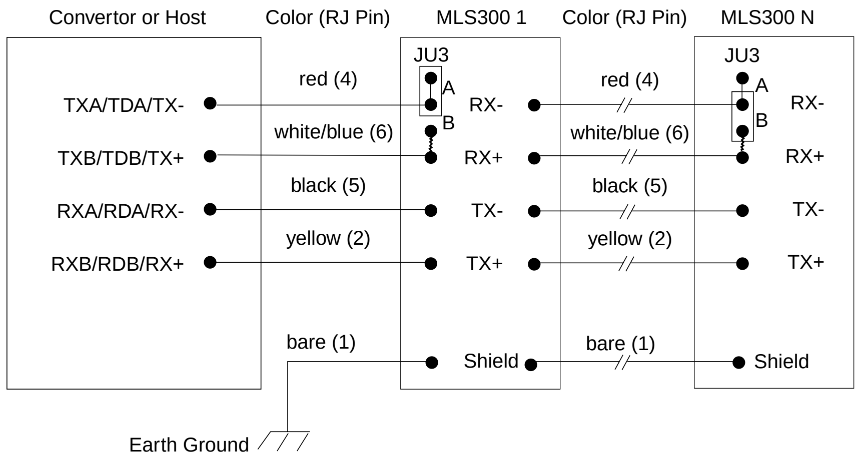


Figure 2.34 EIA/TIA-485 Wiring

Cable Recommendations

Watlow Anafaze recommends Belden #9843 or its equivalent. This cable includes three, 24 AWG, shielded, twisted pairs. It should carry signals of up to 19.2 k baud with no more than acceptable losses for up to 4000 feet.

EIA/TIA-485 Network Connections

Run twisted pair from the host or converter to the EIA/TIA-485 terminal block as close to the first MLS300-PM as possible, and from that point to the next EIA/TIA-485 terminal block near the next MLS300-PM, and so on. Connect the terminal blocks in series using appropriate lengths of 485 cable.

Some systems may experience problems with sensor signal readings if the commons of multiple controllers are tied together. See *Signal Common on page 68* for more information. See *Figure 2.35 on page 68*.

Refer to *Termination on page 68* for more on terminating resistors.

Connect the shield drain to earth ground only at the computer or host end.

MLS300s Mounted Close Together

In installations where two or more MLS300s are close together, use oval cables with RJ-12 connectors on both ends. See *Figure 2.35 on page 68*.

In this case, cables can connect from one MLS300 to another utilizing both RJ-12 connectors on each MLS300 as needed.

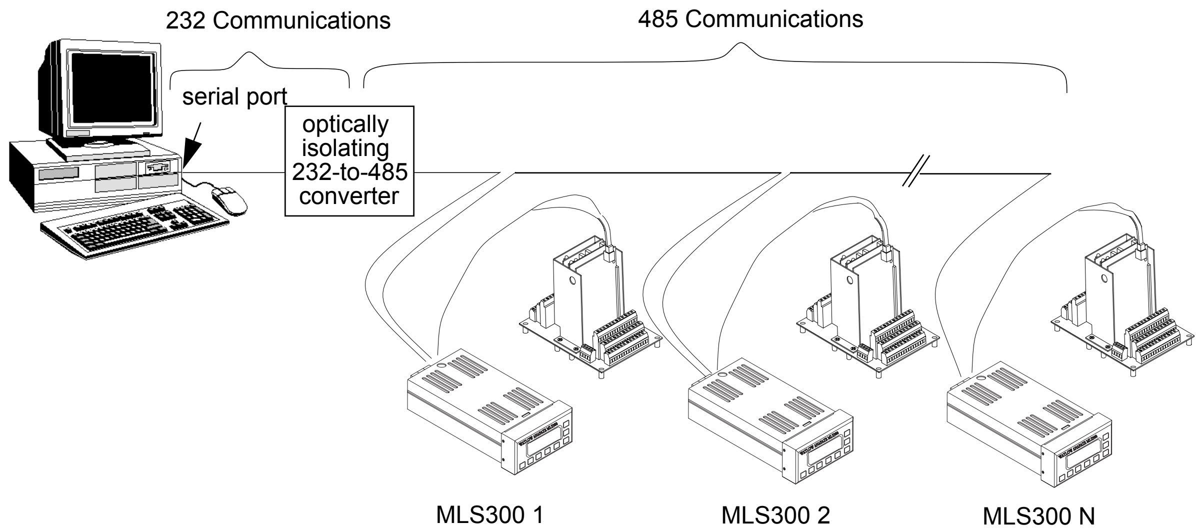


Figure 2.35 Connecting Several MLS300s with Short Cable Runs

Signal Common

For usual installations, do not connect thedc commons of the controllers together or to the converter or host device. Use an optically isolating EIA/TIA-232/485 converter to prevent problems with sensor readings.

Termination

In order for EIA/TIA-485 signals to be transmitted properly, each pair must be properly terminated. The value of the termination resistor should be equal to the impedance of the communications cable used. Values are typically 150 to 200 Ω.

The receive lines at the converter or host device should be terminated in the converter, the connector to the host device, or the device itself. Typically the converter documentation provides instructions for termination.

Use a terminating resistor on the receive lines on the last controller on the 485 line. Set JU3 inside the MLS300-PM in position B to connect a 200 Ω resistor across the receive lines. Refer to *Changing Communications on page 206*.

EIA/TIA-485 Converters and Laptop Computers

In order for an EIA/TIA-232/485 converter to optically isolate the computer from the 485 network, the 232 and 485 sides must be powered independently. Many 232/485 converters can be powered by the computer's communications port. Some computers, laptops in particular, do not automatically provide the appropriate voltages. These computer/converter combinations can usually be used by connecting an external power supply to the 232 side of the converter. Not all converters have power inputs for the 232 side, however.

3

Using the MLS300

This chapter explains how to use the front panel to operate the controller. Figure 3.1 shows the operator menus and displays accessible from the MLS300 controller's front panel.

To change global parameters, loop inputs, control parameters, outputs, and alarms via the setup menus, refer to *Chapter 4, Setup*.

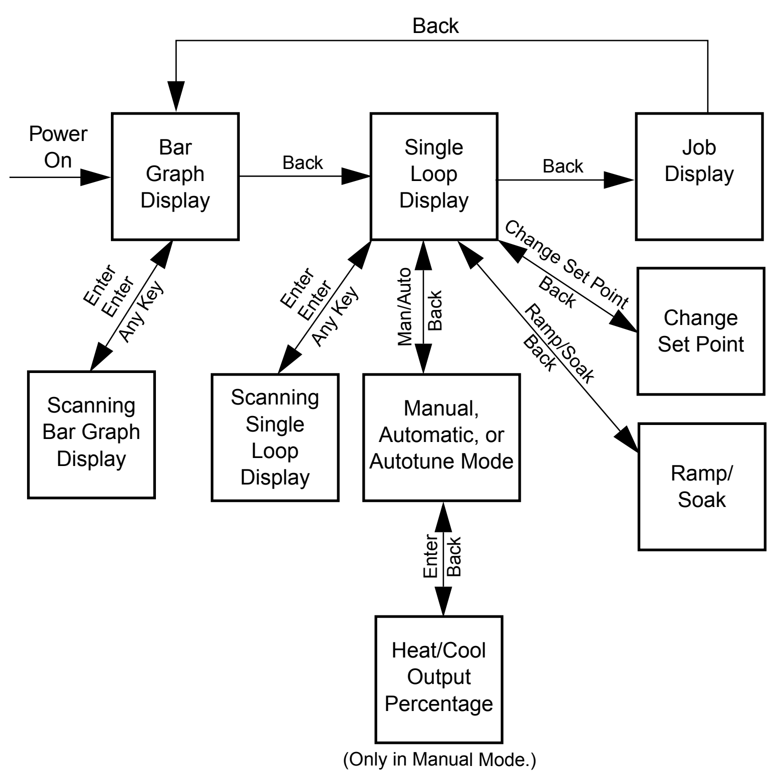


Figure 3.1 Operator Menus

Front Panel

The MLS300 front panel provides a convenient interface with the controller. You can use the front panel keys to program and operate the MLS300.

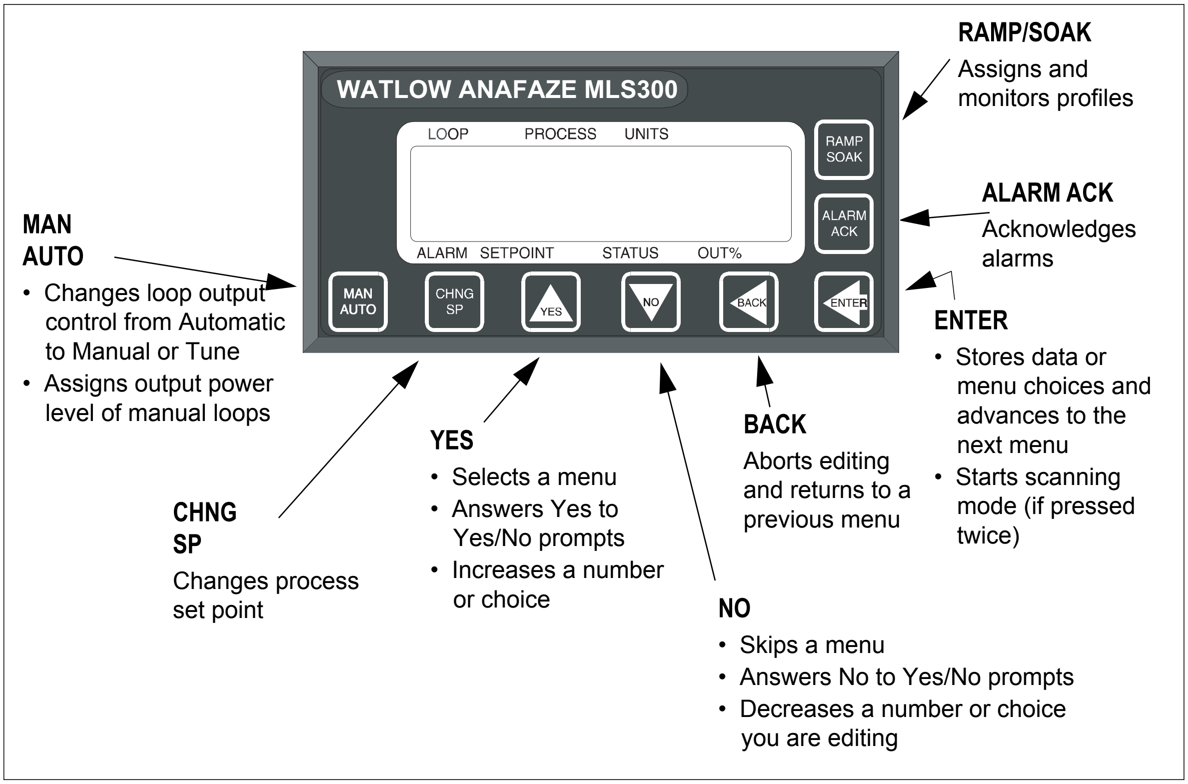


Figure 3.2 MLS300 Front Panel

Front Panel Keys

YES *(Up)*

Press **YES** to:

- Select a menu
- Answer **YES** to flashing ? prompts
- Increase a number or choice you're editing
- Stop scanning mode

NO *(Down)*

Press **NO** to:

- Skip a menu when the prompt is blinking
- Answer **NO** to flashing ? prompts
- Decrease a number or choice when editing
- Stop scanning mode
- Perform a **NO**-key reset

WARNING! ***Pressing the NO key on power up performs a NO-key reset. This procedure clears the RAM and sets the controller's parameters to the default values. See Chapter 9, Troubleshooting and Reconfiguring.***

BACK

Press the **BACK** key to:

- Abort editing
- Return to a previous menu
- Stop scanning mode
- Switch between Bar Graph, Single Loop and Job displays

ENTER

Press the **ENTER** key to:

- Store data or a menu choice after editing
- Go on to the next menu
- Start scanning mode (if pressed twice)

CHNG SP

- Press **CHNG SP** to change the loop set point

MAN
AUTO

Press the **MAN/AUTO** key to:

- Toggle a loop between manual and automatic control
- Adjust the output power level of manual loops
- Automatically tune the loop

RAMP
SOAK

If **RAMP/SOAK** is installed on your controller, press this key to:

- Assign a ramp/soak profile to the current loop
- Select the Ramp/Soak mode
- See the status of a running profile

Your controller may not have the Ramp/Soak feature. If it does not, pressing the **RAMP/SOAK** key displays the following message: **OPTION UNAVAILABLE**.

ALARM
ACK

Press **ALARM ACK** to:

- Acknowledge an alarm condition
- Reset the global alarm output

Displays

The next sections discuss the controller's main displays; Bar Graph, Single Loop, and Job displays.

Bar Graph Display

On power up, the controller displays general symbolic information for up to eight loops. This screen is called Bar Graph display. The diagram below shows the symbols used in Bar Graph display.

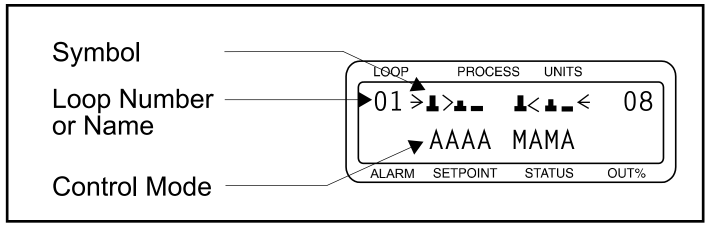


Figure 3.3 Bar Graph Display

Table 3.1 explains the symbols you see on the top line of the Bar Graph display. These symbols appear when the controller is in dual output mode (heat and cool outputs enabled) and single output mode (heat or cool outputs enabled, but not both).

Table 3.1 Bar Graph Display Symbols

Symbol	Symbol's Meaning
<	Loop is in low process or low deviation alarm.
>	Loop is in high process or high deviation alarm.
	Loop is above set point. If you enable the high or low deviation alarm, this symbol is scaled to it. If you don't enable these alarms, these symbols are scaled to the set point ±5% of the sensor's range.
	Loop is at set point. If you enable the high or low deviation alarm, this symbol is scaled to it. If you don't enable these alarms, these symbols are scaled to the set point ±5% of the sensor's range.
	Loop is below set point. If you enable the high or low deviation alarm, this symbol is scaled to it. If you don't enable these alarms, these symbols are scaled to the set point ±5% of the sensor's range.
(blank)	Loop's Input Type is set to `SKIP`.
F	A thermocouple is open, shorted or reversed, or an RTD is open or shorted.

Table 3.2 on page 76 explains the control mode symbols on the bottom line of Bar Graph display. Additional symbols may appear if you use the ramp/soak option. See *Bar Graph Display on page 170*.

Table 3.2 Control Mode Symbols on the Bar Graph and Single Loop Displays

Bar Graph Display Symbol	Single Loop Display Symbol	Description
M	MAN	One or both outputs enabled. Loop is in manual control.
A	AUTO	Only one output (Heat or Cool) is enabled. Loop is in automatic control.
T	TUNE	Indication that the loop is in Auto-tune mode.
H T	HEAT	Both heat and cool outputs are enabled. Loop is in Automatic control and heating.
C L	COOL	Both heat and cool outputs are enabled. Loop is in Automatic control and cooling.
(blank)	(blank)	Both outputs disabled, or input type is set to SKIP.

Navigating in Bar Graph Display

When the Bar Graph display is visible:

- Press the **YES** (up) or **NO** (down) key to see a new group of loops.
- Press **ENTER** twice to scan all groups. The groups will display sequentially for three seconds each. This is called Scanning Mode.
- Press any key to stop scanning.
- Press **BACK** once to go to the Job display, if enabled, or the Single Loop display.

Single Loop Display

Single Loop display (below) shows detailed information for one loop at a time. The Single Loop display is shown below:

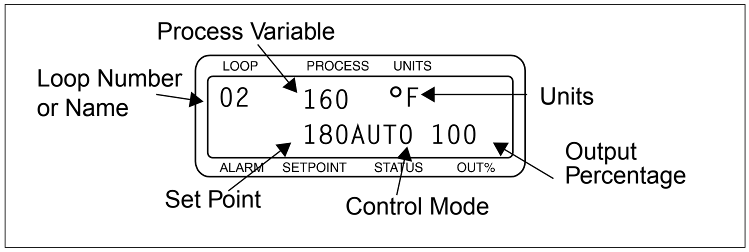


Figure 3.4 Single Loop Display

The control status indicator shows MAN, AUTO or TUNE modes.

If both control outputs for a loop are enabled, the Single Loop display shows HEAT or COOL in automatic control depending on which output is active:

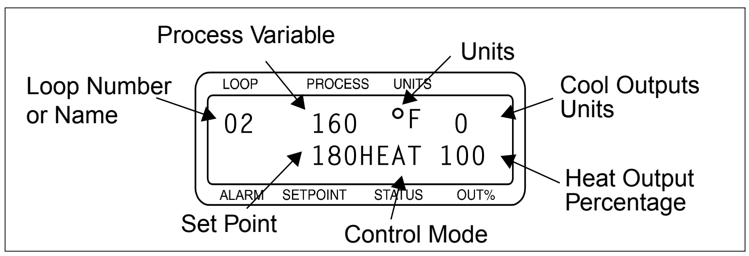


Figure 3.5 Single Loop Display, Heat and Cool Outputs Enabled

Navigating the Single Loop Display

From Single Loop Display:

- Press **YES** to go to the next loop.
- Press **NO** to go to the previous loop.
- Press the **BACK** key once to go to the Job display (if enabled) or Bar Graph display.
- Press **ENTER** twice to start the Single Loop scanning display. (The Single Loop scanning display shows information for each loop in sequence. Data for each loop displays for one second.)
- Press any key to stop scanning.

Alarm Displays

If a process, deviation, failed or system sensor alarm occurs, the controller switches from any Single Loop display or Bar Graph display to the Single Loop display for the loop with the alarm. The global alarm output turns on and a two-character alarm code appears in the lower left corner of the Single Loop display. If the alarm is for a failed sensor, a short message appears in place of the process variable and units. Control outputs associated with failed sensors are set to the value of the SENSOR FAIL HT/CL OUTPUT % parameter (default, 0%).

The alarm code blinks and displays cannot be changed until the alarm has been acknowledged. Once the alarm is acknowledged, the alarm code stops blinking. When the condition that caused the alarm is corrected, the alarm messages disappear.

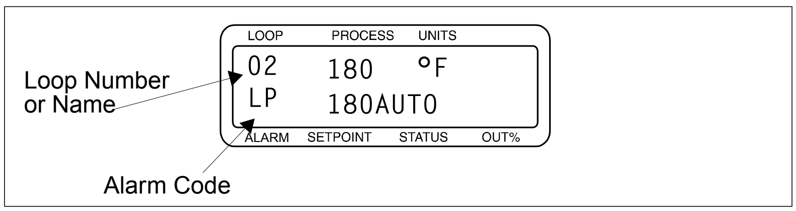


Figure 3.6 Single Loop Display with a Process Alarm

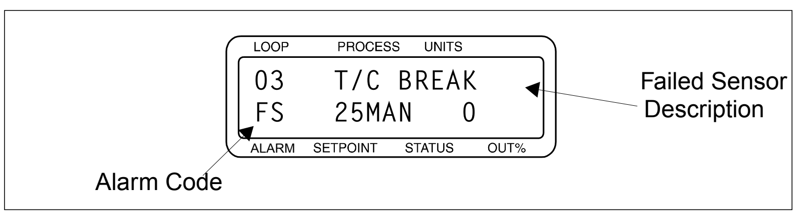


Figure 3.7 Failed Sensor Alarm in the Single Loop Display

Alarms that still exist but have been acknowledged are displayed on the Bar Graph display. A short or symbol indicates the alarm condition. See *Table 3.3 on page 79* for a full list of alarm codes, failed sensor messages and alarm symbols.

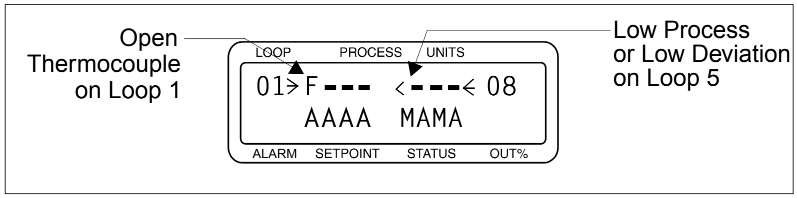


Figure 3.8 Alarm Symbols in the Bar Graph Display

Table 3.3 shows the symbols used in each form of the alarm display.

Table 3.3 Alarm Type and Symbols

Alarm Code	Bar Graph Symbol	Alarm Message	Alarm Description
FS	F	FAILED T/C	Failed Sensor: Break detected in thermocouple circuit.
RO	F	RTD OPEN	RTD Open: Break detected in RTD circuit.
RS	F	RTD SHORTED	RTD Short: Short detected in RTD circuit.
RT	F	REVERSED TC	Reversed Thermocouple: Reversed polarity detected in thermocouple circuit.
ST	F	T/C SHORTED	Shorted Thermocouple: Short detected in thermocouple circuit.
HP	>	No message	High Process Alarm: Process variable has risen above the set limit.
HD	>	No message	High Deviation Alarm: Process variable has risen above the set point plus the deviation alarm value.
LP	<	No message	Low Process Alarm: Process variable has dropped below the set limit.

Alarm Code	Bar Graph Symbol	Alarm Message	Alarm Description
LD	<	No message	Low Deviation Alarm: Process variable has dropped below the set point minus the deviation alarm value.
AW	*	No message	Ambient Warning: Controller's ambient temperature has exceeded operating limits by less than 5°C.

Acknowledging an Alarm

Press **ALARM ACK** to acknowledge the alarm. If there are other loops with alarm conditions, the Alarm display switches to the next loop in alarm. Acknowledge all alarms to clear the global alarm digital output (the keypad and display won't work for anything else until you acknowledge each alarm). The alarm symbols are displayed as long as the alarm condition is valid.

System Alarms

When a system alarm occurs, the global alarm output turns on and an alarm message appears on the display. The message continues to be displayed until the error condition is removed and the alarm is acknowledged. The MLS300-PM can display the following system alarms:

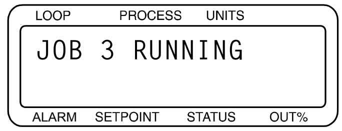
- `AIM COMM FAILURE`
  See *AIM Comm Failure / AIM Fail on page 197*.
- `BATTERY DEAD`
  See *Battery Dead on page 194.*
- `LOW POWER`
  See *Low Power on page 193.*
- `AIM FAILURE`
  See *AIM Comm Failure / AIM Fail on page 197*.
- `AW`
  See *Ambient Warning on page 194*
- `H/W FAILURE: AMBIENT`
  See *H/W Ambient Failure on page 195*
- `H/W FAILURE: GAIN`
  See *H/W Gain or Offset Failure on page 195*
- `H/W FAILURE: OFFSET`
  See *H/W Gain or Offset Failure on page 195*.

Job Display

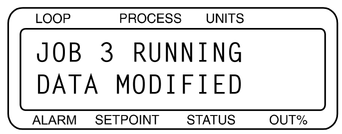
The Job display appears only if:

- You have enabled the `JOB SELECT DIG INPUTS` parameter. See *Load Setup From Job on page 94*.
- You have selected a job from the `LOAD SETUP FROM JOB` parameter.

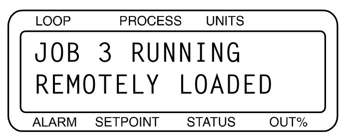
After loading a job using the `LOAD SETUP FROM JOB` parameter, the Job display shows you the following screen:



If parameters are modified while the job is running, this screen will display:



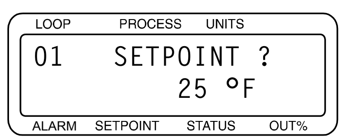
If the job was loaded using digital inputs, the display shows:



Changing the Set Point

Select the Single Loop display for the loop you want to change.

Press **CHNG SP** to display:



- Press **YES** to change the set point.
- Press the **YES** or **NO** (up/down) keys to increase or decrease the set point value.
- Press **ENTER** to save your changes and return to Single Loop display.
  – or –
  Press **NO** or **BACK** (without pressing **ENTER**) to return to Single Loop display without saving the new set point.

Selecting the Control Mode

If you set the control mode to AUTO, the MLS300 automatically controls the process according to the configuration information you give it.

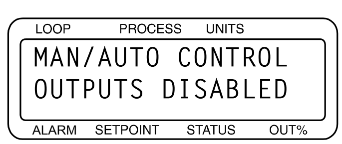
If you set the control mode to MAN, you need to set the output level.

If you set the control mode to TUNE, the controller performs an autotune and chooses PID parameters.

Manual and Automatic Control

1. Switch to the Single Loop display for the loop.
2. Press **MAN/AUTO**.
3. Press **YES** to change the mode
   – or –
   press **NO** if mode is manual to set the output power. Go to *Manual Output Levels on page 83*
   – or –
   press **NO** if in AUTO to abort.
4. Select a mode by pressing the **YES** or **NO** (up/down) key to scroll through the modes.
5. Press **ENTER** to make the mode change
   – or –
   press **BACK** to return to the Single Loop display without saving the new mode setting.
6. If you set the loop to manual, you are prompted for an output power. Go to *Manual Output Levels on page 83.*

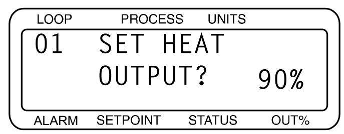
NOTE! ***If the loop outputs are disabled, you cannot toggle between Manual and Automatic output control. If you try it, the screen shows an error message telling you that the outputs are disabled, as shown below.***



Use the* `SETUP LOOP OUTPUTS` *menu to enable the outputs. (See Chapter 4, Setup, for more information about the Setup menus.)

Manual Output Levels

If the loop to is set to `MANUAL` control, the controller prompts for output levels for the enabled control outputs. Use this parameter to set the manual heat and cool output levels. See Outputs Enabled/Disabled in *Enable/Disable Heat or Cool Outputs on page 114*). You should see a display like this:



1. Press **YES** to change the output power level. (If the MLS300's heat outputs are enabled, you will be able to change the heat output power level. If only the cool outputs are enabled, you will be able to change only the cool output power level.)
   – or –
   press **NO** to go to the cool output, if available, and then press **YES** to change the cool output.
2. Then press **YES** or **NO** (up/down) to select a new output power level.
3. When you are satisfied with the power level you have chosen, press **ENTER** to store your changes
   – or –
   press **BACK** to abort.
4. Repeat from *Step 1* for the cool output, if available.
5. Press **BACK** at any time to discard your changes and return to Single Loop display.

Autotuning a Loop

Autotuning is a process by which a controller determines the correct PID parameters for optimum control. This section explains to technicians and engineers how to autotune the MLS300.

Prerequisites

Before autotuning the controller, it must be installed with control and sensor circuitry and the thermal load in place. It must be safe to operate the thermal system, and the approximate desired operating temperature (set point) must be known.

The technician or engineer performing the autotune should know how to use the controller front panel or MMI software interface (e.g. ANAWIN or WatView) to perform the following:

1. Select a loop to operate and monitor.
2. Set a loop's set point.
3. Change a loop's control mode (`MAN`, `TUNE`, `AUTO`).
4. Read and change the controller's global and loop setup parameters.

Background

Autotuning is performed at the maximum allowed output. If you have set an output limit, autotuning occurs at that value. Otherwise, the control output is set to 100% during the autotune. Only the heat output (output 1) of a loop may be autotuned.

The PID constants are calculated according to process's response to the output. The loop need not reach or cross set point to successfully determine the PID parameters. While autotuning the controller looks at the delay between when power is applied and when the system responds in order to determine the proportional band (PB). The controller then looks for the slope of the rising temperature to become constant in order to determine the integral term (TI). The derivative term (TD) is derived mathematically from the TI.

When the controller has finished autotuning, the loop's control mode switches to `AUTO`. If the process reaches 75% of the set point or the autotuning time exceeds ten minutes, the controller switches to `AUTO` and applies the PID constants it has calculated up to that point.

The Watlow Anafaze autotune is started at ambient temperature or at a temperature above ambient. However, the temperature must be *stable* and there must be sufficient time for the controller to determine the new PID parameters.

Performing an Autotune

The following procedure explains how to autotune a loop:

1. Select the Single Loop display of the loop to be tuned.
2. Ensure the loop's process variable is stable, and the loop is in MAN control mode.

NOTE! ***A loop must be stable at a temperature well below the set point in order to successfully autotune. The controller will not complete tuning if the temperature exceeds 75% of set point before the new parameters are found.***

3. Set the set point to a value as near the normal operating temperature as is safe for the system.

NOTE! ***Never set the set point above the safe operating limits of your system.***

4. Use the three-key sequence (**ENTER ALARM ACK CHNG SP**) to access the controller's setup menus. In the SETUP LOOP INPUT menu, locate the INPUT FILTER setting. Note the setting and then change it to 0 scans.
5. Press the **BACK** key until the Single Loop display appears.
6. Press the **MAN/AUTO** key.
7. Press the **NO** key to toggle between the mode choices. With TUNE selected press the **ENTER** key to begin tuning the loop.

   TUNE flashes throughout the tuning process. When tuning is completed the control mode indicator changes to AUTO.
8. Adjust the set point to the desired temperature.
9. Restore the setting of the INPUT FILTER to its original value.

Setting Up Alarms

The MLS300 has three main types of alarms:

- Failed sensor alarms
- Process alarms
- System alarms

Failed Sensor Alarms

Failed sensor alarms alert you if one of the following conditions occurs:

- Thermocouple open
- Thermocouple shorted (must be enabled)
- Thermocouple reversed (must be enabled)
- RTD open positive input or open negative input
- RTD short between the positive and negative inputs

What Happens if a Failed Sensor Alarm Occurs?

If a failed sensor alarm occurs:

- The controller switches to manual mode at the output power indicated by the SENSOR FAIL HT OUTPUT and SENSOR FAIL CL OUTPUT parameters in the SETUP LOOP OUTPUTS menu. (The output power may be different for a thermocouple open alarm; *see Thermocouple Open Alarm on page 86*.)
- The controller displays an alarm code and alarm message on the display. *See Alarm Displays on page 78*.
- The global alarm output is activated.

Thermocouple Open Alarm

The thermocouple open alarm occurs if the controller detects a break in a thermocouple or its leads.

If a thermocouple open alarm occurs, the controller switches to manual mode. The output level is determined as follows:

- If the HEAT/COOL T/C BRK OUT parameter in the SETUP LOOP OUTPUTS menu is set to **ON**, then the controller sets the output power to an average of the recent output.
- If the HEAT/COOL T/C BRK OUT AVG parameter is set to **OFF**, then the controller sets the output to the level indicated by the SENSOR FAIL HT/CL OUTPUT parameter in the SETUP LOOP OUTPUTS menu.

Thermocouple Reversed Alarm

The thermocouple reversed alarm occurs if the temperature goes in the opposite direction and to the opposite side of ambient temperature than expected—for example, a loop is heating and the measured temperature drops below the ambient temperature.

The thermocouple reversed alarm is disabled by default. To enable this alarm, set the `REVERSED T/C DETECT` parameter in the `SETUP LOOP INPUTS` menu to **`ON`**. It may be disabled if false alarms occur in your application. *See Reversed Thermocouple Detection on page 106*.

Thermocouple Short Alarm

The thermocouple short alarm occurs if the process power is on and the temperature does not rise or fall as expected. To enable the thermocouple short alarm, you must do the following:

- Choose a digital input for the `PROCESS POWER DIGIN` parameter in the `SETUP GLOBAL PARAMETERS` menu.
- Connect the digital input to a device that connects the input to controller common when the process power is on.

RTD Open or RTD Shorted Alarm

The RTD open alarm occurs if the controller detects that the positive or negative RTD lead is broken or disconnected.

The RTD shorted alarm occurs if the controller detects that the positive and negative RTD leads are shorted.

You do not have to set any parameters for the RTD alarms.

Restore Automatic Control After a Sensor Failure

This feature returns a loop to automatic control after a failed sensor is repaired. To enable this feature:

- Choose a digital input for the `RESTORE PID DIGIN` parameter in the `SETUP LOOP CONTROL PARAMS` menu.
- Connect the digital input to the dc common terminal on the controller.

Process Alarms

The MLS300 has four process alarms, each of which you can configure separately for each loop:

- Low process alarm
- High process alarm
- Low deviation alarm
- High deviation alarm

What Happens If a Process Alarm Occurs?

If a process alarm occurs, the controller does the following:

- Shows an alarm code on the display. *See Alarm Displays on page 78*.
- Activates the global alarm output. *See Global Alarm on page 89*.
- Activates the digital output that is assigned to the process alarm (if applicable). The digital output remains active until the process variable returns within the corresponding limit and deadband. The alarm output deactivates when the process returns to normal.

Process Alarm Outputs

Any digital output that is not used as a control output can be assigned to one or more process alarms.

The controller activates the output if any alarm assigned to the output is active. Process alarm outputs are non-latching—that is, the output is deactivated when the process returns to normal, whether or not the alarm has been acknowledged.

Specify the active state of process alarm outputs at the DIG OUT POLARITY ON ALARM setting in the SETUP GLOBAL PARAMETERS.

Alarm Type: Control or Alarm

You can configure each process alarm as either a control or alarm.

- Alarm configuration provides traditional alarm functionality: The operator must acknowledge the alarm message on the controller display, a latching global alarm is activated, and the alarm can activate a user-specified non-latching alarm output.
- Control configuration provides on/off control output using the alarm set points. For example, you could configure a high deviation alarm to turn on a fan. The alarm activates a user-specified non-latching output. Alarm messages do not have to be acknowledged, and the global alarm is not activated.

High and Low Process Alarms

A high process alarm occurs if the process variable rises above a user-specified value. A low process alarm occurs if the process variable drops below a separate user-specified value. See *Figure 3.9*.

Enter the alarm high and low process set points at the HI PROC ALARM SETPT and LO PROC ALARM SETPT parameters in the SETUP LOOP ALARMS menu.

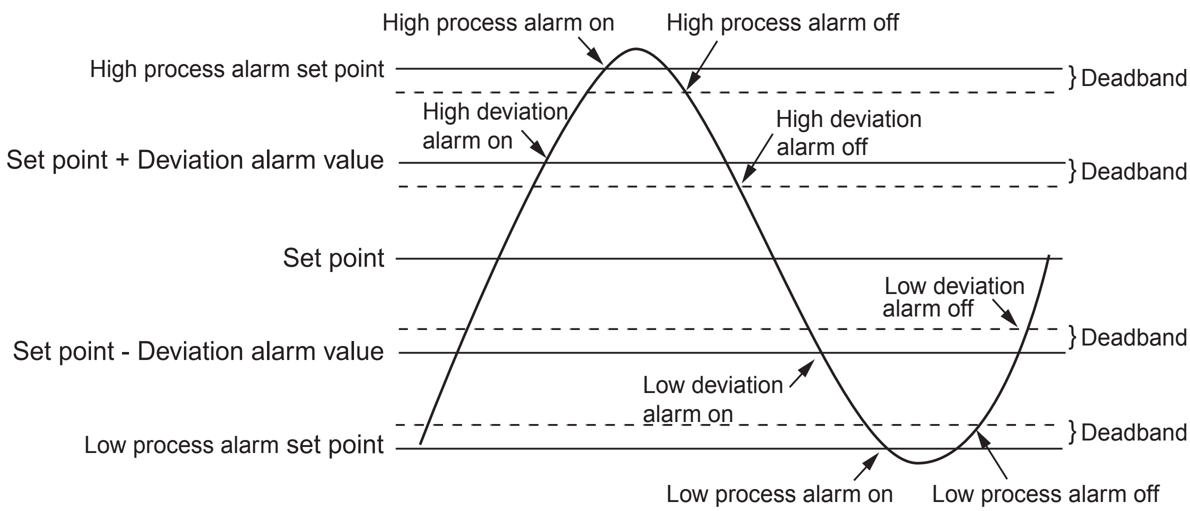


Figure 3.9 Activation and Deactivation of Process Alarms

Deviation Alarms

A deviation alarm occurs if the process deviates from set point by more than a user-specified amount; see *Figure 3.9*. Set the deviation with the DEV ALARM VALUE parameter in the SETUP LOOP ALARMS menu.

Upon power up or when the set point changes, the behavior of the deviation alarms depends upon the alarm function:

- If the alarm type parameter is set to ALARM, then deviation alarms do not activate until the after the process variable has first come within the deviation alarm band. This prevents nuisance alarms.
- If the alarm type parameter is set to CONTROL, then the deviation output switches on whenever the set point and process variable differ by more than the deviation setting, regardless of whether the process variable has been within the deviation band. This allows you to use boost control upon power up and set point changes.

Global Alarm

The MLS300 comes equipped with a global alarm output. The global output is activated if one or more of the following conditions occurs:

- A system alarm occurs, or
- A failed sensor alarm occurs and is unacknowledged, or
- A process alarm occurs and is unacknowledged. The global alarm occurs only if the alarm type is set to ALARM in the SETUP LOOP ALARMS menu. (The global alarm does *not* occur if the alarm function is set to CONTROL.)

The global alarm output stays active until all alarms have been acknowledged.

When the global alarm output is active, it conducts current to the controller's dc common. When the global alarm output is not active, it does not conduct current.

NOTE! ***You cannot configure any parameters for the global alarm. The active state of the global alarm output is NOT affected by the*** DIG OUT POLARITY ON ALARM ***polarity parameter in the*** SETUP GLOBAL PARAMETERS ***menu.***

Ramp/Soak

If you have a controller *without* the Ramp/Soak option, pressing the **RAMP/SOAK** key has no effect.

If you have a controller *with* this option installed, refer to *Chapter 7, Ramp/Soak.*

4

Setup

The setup menus let you change the controller’s detailed configuration information. This section describes how to setup the controller from menus in the controller firmware. The following information is included in this chapter.

- Accessing the setup menus
- Changing parameter settings
- Description of controller parameters

If you have not set up a MLS300 series controller before, or if you don't know what values to enter, please read *Chapter 8, Tuning and Control*, which contains PID tuning constants and useful starting values.

How to Access the Setup Menus

Use the *three-key sequence* to access the setup menus:

1. Select the Single Loop display for the loop you wish to edit.
2. Press: **ENTER** then **ALARM ACK** then **CHNG SP** to access the setup menus. (Do not press these keys at the same time; press them one at a time.)

3. The first setup menu appears.

To prevent unauthorized personnel from accessing setup parameters, the controller reverts to Single Loop display if you don't press any keys for three minutes.

How to Change a Parameter

To change a parameter, first select the appropriate menu, then the parameter.

When you enter the setup menus, the first menu displays `SETUP GLOBAL PARAMETERS`.

Refer to *Figure 4.1 on page 93* for a listing of all top level menus and their related parameters.

1. Select the Single Loop display for the loop to setup.
2. Enter the Three-Key sequence. The first menu is displayed: `SETUP GLOBAL PARAMETERS`.
3. To select the appropriate menu:
   - Press **NO** to move from one menu to the next. The menus wrap around; pressing **NO** continuously advances through the top level menus.
   - Press **YES** to enter into the displayed menu.
4. To select the parameter to be edited:
   - Press **NO** to advance from one parameter to the next. Parameters do not wrap around.
   - Press **YES** to edit the displayed parameter.
5. To edit the parameter's setting:
   - Press **YES/NO** (up/down) to scroll to the new value or choice you want to select.
   - Press **ENTER** to accept or the change
- or -
Press **BACK** to abort the change.
6. Select another parameter and repeat from *Step 5*, or press **BACK** to return to the top level menu.
7. Select another menu to edit another parameter and repeat from *Step 3*,
- or -
press **BACK** to exit the setup menus.

The following sections tell more about the parameters for each of the six top level menus. Each display illustration contains the default value for that specific parameter. If you have a controller with the Enhanced Features option, there will be additional menus. See *Chapter 6, Enhanced Features* for additional information.

Figure 4.1 on page 93 shows the top level menus accessible from the Single Loop display.

SETUP GLOBAL PARAMETERS?	SETUP LOOP INPUT?	SETUP LOOP CONTROL PARAMS?	SETUP LOOP OUTPUTS?	SETUP LOOP ALARMS?	MANUAL I/O TEST?
LOAD SETUP FROM JOB?	INPUT TYPE?	HEAT CONTROL PB?	HEAT CONTROL OUTPUT?	HI PROC ALARM SETPT?	DIGITAL INPUTS
SAVE SETUP TO JOB?	LOOP NAME?	HEAT CONTROL TI?	HEAT OUTPUT TYPE?	HI PROC ALARM TYPE?	TEST DIGITAL OUTPUT?
JOB SELECT DIG INPUTS?	INPUT UNITS?	HEAT CONTROL TD?	HEAT OUTPUT CYCLE TIME? (TP)	HI PROC ALARM OUTPUT?	KEYPAD TEST
JOB SEL DIG INS ACTIVE?	INPUT READING OFFSET	HEAT CONTROL FILTER?	SDAC MENUS [SDAC ONLY]	DEV ALARM VALUE?	DISPLAY TEST?
OUTPUT OVERRIDE DIG INPUT?	REVERSED T/C DETECT	COOL CONTROL PB?	HEAT OUTPUT ACTION?	HI DEV ALARM TYPE?	
OVERRIDE DIG IN ACTIVE?	PULSE SAMPLE TIME? [PULSE]	COOL CONTROL TI?	HEAT OUTPUT LIMIT?	HI DEV ALARM OUTPUT?	
STARTUP ALARM DELAY?	DISP FORMAT? [LINEAR & PULSE]	COOL CONTROL TD?	HEAT OUTPUT LIMIT TIME?	LO DEV ALARM TYPE?	
KEYBOARD LOCK STATUS?	INPUT SCALING HI PV? [LINEAR & PULSE]	COOL CONTROL FILTER?	SENSOR FAIL HT OUTPUT?	LO DEV ALARM OUTPUT?	
POWER UP OUTPUT STATUS?	INPUT SCALING HI RDG? [LINEAR & PULSE]	HEAT/COOL SPREAD?	HEAT T/C BRK OUT AVG?	LO PROC ALARM SETPT?	
PROCESS POWER DIGIN?	INPUT SCALING LO PV? [LINEAR & PULSE]	RESTORE PID DIGIN ?	HEAT OUTPUT?	LO PROC ALARM TYPE?	
CONTROLLER ADDRESS?	INPUT SCALING LO RDG? [LINEAR & PULSE]		COOL CONTROL OUTPUT?	LO PROC ALARM OUTPUT?	
COMMUNICATIONS BAUD RATE?	INPUT FILTER?		COOL OUTPUT TYPE?	ALARM DEADBAND?	
COMMUNICATIONS PROTOCOL?			COOL OUTPUT CYCLE TIME? [TP]	ALARM DELAY?	
COMMUNICATIONS ERR CHECK?			SDAC MENUS [SDAC ONLY]		
AC LINE FREQ?			COOL OUTPUT ACTION?		
DIG OUT POLARITY ON ALARM?			COOL OUTPUT LIMIT?		
LOAD A JOB			COOL OUTPUT LIMIT TIME?		
AIM COMM FAILURE OUTPUT			SENSOR FAIL CL OUTPUT?		
MLS300 [FIRMWARE INFO]			COOL T/C BRK OUT AVG?		
			COOL OUTPUT?		

If you have Ramp/Soak or Enhanced Features fi mware, refer to *Chapter 6, Enhanced Features* or *Chapter 7, Ramp/Soak* for additional menus.

Figure 4.1 MLS300 Menu Tree

Setup Global Parameters Menu

The SETUP GLOBAL PARAMETERS menu is shown below:

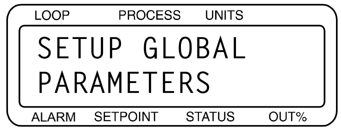


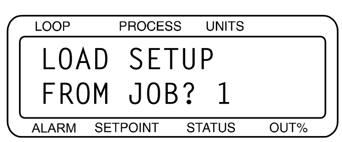
Table 4.1 shows the parameters available in the GLOBAL PARAMETERS menu.

Table 4.1 Global Parameters

Parameter	Default Value
LOAD SETUP FROM JOB?	1
SAVE SETUP TO JOB?	1
JOB SELECT DIG INPUTS?	NONE
JOB SEL DIG INS ACTIVE?	LOW
OUTPUT OVERRIDE DIG INPUT?	NONE
OVERRIDE DIG IN ACTIVE?	LOW
STARTUP ALARM DELAY?	0 mins
KEYBOARD LOCK STATUS?	OFF
POWER UP OUTPUT STATUS?	OFF
PROCESS POWER DIGIN?	NONE
CONTROLLER ADDRESS?	1
COMMUNICATIONS BAUD RATE?	19200
COMMUNICATIONS PROTOCOL?	MOD
COMMUNICATIONS ERR CHECK?	BCC
AC LINE FREQ?	60 HERTZ
DIG OUT POLARITY ON ALARM?	LOW
LOAD A JOB	
AIM COMM FAILURE OUTPUT	
MLS300 [model no., fi mware rev.]	

Load Setup From Job

Use this parameter to load any one of eight jobs saved in battery-backed RAM.



Selectable Values: 1 to 8

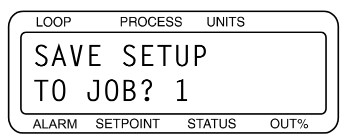
The following parameters are loaded for each loop as part of a job:

- PID constants, filter settings, set points and spread values.
- Loop control status (Automatic or Manual) and output values (if the loop is in Manual control)
- Alarm function (Off, Alarm Control) set points, high/low process set points, high/low deviation set points and deadband settings, and loop alarm delay.

WARNING! ***Current settings are overwritten when you select a job from memory. Save your current settings to another job number if you want to keep them.***

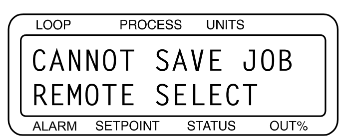
Save Setup to Job

Use this parameter to save the job information for every loop to one of eight jobs in the MLS300's battery-backed RAM.



Selectable Values: 1 to 8

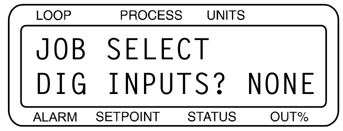
If you have enabled the remote job select function, you will not be able to save a job. If you try to do it, you will see this message:



Job Select Digital Inputs

Use this parameter to set the number of job select inputs. The controller uses these inputs as a binary code that specifies the job number to run. The number of inputs you choose in this menu controls the number of jobs you can select remotely.

The default setting is NONE. In that case jobs may be loaded and saved using the screens described above and digital inputs do not affect job selection.



Selectable Values: 1, 2, or 3 inputs, or NONE. These choices have the following effect:

Table 4.2 Job Select Inputs

Setting	Enables
1 input	Jobs 1 to 2
2 inputs	Jobs 1 to 4
3 inputs	Jobs 1 to 8
None (no inputs)	Remote Select disabled

Below is the truth table that tells you which input states select which jobs. When nothing is connected, the inputs are all False and Job 1 is selected.

Table 4.3 Job Selected for Various Input States

Digital Input 3	Digital Input 2	Digital Input 1	Job #
F	F	F	1
F	F	T	2
F	T	F	3
F	T	T	4
T	F	F	5
T	F	T	6
T	T	F	7
T	T	T	8

Job Select Digital Input

Use this parameter to set which state of the digital inputs used for job selection is considered true. Default is LOW, meaning that an input must be pulled low to be considered true. If HIGH is selected, an input will be considered true unless pulled low.

Changing this setting has the effect of reversing the job order in *Table 4.3 on page 96*.

```
LOOP     PROCESS   UNITS
JOB SEL DIG INS
ACTIVE ? LOW
ALARM  SETPOINT  STATUS  OUT%
```

Selectable Values: HIGH or LOW.

Output Override Digital Input

Use this parameter to select a digital input to set all loops to manual mode at output levels you select. This menu, and the next one, let you configure a "panic button" or "kill switch" that sets all outputs to the percentage you set in the sensor fail heat and cool output screen on the LOOP OUTPUTS menu.

```
LOOP     PROCESS   UNITS
OUTPUT OVERRIDE
DIG INPUT? NONE
ALARM  SETPOINT  STATUS  OUT%
```

Selectable Values: NONE or input number 1 to 8.

WARNING! ***Watlow Anafaze recommends installing external safety devices or over-temperature devices for emergency shutdowns. Do not rely solely on the output override feature to shut down your process.***

Override Digital Input Active

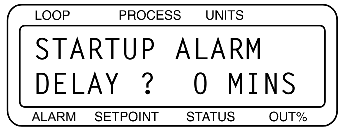
Set whether a low or high signal activates the output overide feature. You can set the input to be active when low or active when high. The default is LOW which means when the input selected in the above parameter is pulled low, all outputs are set to their sensor fail levels.

```
LOOP     PROCESS   UNITS
OVERRIDE DIG IN
ACTIVE ?  LOW
ALARM  SETPOINT  STATUS  OUT%
```

Selectable Values: HIGH or LOW.

Startup Alarm Delay

Use this parameter to set a startup delay for process and deviation alarms for all loops. The controller does not report these alarm conditions for the specified number of minutes after the controller powers up. This feature does not delay failed sensor alarms.



Selectable Values: 0 to 60 minutes.

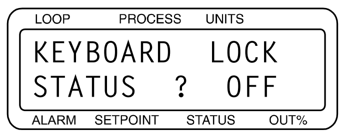
Keyboard Lock Status

Use this parameter to disable the following front panel keys:

- **CHNG SP**
- **MAN/AUTO**
- **RAMP/SOAK**

Pressing these keys have no effect once they are disabled.

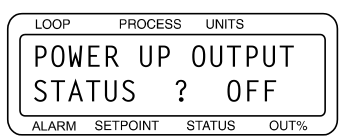
If you want to use these functions, turn off the keyboard lock.



Selectable Values: ON or OFF.

Power Up Output Status

Use this parameter to set the initial power-up state of the control outputs. If you choose OFF, all control outputs are initially set to Manual mode at 0% output level. If you choose MEMORY, the loops are restored to the control mode and output value prior to powering down. See *"In Case of a Power Failure" on page 176* for information on how this feature interacts with ramp/soak profiles.



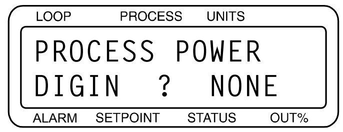
Selectable Values: OFF or MEMORY.

WARNING! ***Do not set the controller to start from memory if it may be unsafe for your process to have outputs on upon power-up.***

Process Power Digital Input

Selecting a digital input and then pulling that input low enables the thermocouple short detection feature. Connect the input to a device that pulls the input low when the process power is on. Shorts are indicated when the process power is on and the temperature does not rise as expected.

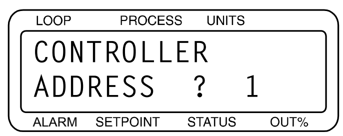
When the controller determines that there is a thermocouple short, the loop is set to manual mode at the power level set for the SENSOR FAIL OUTPUT parameter in the SETUP LOOP OUTPUTS menu.



Selectable Values: 1 to 8, or NONE.

Controller Address

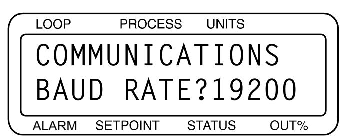
Use this parameter to set the controller's address. The controller address is used for communications. On an EIA-TIA 485 communication loop, each controller must have a unique address. Begin with address 1 for the first controller and assign each subsequent controller the next higher address.



Selectable Values: 1 to 247. When using one controller with WatView, select address 1.

Communications Baud Rate

Use this parameter to set the communications baud rate.



Selectable Values: 2400, 9600 or 19200.

NOTE! ***Be sure to set the baud rate to the same speed in both the controller and the MMI software or panel.***

Communications Protocol

Use this parameter to set the communications protocol. Choose the correct protocol for the software or device with which the controller will communicate. Cycle power to make changes effective.

```
LOOP        PROCESS   UNITS
COMMUNICATIONS
PROTOCOL ?  MOD
ALARM  SETPOINT   STATUS   OUT%
```

Selectable Values: MOD (Modbus RTU), ANA (*Anafaze*), AB (Allen Bradley).

Communications Error Checking

This parameter appears only when you choose ANA or AB as your communications protocol. Use it to set the data check algorithm used in MLS300 communications to Block Check Character (BCC) or to Cyclic Redundancy Check (CRC).

```
LOOP        PROCESS   UNITS
COMMUNICATIONS
ERR CHECK ? BCC
ALARM  SETPOINT   STATUS   OUT%
```

Selectable Values: BCC or CRC.

CRC is a more secure error checking algorithm than BCC, but it requires more calculation time and slows the MLS300 communications. BCC ensures a high degree of communications integrity; Watlow Anafaze recommends that you use BCC unless your application specifically requires CRC.

NOTE! ***If you are using Anasoft, be sure to configure it with ANAINSTL for the same Error Checking method and the same Baud Rate that you set in the controller.***

AC Line Frequency

Use this parameter to configure the controller to match the ac line frequency. This function is provided for heater or process power requiring 50 Hz power. Since the controller reduces the effect of power line noise on the analog measurement by integrating the signal over the period of the ac line frequency, the controller must know the frequency of power in use.

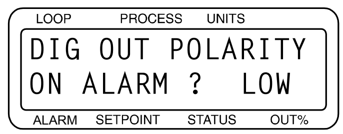
```
LOOP        PROCESS   UNITS
AC LINE FREQ  ?
60 HERTZ
ALARM  SETPOINT   STATUS   OUT%
```

Selectable Values: 50 Hz or 60 Hz.

NOTE! ***You must switch power to the controller off and on for a change in ac line frequency to take effect.***

Digital Output Polarity on Alarm

Use this parameter to set the polarity of the digital outputs used for alarms. When the default, LOW, is selected and an alarm occurs, the output sinks to analog common. When set to high, the outputs sink to common when no alarm is active and go high when an alarm occurs. This setting does not affect the behavior of the Global Alarm output.

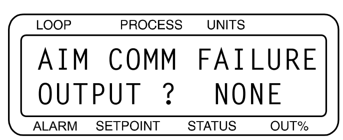


Selectable Values: HIGH or LOW.

AIM Communications Failure Output

Use this parameter to select the digital output that activates if communications fail between the MLS300-AIM and the controller. You can use this output, along with the Global Alarm output, to power an alarm horn or buzzer that sounds if communications fail.

The Global Alarm and AIM communications failure outputs will activate if there is an AIM communications failure. Both will reset automatically when the problem is corrected. The controller will revert to manual mode when an AIM communications failure occurs.



Selectable Values: NONE, or any output from 1 to 34 as long as it is not used for control or for SDAC clock.

EPROM Information

This display shows the controller type, any firmware option, the firmware version and EPROM checksum. *Table 4.4* lists the firmware options available.

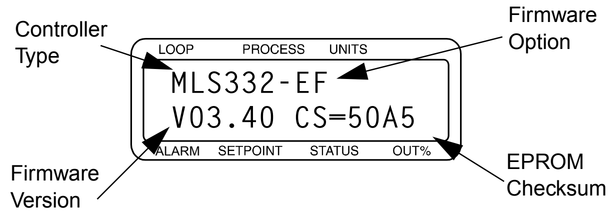
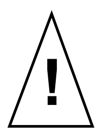


Table 4.4 Firmware Option Codes

Firmware Options	Descriptions
(None)	Standard Firmware
-EF	Enhanced Features Option
-RS	Ramp/Soak Option
-EX	Extruder Option



NOTE!

If the EPROM Information display does not match this description, the EPROM probably contains a custom program. Custom programs may not work as described in this manual. In that case, contact your dealer for more information on the firmware function.

Setup Loop Input Menu

The SETUP LOOP INPUT menu includes parameters related to the loop input:

- Input type
- Input units
- Input scaling and calibration
- Input filtering

This section explains the Input parameters.

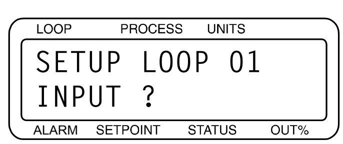


Table 4.5 shows the parameters available in the `SETUP LOOP INPUT` menu.

Table 4.5 Setup Loop Input

Parameter	Default Value	Notes
INPUT TYPE?	J	
LOOP NAME?	1	
INPUT UNITS?	°F	
INPUT READING OFFSET?	0 °F	
REVERSED T/C DETECT?	OFF	
INPUT PULSE SAMPLE TIME?	1s	See *Note 1* below
DISPLAY FORMAT?	-999 to 3000	See *Note 2* below
INPUT SCALING HI PV?	1000	See *Note 2* below
INPUT SCALING HI RDG?	100.0% FS	See *Note 2* below
INPUT SCALING LO PV?	0	See *Note 2* below
INPUT SCALING LO RDG?	.0% FS	See *Note 2* below
INPUT FILTER?	3 SCANS	

NOTE!

[1] Only available for the Pulse loop (Loop 17 on the MLS316 or Loop 33 on the MLS332).

[2] Only available when Linear is selected for Input Type.

Input Type

Use this parameter to configure the input sensor for each loop as one of these input types:

- Thermocouple types (J, K, T, S, R, B and E).
- RTD 1 and RTD 2.
- Linear inputs.
- Skip (an input type available for unused channels.) Alarms are not detected and the scanning display doesn't show loops you've set to Skip.

Pulse input (Loop 17 on the MLS316 or Loop 33 on the MLS332).

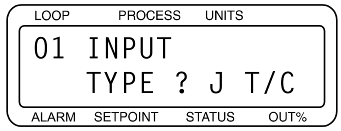
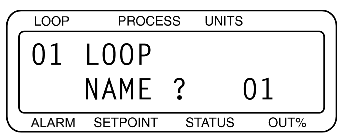


Table 4.6 MLS Input Types and Ranges

Input Type	Fahrenheit Range	Celsius Range
J	-350 to +1400	-212 to +760
K	-450 to +2500	-268 to +1371
T	-450 to +750	-268 to +399
S	0 to +3200	-18 to +1760
R	0 to +3210	-18 to 1766
B	+150 to +3200	+66 to 1760
RTD1	-148.0 to 572.0	-100.0 to +275.0
RTD2	-184 to +1544	-120 to +840
Pulse	0 to 2 kHz	
Skip	Loop not used.	
Linear	See *"Linear Scaling Parameters" on page 106*.	

Loop Name

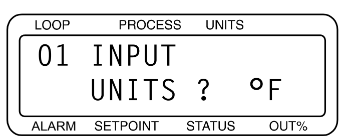
Use this parameter to name your loop using two-characters. After specifying a new name, it is shown on the Single Loop display instead of the loop's number.



Selectable Values: 0 to 9, A to Z,%, /, DEGREES

Input Units

For loops with temperature sensor input types, choose a temperature scale: Fahrenheit or Celsius. For a linear or pulse loop, choose a three-character description of the loop's engineering units.



Selectable Values: The table below shows the character set for input units.

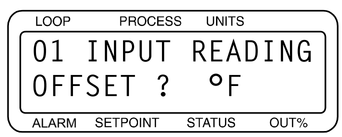
Table 4.7 Input Character Sets

Input	Character Sets for Units
Thermocouple and RTD	°F or °C
Linear & Pulse	0 to 9, A to Z,%, /, degrees, space

Input Reading Offset

This parameter is only available if the input type is a thermocouple type or RTD type.

Use this parameter to make up for the input signal's inaccuracy at any given point. For example, at temperatures below 400°F, a type J thermocouple may be inaccurate ("offset") by several degrees F. Use an independent thermocouple or your own calibration equipment to find the offset for your equipment. To correct for offset errors, change the factory default setting to a positive or negative value for the loop you are editing. (A positive value increases the reading and a negative value decreases it.)



Selectable Range: For thermocouples and RTD2s, the offset correction ranges from -300 to +300.

For RTD1 the offset range is -300.0 to +300.0.

The range ot the INPUT READING OFFSET for some thermocouples is limited when INPUT UNITS is set to °F.

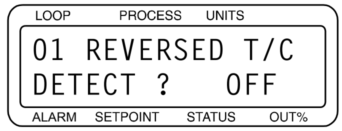
Table 4.8 on page 105 lists thermocouples and their respective Input Reading Offset ranges when INPUT UNITS is set to °F.

Table 4.8 °F Input Reading Offset Ranges for Thermocouples

Thermocouple	Range
B	-300 to 76°F
S	-300 to 76°F
R	-300 to 66°F
All others	-300 to 300°F

Reversed Thermocouple Detection

This selection enables polarity checking for thermocouples. If a reversed thermocouple alarm occurs, the controller sets the loop to Manual control at the SENSOR FAIL OUTPUT power level and displays the alarm.

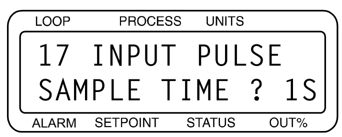


Selectable Range: ON or OFF.

Input Pulse Sample Time

This parameter is only available for Loop 17 on MLS316 and Loop 33 on the MLS332.

You can connect a digital pulse signal of up to 2 kHz to the controller's pulse input. In this menu, you specify the pulse sample period. Every sample period, the number of pulses the controller receives is divided by the sample time. The controller scales this number and uses it as the pulse loop's process variable.



Selectable Range: 1 to 20 seconds.

Linear Scaling Parameters

The following screens are only available if the input type is LINEAR or PULSE.

The linear scaling screens appear under the SETUP LOOP INPUTS menu. They let you scale the “raw” input readings (readings in millivolts or Hertz) to the engineering units of the process variable.

For linear inputs, the input reading is in percent (0 to 100%) representing the 0 to 60 mV input range of the controller. For pulse inputs, the input reading is in Hertz (cycles per second.)

The scaling function is defined by two points on a conversion line. This line relates the Process Variable to the input signal. The engineering units of the process variable can be any arbitrary units. The graph in *Figure 4.2* shows PSI as an example.

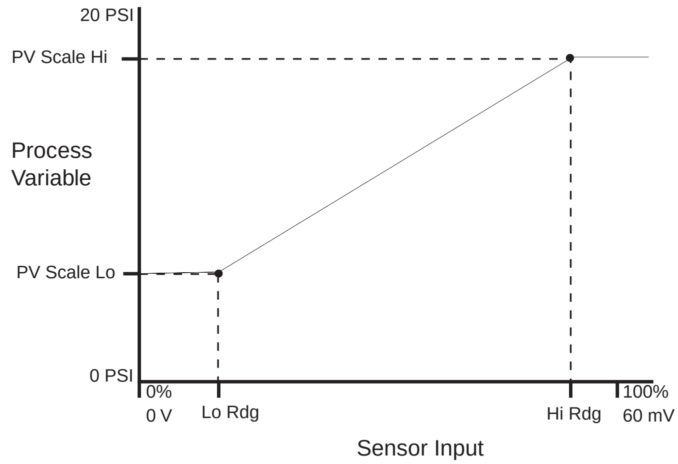


Figure 4.2 Two Points Determine Process Variable Conversion

Before you enter the values determining the two points for the conversion line, you must choose an appropriate display format. The controller has six characters available for process variable display; select the setting with the desired number of decimal places. Use a display format that matches the range of the process variable and resolution of the sensor. The display format you choose is used for the process variable set point, alarms limits, deadband, spread, and proportional band. See *"Display Format" on page 108*.

The Process Variable range for the scaled input is between the Process Variable values that correspond to the 0% and 100% input readings. For the pulse input, it is between the 0 Hz and 2000 Hz readings. The Process Variable range defines the limits for the set point and alarms. See *Figure 4.3*.

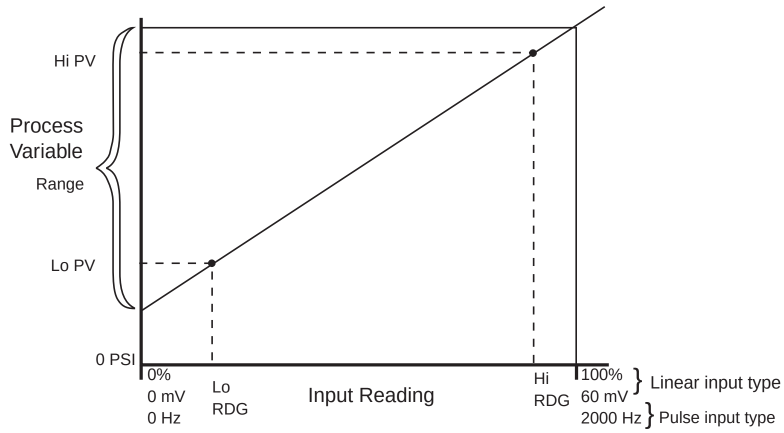
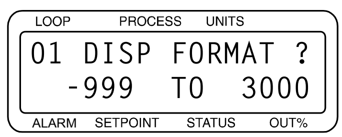


Figure 4.3 Process Variable Limited by Input Reading Range

Display Format

Select a display format for a linear or pulse input. Choose a format appropriate for your input range and sensor accuracy. You only see the `DISP FORMAT` parameter when editing a linear or pulse input.



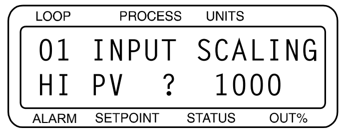
Selectable Values: The controller has several available display formats, as shown below. *Table 4.9* also shows the maximum and minimum Process Variable for each display format.

Table 4.9 Display Formats

Display Format	Maximum Process Variable	Minimum Process Variable
-9999 to +30000	30000	-9999
-999 to +3000	3000	-999
-999.9 to +3000.0	3000.0	-999.9
-99.99 to +300.00	300.00	-99.99
-9.999 to +30.000	30.000	-9.999
-.9999 to +3.0000	3.0000	-.9999

High Process Variable

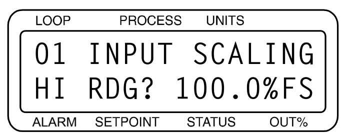
Enter a high process value. The high process variable and the high reading together define one of the points on the linear scaling function's conversion line. Set the HI PV to the value you want displayed when the signal is at the level set for the high reading.



Selectable Values: Any value between the Low Process Variable and the maximum Process Variable for the selected display format. See *Table 4.9*.

High Reading

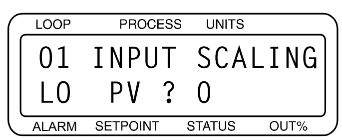
Enter the input signal level that corresponds to the high process variable you entered in the previous screen. For linear inputs, the high reading is a percentage of the full scale input range. For pulse inputs, the high reading is expressed in Hz.



Selectable Range: For LINEAR inputs: any value between -99.9% and 110.0% where 100% corresponds to 60 mV and 0% corresponds to 0 mV. For PULSE inputs: any value between 0 and 2000 Hz. You cannot set the high reading to a value less than or equal to the low reading.

Low Process Variable

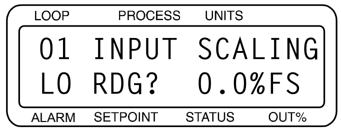
Set a low process variable for input scaling purposes. The low process variable and the low reading together define one of the points on the linear scaling function's conversion line. Set the LO PV to the value you want displayed when the signal is at the level set for the low reading.



Selectable Values: Any value between the minimum Process Variable and the High Process Variable for the selected display format. See *Table 4.9 on page 108*.

Low Reading

Enter the input signal level that corresponds to the low process variable you selected in the previous screen. For linear inputs, the low reading is a percentage of the full scale input range; for pulse inputs, the low reading is expressed in Hz.

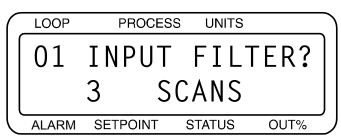


Selectable Range: For LINEAR inputs: any value between -99.9% and 110.0% where 100% corresponds to 60 mV and 0% corresponds to 0 mV. For PULSE inputs: any value between 0 and 2000 Hz. You cannot set the low reading to a value greater than or equal to the high reading.

Input Filter

The controller has two types of input filtering:

- The rejection filter ignores sensor readings outside the acceptance band when subsequent readings are within the band. For temperature sensors, the band is ±5 degrees about the last accepted reading. For linear inputs the band is ±0.5% of the input range. This filter is not adjustable.
- A simulated resistor-capacitor (RC) filter damps the input response if inputs change unrealistically or change faster than the system can respond. If the input filter is enabled, the process variable responds to a step change by going to 2/3 of the actual value within the number of scans you set.



Selectable Range: 0 to 255 scans. 0 disables the filter.

Setup Loop Control Parameters Menu

Use the SETUP LOOP CONTROL PARAMS menu to adjust heat and cool control parameters including:

- Proportional Band (PB or Gain), Integral (TI or Reset), and Derivative (TD or Rate) settings
- Output Filter
- Spread between heat and cool outputs

The controller has separate PID and filter settings for heat and cool outputs. The screens used to set these parameters are nearly identical. In this section, only the heat screens are shown and explained. The heat and cool screens appear in the menu only when the corresponding output is enabled.

See *"Setup Loop Outputs Menu" on page 113* for help enabling and disabling heat and cool outputs.

```
LOOP      PROCESS    UNITS
SETUP LOOP 01
CONTROL PARAMS?
ALARM  SETPOINT  STATUS  OUT%
```

Table 4.10 shows the parameters available in the SETUP LOOP CONTROL PARAMS menu.

Table 4.10 Setup Loop Control Parameters

Parameter	Default Value
HEAT CONTROL PB?	50 (for J-type thermocouple) *depends on Input Type setting*
HEAT CONTROL TI?	180 SEC/R
HEAT CONTROL TD?	0 SEC
HEAT CONTROL FILTER?	3
COOL CONTROL PB	50 (for J-type thermocouple) *depends on Input Type setting.*
COOL CONTROL TI?	60 SEC/R
COOL CONTROL TD?	0 SEC
COOL CONTROL FILTER?	3
HEAT AND COOL SPREAD?	5
RESTORE PID DIGIN?	NONE

Heat or Cool Control PB

Set the Proportional Band (also known as Gain). Larger numbers entered for PB result in less proportional action for a given deviation from set point.

```
LOOP      PROCESS    UNITS
01 HEAT CONTROL
PB   ?         50
ALARM  SETPOINT  STATUS  OUT%
```

Selectable Range: Dependent upon sensor type.

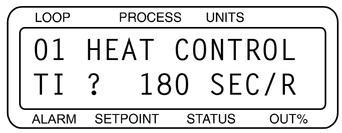
The controller internally represents the proportional band (PB) as a gain value. When you edit the PB, you'll see the values change in predefined steps; small steps for narrow PB values and large steps for wide PB values.

The controller calculates the default PB for each input type according to the following equation:

$$\text{Default PB} = \frac{(\text{High Range - Low Range})}{\text{Gain}}$$

Heat or Cool Control TI

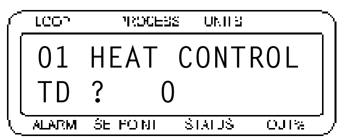
Set the Integral term, or Reset. A larger number yields less integral action.



Selectable Range: 0 (off) to 6000 seconds.

Heat or Cool Control TD

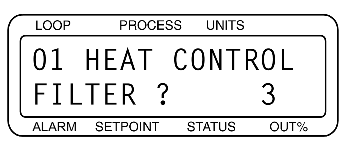
Set the derivative constant. A larger number yields greater derivative action.



Selectable Range: 0 to 255 seconds.

Heat or Cool Output Filter

Use this parameter to damp the heat or cool output's response. The output responds to a step change by going to approximately 2/3 of its final value within the number of scans you set here. A larger number set here results in a slower, or more dampened, response to changes in the process variable.



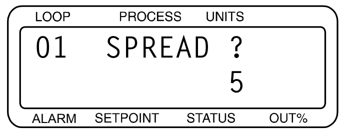
Selectable Range: 0 to 255. 0 turns the output filter off.

Spread

For a loop using on-off control, the spread is the control hysteresis. This determines the difference between the point at which a heat output turns off as the temperature rises, and the point at which it turns back on as the temperature falls.

For a loop using PID control, the spread determines how far the process variable must be from set point before the controller can switch from heating to cooling. A channel will not switch from heat to cool or vice versa unless the process variable deviates from set point by more than the spread.

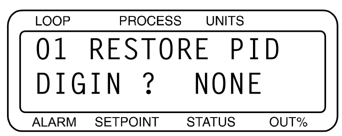
When the loop is using PID control and the spread is set to 0, the PID calculation alone determines when the heat or cool output should be on.



Selectable Ranges: 0 to 255, 25.5, 2.55, .255 or .0255, depending on the DISP FORMAT setting.

Restore PID Digital Input

Selecting a digital input in this parameter enables a sensor failure recovery feature. If the specified input is held low, when the sensor fails, the loop returns to automatic control after a failed sensor is corrected.



Selectable Range: NONE, 1 to 8.

Setup Loop Outputs Menu

Use the parameters in SETUP LOOP OUTPUTS to:

- Enable or disable outputs
- Set output type
- Set cycle time for TP outputs
- Enter SDAC parameters (for SDAC outputs)
- Select control action
- Set output level limit and limit time
- Select sensor fail output (output override)

- Select a nonlinear output curve

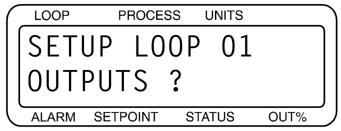


Table 4.11 shows the parameters available in the SETUP LOOP OUTPUTS menu. Both heat and cool outputs have the same menus; only one of each menu is shown.

Table 4.11 Setup Loop Outputs Menu

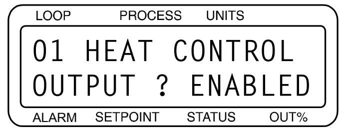
Parameter	Default Value	Notes
HEAT CONTROL OUTPUT?	ENABLED	
HEAT OUTPUT TYPE?	TP	
HEAT OUTPUT CYCLE TIME?	10s	
SDAC MODE?	VOLTAGE	*See Note on page 114*
SDAC LO VALUE	0.00 Vdc	*See Note on page 114*
SDAC HI VALUE	10.00 Vdc	*See Note on page 114*
HEAT OUTPUT ACTION?	REVERSE	
HEAT OUTPUT LIMIT?	100%	
HEAT OUPTUT LIMIT TIME?	CONT	
SENSOR FAIL HT OUTPUT?	0%	
HEAT T/C BRK OUT AVG?	OFF	
HEAT OUTPUT?	LINEAR	
COOL CONTROL OUTPUT?	DISABLED	

NOTE!

These parameters are only available if you select SDAC as the output type. Configure the signal output by the SDAC using these parameters.

Enable/Disable Heat or Cool Outputs

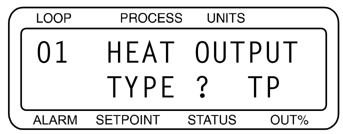
Enable or disable the heat or cool output for the loop. Only loops 1 to 16 may have a cool output. If you want the loop to have a control output, you must enable at least one output. You can also disable a heat or cool control output and use the output pin for something else, such as an alarm. The following display is for the heat control output:



Selectable Values: ENABLED or DISABLED.

Heat or Cool Output Type

Select the output type. The following display is a heat output example:



Selectable Types: TP, DZC, SDAC, ON/OFF, 3P DZC

Table 4.12 on page 115 describes the available output types.

NOTE!

The controller assigns digital output 34 as a clock line for the SDAC.

You won't be able to assign another function to output 34 while any loop's output is set to SDAC.

Table 4.12 Heat / Cool Output Types

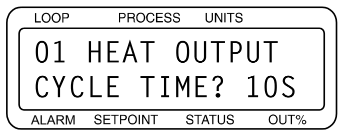
Display Code	Output Type	Definition
TP	Time Proportioning	Percent output converted to a percent duty cycle over the user-selected, fi ed time base.
DZC	Distributed Zero Crossing	Outputs on/off state calculated for every ac line cycle. Use with DAC.
SDAC	Serial DAC	Use with Serial Digital to Analog Converter.
ON/OFF	On / Off	Output either full on or full off.

Display Code	Output Type	Definition
3P DZC	3 Phase Distributed Zero Crossing	Use with 3-phase heaters when wired in the delta configu ations. (Use DZC with grounded Y configu ation.)

For an expanded description of these output types, see *Chapter 8, Tuning and Control.*

Heat or Cool Cycle Time

Set the Cycle Time for Time Proportioning outputs. The following display is a heat output cycle example:



This menu only appears if the heat or cool output type for the loop is set to Time Proportioning.

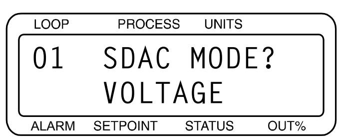
Selectable Range: 1 to 255 seconds.

SDAC Parameters

If you attach the optional SDAC to an output, you must configure that output for the SDAC using the following series of parameters.

SDAC Mode

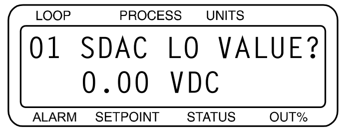
Select CURRENT or VOLTAGE for the SDAC output signal.



Selectable Values: CURRENT or VOLTAGE.

SDAC Low Value

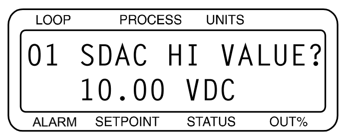
Set a low output signal level for the SDAC. Set the high and low values to match the input range of the output device. For instance, if the output device has a 0.00 to 10.00 V range, set the SDAC HI VALUE to 10.00 V and the SDAC LO VALUE to 0.00 V. The SDAC converts 0% output from the controller to the value set here.



Selectable Values: If the SDAC mode is set to VOLTAGE, the range is 0.00 to 9.90 volts. If the SDAC mode is set to CURRENT, the range is 0.0 to 19.90 mA. You cannot set the low value to be greater than or equal to the SDAC HI VALUE.

SDAC High Value

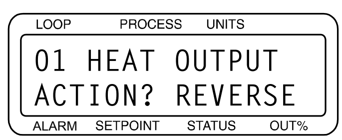
Set a high output signal level for the SDAC. Set the high and low values to match the range of the output device. For instance, if the output device has a 4 to 20 mA range, set the SDAC HI VALUE to 20.00 mA and the SDAC LO VALUE to 4.00 mA. The SDAC converts 100% output from the controller to the value set here.



Selectable Values: If the SDAC mode is set to VOLTAGE, the range is 0.10 to 10.00 Vdc. If the SDAC mode is set to CURRENT, the range is 0.10 to 20.00 mA. You cannot set the high value to be less than or equal to the SDAC LO VALUE.

Heat or Cool Output Action

Select the control action for the output. Normally, heat outputs are set to reverse action and cool outputs are set to direct action. When output action is set to reverse, the output goes up when the Process Variable goes down. When set to direct, the output goes up when the Process Variable goes up.

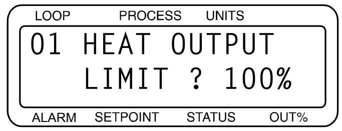


Selectable Values: REVERSE or DIRECT.

Heat or Cool Output Limit

This parameter limits the maximum PID control output for a loop's heat or cool output. This limit may be continuous, or it may be in effect for a specified number of seconds (see *Heat or Cool Output Limit Time* below). If you choose a timed limit, the output limit time restarts when the controller powers up and whenever the loop goes from Manual to Automatic control.

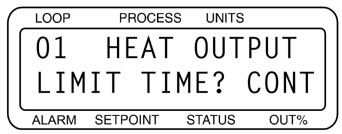
The output limit only affects loops under automatic control. It does not affect loops under manual control.



Selectable Range: 0 to 100%.

Heat or Cool Output Limit Time

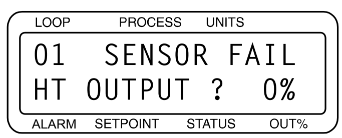
Set a time limit for the output limit.



Selectable Values: 1 to 999 seconds (1 second to over 16 minutes), or to CONT (continuous).

Sensor Fail Heat or Cool Output

When a sensor fail alarm occurs or when the OUTPUT OVERRIDE DIGITAL INPUT (*see p. 97*) becomes active on a loop that is in automatic control, that loop goes to manual control at the percent power output set here.



Selectable Range: 0 to 100%.

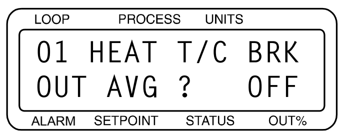
NOTE!

When a sensor fails or the override input is detected, both the heat and cool outputs are set to their fail settings. In most applications, SENSOR FAIL HT OUTPUT and SENSOR FAIL CL OUTPUT should be set to 0%.

WARNING! ***Do not rely solely on the sensor fail alarm to adjust the output in the event of a sensor failure. If the loop is in manual control when a failed sensor alarm occurs, the output is not adjusted. Install independent external safety devices that will shut down the system if a failure occurs.***

Heat or Cool Thermocouple Break Output Average

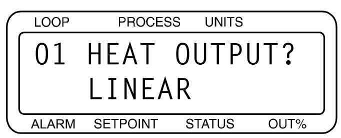
If you set this parameter to ON and a thermocouple break occurs, a loop set to automatic control mode will go to manual mode at a percentage equal to the average output prior to the break.



Selectable Range: ON or OFF

Heat or Cool Nonlinear Output Curve

Select one of two nonlinear output curves for nonlinear processes.



Selectable Values: CURVE 1, CURVE 2, or LINEAR. Refer to *Figure 4.4*.

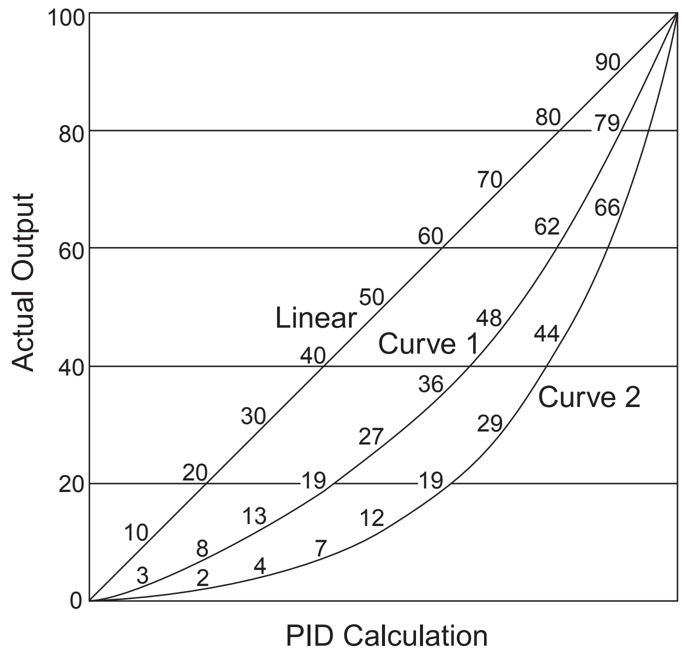


Figure 4.4   Linear and Non-Linear Outputs

With 1 or 2 selected, a PID calculation results in a lower actual output level than the linear output requires. One of the non-linear curves may be used when the response of the system to the output device is non-linear.

Setup Loop Alarms Menu

Use the setup loop alarms menu to set:

- High/low process and deviation alarm limits
- Alarm outputs
- Alarm/control behavior
- Alarm deadband
- Alarm delay

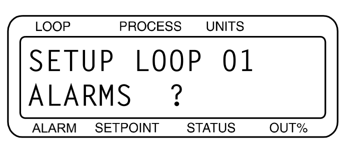


Table 4.13 shows the parameters available in the SETUP LOOP ALARMS menu.

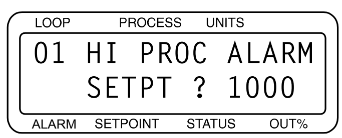
Table 4.13 Setup Loop Alarms Menu

HI PROC ALARM SETPT?	1000
HI PROC ALARM TYPE?	OFF
HI PROC ALARM OUTPUT?	NONE
DEV ALARM VALUE?	5
HI DEV ALARM TYPE?	OFF
HI DEV ALARM OUTPUT?	NONE
LO DEV ALARM TYPE?	OFF
LO DEV ALARM OUTPUT?	NONE
LO PROC ALARM SETPT?	0
LO PROC ALARM TYPE?	OFF
LO PROC ALARM OUTPUT?	NONE
ALARM DEADBAND?	2
ALARM DELAY	0 seconds

When the loop's control mode is AUTO or TUNE and a failed sensor alarm occurs, the controller sets the control mode to manual with the heat output at the SENSOR FAIL HEAT OUTPUT value and the cool output at the SENSOR FAIL COOL OUTPUT value. If you set the HEAT T/C BRK OUT AVG and/or the COOL T/C BRK OUT AVG parameter to ON, the output power is set to an average of the recent output instead of the override value.

High Process Alarm Set Point

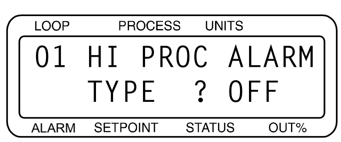
Set the value at which the high process alarm activates.



Selectable Range: any point within the scaled sensor range.

High Process Alarm Type

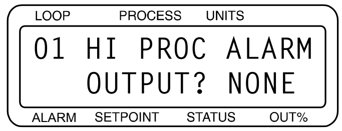
Select an alarm type for the high process alarm.



Selectable Values: OFF, ALARM or CONTROL.

High Process Alarm Output Number

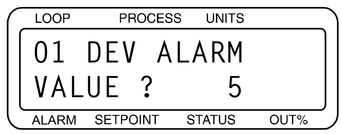
Choose a digital output to activate when the high process alarm occurs, if desired.



Selectable Values: `NONE`, or any output from `1` to `34` not enabled for closed-loop control or for the SDAC clock.

Deviation Alarm Value

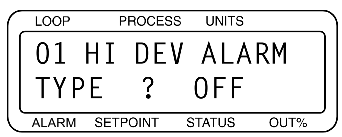
Set the deviation from set point at which the high or low deviation alarms occur.



Selectable Values: `0` to `255, 25.5, 2.55, .255` or `.0255`, depending on the `INPUT TYPE` and `DISPLAY FORMAT` settings.

High Deviation Alarm Type

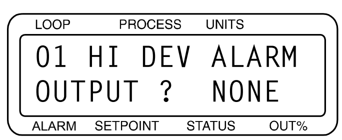
Select an alarm type for the high deviation alarm.



Selectable Values: `ALARM, CONTROL` or `OFF`

High Deviation Alarm Output Number

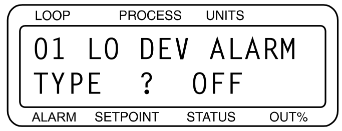
Choose a digital output to activate when the high deviation alarm occurs, if desired.



Selectable Values: `NONE`, or any output from `1` to `34` not enabled for closed-loop control or for the SDAC clock.

Low Deviation Alarm Type

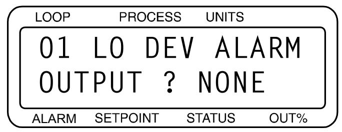
Select an alarm type for the low deviation alarm.



Selectable Values: ALARM, CONTROL or OFF.

Low Deviation Alarm Output Number

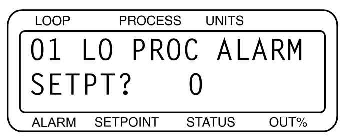
Choose a digital output to activate when the low deviation alarm occurs, if desired.



Selectable Values: NONE, or any output from 1 to 34 not enabled for closed-loop control or for the SDAC clock.

Low Process Alarm Set Point

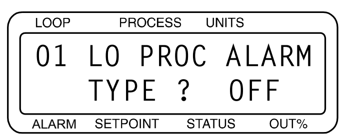
Set a low process alarm set point.



Selectable Range: Any value within the input sensor's range.

Low Process Alarm Type

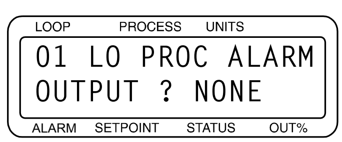
Select an alarm type for the low process alarm.



Selectable Values: ALARM, CONTROL or OFF.

Low Process Alarm Output Number

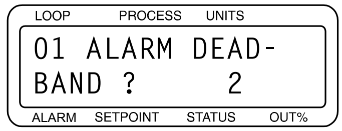
Choose a digital output to activate when the low process alarm occurs, if desired.



Selectable Values: NONE, or any output from 1 to 34 not enabled for closed-loop control or for the SDAC clock.

Alarm Deadband

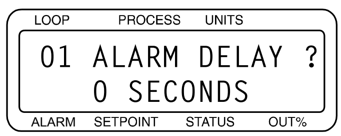
Set an alarm deadband. This deadband value applies to the high process, low process, high deviation, and low deviation alarms for the loop. Use the Alarm Deadband to avoid repeated alarms as the Process Variable cycles slightly around an alarm value.



Selectable Values: 0 to 255, 25.5, 2.55, .255 or .0255, depending on the INPUT TYPE and DISPLAY FORMAT settings.

Alarm Delay

Set a loop alarm delay. This parameter delays failed sensor and process alarms until the alarm condition has been continuously present for longer than the alarm delay time.



Selectable Range: 0 to 255 seconds.

Manual I/O Test Menu

This menu facilitates testing of:

- Digital inputs
- Digital outputs
- The keypad buttons

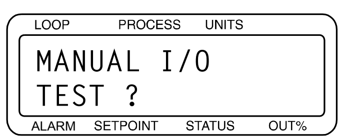


Table 4.14 shows the parameters available within the MANUAL I/O TEST menu.

Table 4.14 Manual I/O Test Menu

Parameter	Default Value	Notes
DIGITAL INPUTS	HHHHHHHH	
TEST DIGITAL OUTPUT?	1: IN USE	
DIGITAL OUTPUT NUMBER XX?	OFF	See *Note 1 below.*
KEYPAD TEST	N/A	
DISPLAY TEST?	N/A	

NOTE! ***1 This screen appears only if an unassigned output has been selected in the previous menu (TEST DIGITAL OUTPUT).***

Digital Inputs

Use this parameter to view the logic state of the 8 digital inputs as H (High) meaning the input is not pulled low, or L (Low), meaning the input is connected to the controller common. The parameter displays inputs 1 to 8 from left to right. See *Figure 4.5*. Since inputs are pulled High when they are not connected, test an input by shorting it to controller common and making sure this parameter shows the correct state for that input.

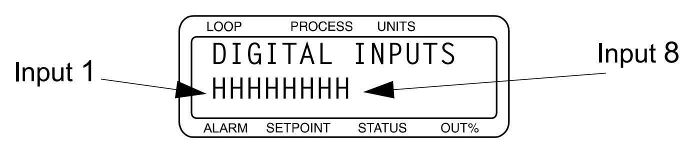


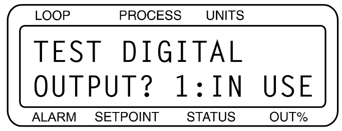
Figure 4.5 Digital Inputs Screen

Using the Input Test Screen

- Short the digital input you are testing to controller common: the input's state should change to L.
- Press **YES** or **NO** to advance to the next parameter.
- Press **BACK** to return to the top of the MANUAL I/O TEST menu.

Test Digital Output

Use this parameter to select one of the digital alarm outputs to test in the next parameter. You cannot force the state of an output enabled for control.

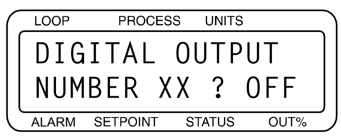


Selectable Values: Any output from 1 to 34 that is not enabled for closed-loop control or for the SDAC clock and GA, the global alarm output.

Digital Output Number

This screen appears if an unassigned output number has been selected in the previous parameter (TEST DIGITAL OUTPUT).

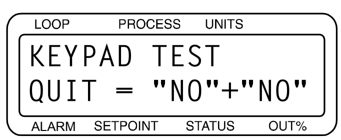
Use this screen to manually toggle a digital output On or Off to test it. Toggling an output ON sinks current from the output to the controller common. Toggling the output OFF stops current flow. All tested outputs are set to OFF when you exit the MANUAL I/O TEST menu. Outputs enabled for control cannot be toggled. To test a control loop output, first disable it using the SETUP LOOP OUTPUTS menu.



Selectable Values: ON or OFF.

Keypad Test

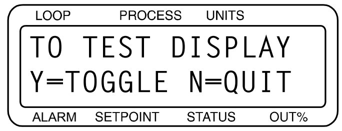
Use this function to test the keypad. The test begins automatically when the screen appears.



- Press any key to test the keypad. The controller will display the name of the key you have pressed.
- Press **NO** twice end the test

Display Test

Use this function to test the display.



- Press **YES** to begin the display of a discernable pixel pattern.
- Press **YES** to toggle the pixel pattern.
- Press **NO** to end the test and return to the top of the `MANUAL I/O TEST` menu.

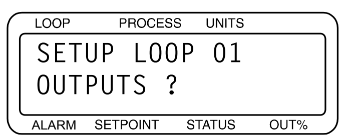
5

Extruder Control

This chapter explains the additional features for the MLS300 series controller equipped with Extruder Control Firmware. Except for setup, default and control algorithm differences described below, the Extruder Control Firmware operates the same as the standard control firmware.

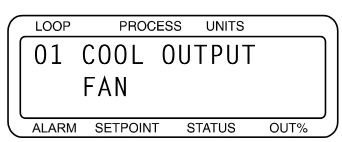
Setup Loop Outputs Menu

The `SETUP LOOP OUTPUTS` menu contains a parameter with descriptors for the selections that are different than those in the standard control firmware.



Cool Output Nonlinear Output Curve

Select linear or nonlinear output curves for the cool output.



Selectable Values: `FAN`, `OIL` or `H2O`. Refer to *Figure 5.1 on page 130*.

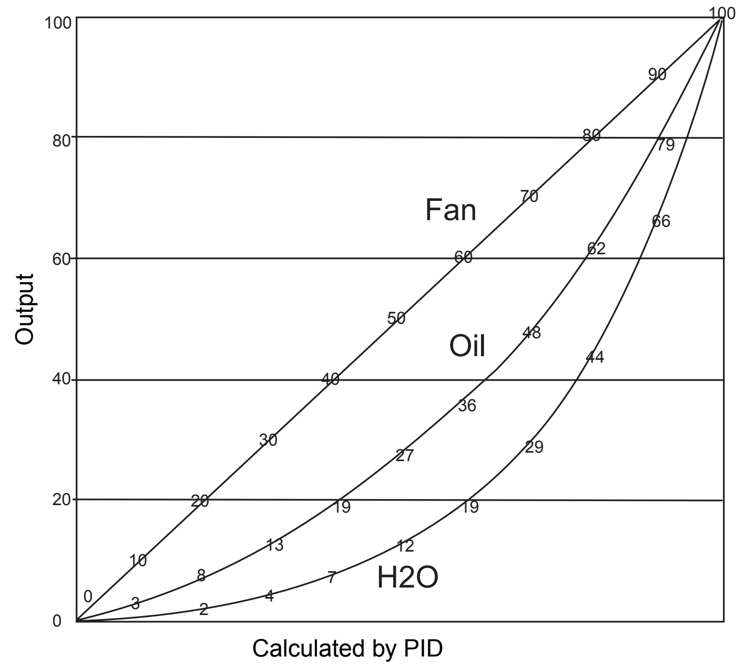


Figure 5.1 Cool Output Nonlinear Output Curve

The COOL OUTPUT parameter is located in the SETUP LOOP OUTPUTS menu. Select one of three nonlinear or linear output curves for cooling.

Defaults

The Extruder Control Firmware uses different defaults for some parameters in the SETUP LOOP CONTROL PARAMS menu. Furthermore, a unique set of control defaults are asserted whenever the COOL OUTPUT parameter on the SETUP LOOP OUTPUTS menu is changed. *Table 5.1* through *Table 5.3 on page 131* list the default parameter settings for each cool output curve.

NOTE! ***Changing the cool output curve parameter will change control parameter settings to defaults for that particular cool output curve.***

Table 5.1 Default Control Parameters for Fan Cool Output

Parameter	Default Value
HEAT CONTROL PB?	50 (for J-type thermocouple) depends on Input Type setting
HEAT CONTROL TI?	500 sec/repeat
HEAT CONTROL TD?	125 sec
HEAT CONTROL FILTER	6
COOL CONTROL PB?	10 (for J-type thermocouple) depends on Input Type setting
COOL CONTROL TI?	0 sec/repeat
COOL CONTROL TD?	0 sec
COOL CONTROL FILTER?	4

Table 5.2 Default Control Parameters for Oil Cool Output

Parameter	Default Value
HEAT CONTROL PB?	50 (for J-type thermocouple) depends on Input Type setting
HEAT CONTROL TI?	500 sec/repeat
HEAT CONTROL TD?	125 sec
HEAT CONTROL FILTER	6
COOL CONTROL PB?	35 (for J-type thermocouple) depends on Input Type setting
COOL CONTROL TI?	300 sec/repeat
COOL CONTROL TD?	60 sec
COOL CONTROL FILTER?	3

Table 5.3 Default Control Parameters for H2O Cool Output

Parameter	Default Value
HEAT CONTROL PB?	50 (for J-type thermocouple) depends on Input Type setting
HEAT CONTRO TI?	500 sec/repeat
HEAT CONTROL TD?	125 sec
HEAT CONTROL FILTER	6
COOL CONTROL PB?	70 (for J-type thermocouple) depends on Input Type setting
COOL CONTROL TI?	500 sec/repeat
COOL CONTROL TD?	90 sec
COOL CONTROL FILTER?	2

Extruder Control Algorithm

The Extruder Control Firmware uses a control algorithm that has been optimized for controlling temperature loops in plastic extruder equipment. Typically, overshoot is undesirable and ambient cooling is not sufficient to dampen the effects of self heating that are inherent in the extrusion process. This control method uses both heat and cool outputs. Under some conditions both heat and cool outputs may be on at the same time.

6

Enhanced Features

This chapter explains five additional features for the MLS300 series controller when enabled with Enhanced Features Option (EFO) firmware:

- Process Variable Retransmit
- Cascade Control
- Ratio Control
- Remote Analog Set Point
- Differential Control

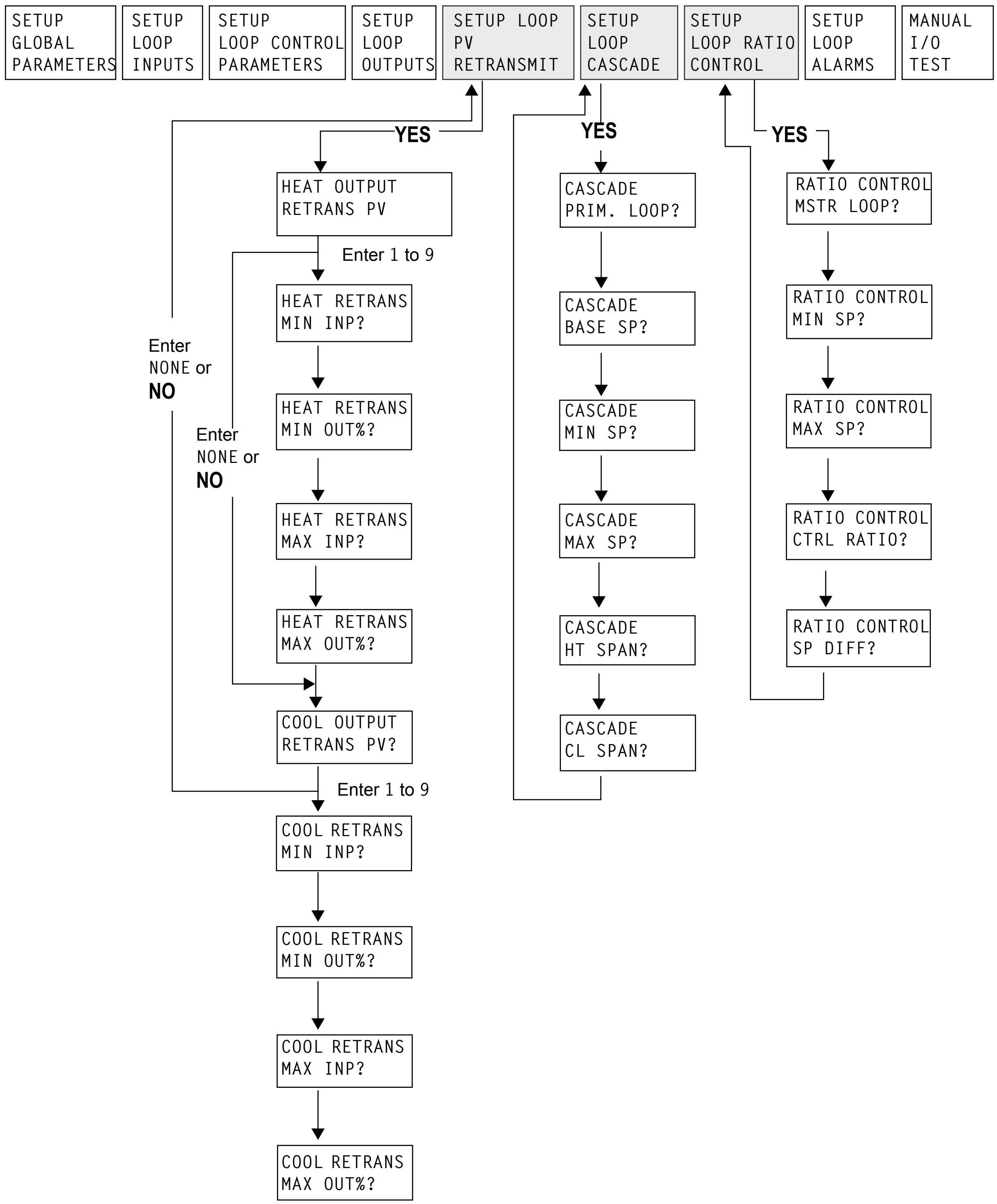


Figure 6.1 Enhanced Features Option Menus

Process Variable Retransmit

The process variable retransmit feature retransmits the process signal of one loop (primary) via the control output of another loop (secondary). This signal is linear and proportional to the engineering units of the primary loop input.

Typical uses include data logging to analog recording systems and long distance transmission of the primary signal to avoid degradation of the primary signal. The signal can also be used as an input to other types of control systems, such as a PLC.

Any available output (heat or cool) may be used as a retransmit output. Any process variable (including the same loop number input) may be retransmitted.

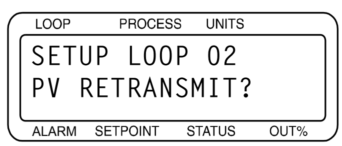
The controller output signal must be connected to a Dual DAC or Serial DAC converter to get a 4 to 20 mA dc or 0 to 5 V dc signal. The choice of converter depends on application requirements.

The process variable retransmit feature is included in both the ramp/soak and enhanced features options.

NOTE! ***If an output is defined as a process variable retransmit, it cannot be used for PID control.***

Setup Loop Process Variable Retransmit Menu

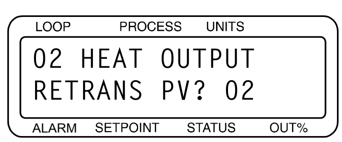
The setup parameters for the process variable retransmit feature appear in the `SETUP LOOP PV RETRANSMIT` menu.



Press **YES** to view the process variable retransmit parameters.

Retransmit Process Variable

Enter the number of the loop that provides the process variable for the retransmit calculation.

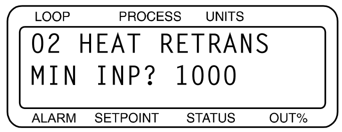


If you set this parameter to `NONE` and press **NO**, the controller skips to the `COOL OUTPUT RETRANS PV` screen. The `COOL` parameter is set up the same way as the `HEAT` parameter.

Selectable values: Any loop or `NONE`.

Minimum Input

Enter the lowest value of the process variable to be retransmitted. This value is expressed in the same engineering units as the input loop.

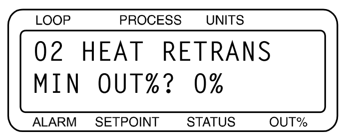


If the process variable falls below the minimum, the output will stay at the minimum value.

Selectable values: Any value in the input loop's range.

Minimum Output

Enter the output value (0 to 100%) that corresponds to the minimum input.

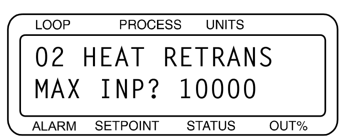


Selectable values: `0` to `100%`

If you select a minimum output value other than 0%, the output will never drop below `MIN OUT`, even if the process variable drops below the `MIN INP` that you specified.

Maximum Input

Enter the highest value of the process variable to be retransmitted. This value is expressed in the same engineering units as the input loop.



If the process variable goes above the maximum, the output will stay at the maximum value.

Selectable values: Any value in the input loop's range.

By adjusting the maximum and minimum inputs, you can scale the output appropriately. See *Figure 6.2*.

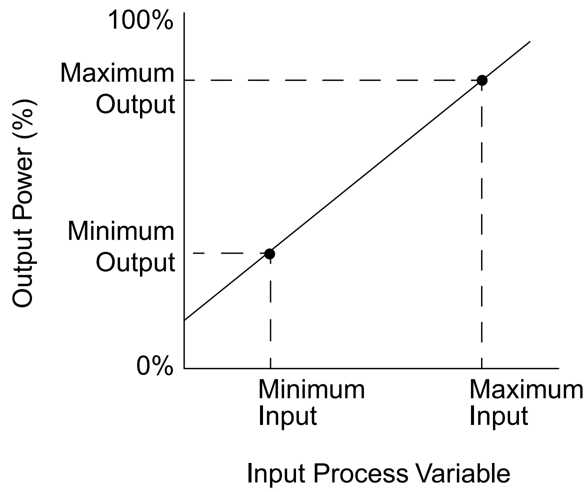
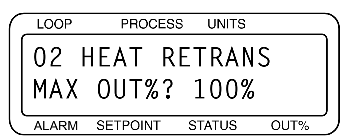


Figure 6.2 Linear Scaling of Process Variable for Retransmit

Maximum Output

Enter the output value (0 to 100%) that corresponds to the maximum input.



The output will never go above this maximum output percentage, regardless of how high the process variable goes.

Selectable values: `0` to `100%`

Process Variable Retransmit Example: Data Logging

The MLS300 controls the temperature of a furnace. The thermocouple in one of the zones is connected to the controller and is used for closed-loop PID control. An analog recorder data logging system is also in place, and a recording of the process temperature is required. The recorder input is a linear 4 to 20 mA dc signal representing a process variable range of 0 to 1000˚F.

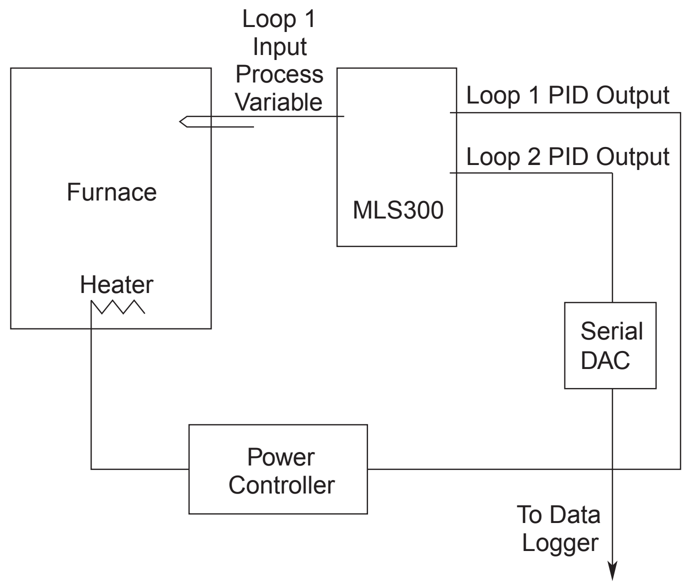


Figure 6.3 Application Using Process Variable Retransmit

To set up this application, you would do the following:

1. First, set up the standard control loop parameters according to the furnace application, in this case on loop 1.
2. Select another unused PID output for retransmitting the thermocouple value (for example, loop 2 heat output).
3. Change the display to loop 2, and then enter the three-key sequence (**ENTER**, then **ALARM ACK**, then **CHNG SP**) and go to the first screen in *Table 6.1*.
4. Follow the steps in *Table 6.1* to configure the process variable retransmit option.
5. After following the steps in *Table 6.1*, press **BACK** several times until the normal loop display appears. The controller will now produce an output on loop 2 which is linear and proportional to the loop 1 process variable.

Table 6.1 Application Example: Setting Up Process Variable Retransmit

Display	User Input
SETUP LOOP 02 PV RETRANSMIT	Press **YES**.
02 HEAT OUTPUT RETRANS PV? 01	Enter 01 for loop 1 process variable. Press **ENTER**.
02 HEAT RETRANS MIN INP? 0	Enter the minimum input value, which corresponds to the minimum output percentage. For a range of 0 to 1000°F, set the minimum input value to 0°F. Press **ENTER**.
02 HEAT RETRANS MIN OUT%? 0	Enter the minimum output percentage, from 0 to 100%. For this example we will assume a full span with a minimum of 0%. Press **ENTER**.
02 HEAT RETRANS MAX INP? 1000	Enter the maximum input value, which corresponds to the maximum output percentage. For a range of 0 to 1000°F, set the maximum input value to 1000°F. Press **ENTER**.
02 HEAT RETRANS MAX OUT%? 100	Enter the maximum output percentage, from 0 to 100%. For this example we will assume a full span with a maximum of 100%. Press **ENTER**.
02 COOL OUTPUT RETRANS PV? NONE	The process variable retransmit section of the controller programming is now completed. We are not using the cool output of loop 2 to retransmit a process variable, so choose NONE. Press **ENTER**.

Notes about this application:

- This is not a thermocouple curve type of signal and requires a linear input range in the recorder.
- To complete this configuration, the loop 2 output must be enabled and tailored to meet the requirements of the data-application. In this example, the data logger requires an analog input of 4 to 20 mA.
- The MLS300 Series controllers must be used with a Watlow Anafaze Dual DAC or Serial DAC for proper signal conversion.
- The Dual DAC accuracy on retransmit is 0.75% of reading which matches the standard thermocouple rated accuracy statement of 0.75% of reading.
- For higher accuracies of 0.05% of full scale, the Serial DAC is recommended.

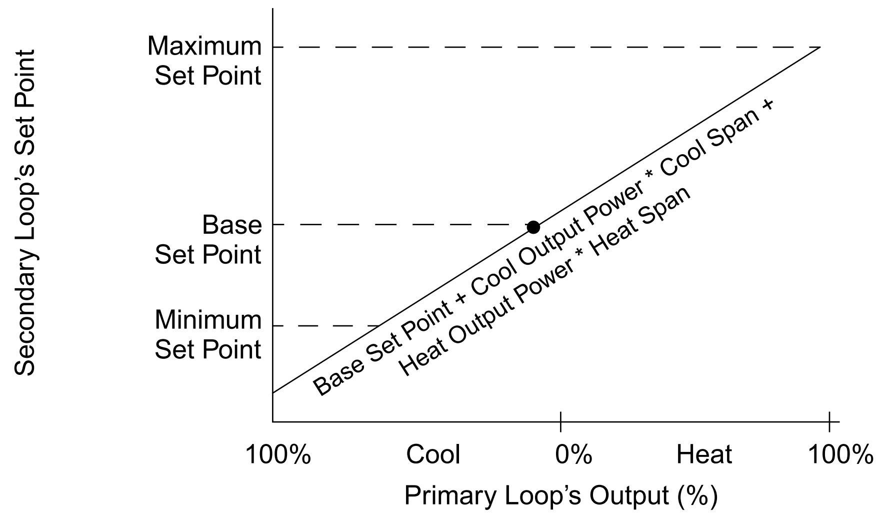
Consult *Chapter 4, Setup*, for information on setting up the other options of the controller.

Cascade Control

Cascade control is used to control thermal systems with long lag times, which cannot be as accurately controlled with a single control loop. The output of the first (primary) loop is used to adjust the set point of the second (secondary) loop. The secondary loop normally executes the actual control.

The cascade control feature allows the output percentage of one control loop to determine the set point of a second control loop. By adjusting the set point (SP) parameters, the user can adjust the influence that the primary loop has on the set point of the secondary loop. See *Figure 6.4.*

Some applications, such as aluminum casting, use two-zone cascade control where the primary output is used for the primary heat control and the cascaded output is used for boost heat. The MLS300 allows you to use the primary heat output for both control and for determining the set point of the secondary loop.



Calculation of new secondary loop set point:
Set Point 2 = Base Set Point + Cool Output Power * Cool Span
+ Heat Output Power * Heat Span

Figure 6.4 Relationship Between the Primary Loop's Output and the Secondary Loop's Set Point

NOTE! ***Cascade control cannot be used on the same control loop as ratio control. However, both features may be used in the same multiloop controller.***

Setup Loop Cascade Menu

The setup parameters for cascade control appear under the `SETUP LOOP CASCADE` menu.

LOOP PROCESS UNITS

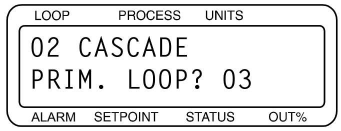
```
SETUP LOOP 02
CASCADE?
```

ALARM SETPOINT STATUS OUT%

Press **YES** to set up the cascade parameters. The loop currently displayed (loop `02` in this case) will be the secondary control loop, which performs the actual control.

Primary Loop

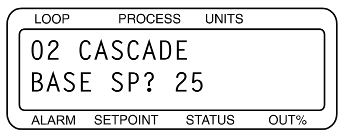
Enter the primary loop number. The output percentage of this loop will control the set point of the secondary loop.



Selectable values: Any loop except the secondary loop.

Base Set Point

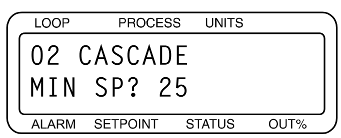
Enter the set point that corresponds to 0% (heat and cool) output from the primary loop (`PRIM. LOOP`). This value is expressed in the same engineering units as the secondary loop’s process variable.



Selectable values: Any value from the secondary loop’s minimum process variable to its maximum process variable.

Minimum Set Point

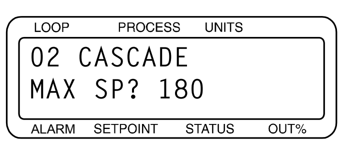
Enter the lowest value of the secondary loop set point. This minimum set point overrides any calculation caused by the primary loop calling for a lower set point. This value is expressed in the same engineering units as the secondary loop’s process variable.



Selectable values: Any value from the secondary loop’s minimum process variable to its maximum process variable.

Maximum Set Point

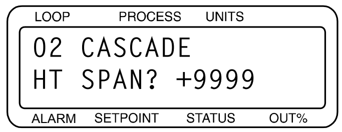
Enter the highest value of the secondary loop set point. This maximum set point overrides any calculation caused by the primary loop calling for a higher set point. This value is expressed in the same engineering units as the secondary loop’s process variable.



Selectable values: Any value from the secondary loop's minimum process variable to its maximum process variable.

Heat Span

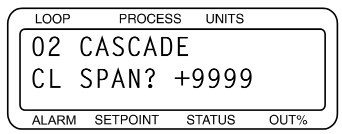
Enter the multiplier to apply to the primary loop heat output percentage.



Selectable values: `-9999` to `+9999`.

Cool Span

Enter the multiplier to apply to the primary loop cool output percentage.



Selectable values: `-9999` to `+9999`.

Cascade Control Example: Water Tank

A tank of water has an inner and outer thermocouple. The outer thermocouple is located in the center of the water. The inner thermocouple is located near the heating element. The desired temperature of the water is 150˚F, which is measured at the outer thermocouple. Using cascade control, the outer thermocouple is used on the primary loop (in this example, loop 1), and the inner thermocouple is used on the secondary loop (loop 2). The heater is controlled by loop 2 with a set point range of 150 to 190˚F.

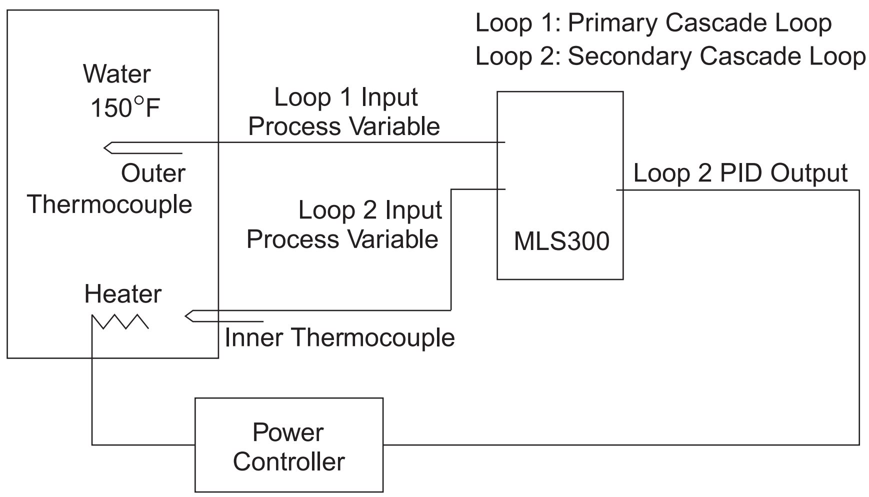


Figure 6.5 Application Using Cascade Control

To set up this application, you would do the following:

1. Change the display to loop 2, which will be the secondary loop, and then enter the three-key sequence (**ENTER**, then **ALARM ACK**, then **CHNG SP**) and go to the first screen in *Table 6.2*.
2. Follow the steps in *Table 6.2* to configure cascade control.

Table 6.2 Application Example: Setting Up Cascade Control

Display	User Input

LOOP PROCESS UNITS
`SETUP LOOP 02`
`CASCADE?`
ALARM SETPOINT STATUS OUT%
	Press **YES** to set up the cascade parameters with loop 2 as the secondary loop.

LOOP PROCESS UNITS
`02 CASCADE`
`PRIM. LOOP? 01`
ALARM SETPOINT STATUS OUT%
	Enter 01 to make loop 1 the primary loop. Press **ENTER**.

Display	User Input
LOOP PROCESS UNITS 02 CASCADE BASE SP? 150 ALARM SETPOINT STATUS OUT%	The base set point corresponds to the 0% level output of the primary loop. Enter the base set point of the secondary loop. For this example, we will assume a base set point of 150°F, which is the desired water temperature. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE MIN SP? -350 ALARM SETPOINT STATUS OUT%	Enter the minimum set point of the secondary loop. For this example, we will use a minimum set point of -350°F. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE MAX SP? 1400 ALARM SETPOINT STATUS OUT%	Enter the maximum set point of the secondary loop. For this example, we will use a maximum set point of 1400°F. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE HT SPAN? 40 ALARM SETPOINT STATUS OUT%	Enter the heat span of the secondary loop. This is the span over which the primary output from 0 to 100% is used to change the set point. The desired set point range is 150 to 190°F. We will assume a linear rise in set point, so the heat span is 40°F. Press **ENTER**.
LOOP PROCESS UNITS 02 CASCADE CL SPAN? 0 ALARM SETPOINT STATUS OUT%	Enter the cool span of the secondary loop. For this example we will assume no low-side adjustment to the set point, so the cool span is 0°F. Press **ENTER**.

3. Press **BACK** several times until the normal loop display appears. The output percentage of loop 1 will now control the set point of loop 2.

To verify that cascade is working as expected, you would follow these steps:

1. Set loop 1 to MANUAL and the OUTPUT to 0%. Loop 2 set point should equal 150 (BASE SP).
2. Adjust loop 1 MANUAL OUTPUT to 50%. Loop 2 set point should equal 170 (BASE SP + 50% of HT SPAN)
3. Adjust loop 1 MANUAL OUTPUT to 100%. Loop 2 set point should equal 190 (BASE SP + HT SPAN).
4. To complete the cascade setup, both loop 1 and loop 2 must be configured for inputs, outputs, and alarms.

In addition, the PID parameters of loop 1 must be tuned to produce the desired effect for the application on the set point of loop 2. For a cascade control application that uses the secondary loop for PID control, loop 1 typically uses only proportional mode. This must be set for the amount of change in the process variable to cause a 100% change in the output level.

The proportional band is selected so the set point of the secondary loop has the desired relationship to the process variable of the primary loop. In this application, the proportional band (PB) of the primary loop is set to 10˚F and the integral and derivative are turned off.

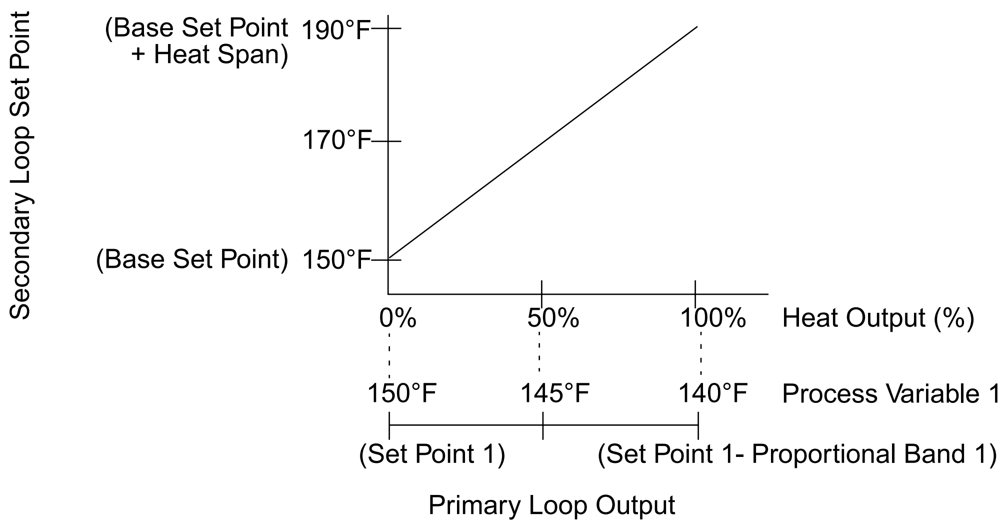


Figure 6.6 Secondary Loop Set Point Related to Primary Loop Output

As the temperature of loop 1 drops, the output of loop 1 goes up proportionally and the set point of loop 2 goes up proportionally. Thus heat is added to the system at the element even though the temperature near the element may have been at set point (150˚F).

With proportional control, when loop 1 is at set point, its output is 0%, and the set point of loop 2 is equal to the base set point (150˚F). If the temperature of loop 1 drops to 149˚F, the deviation results in a proportional output of 10%. This times the span of 40˚F results in an increase in set point for loop 2 of 4˚F. The loop 2 set point increases to 154˚F. For every degree that loop 1 drops, loop 2 increases by 4˚F until the output of loop 1 is 100% and the loop 2 set point is 190˚F. Any further drop in the loop 1 process variable does not affect loop 2.

The PID parameters of loop 2 must be tuned to perform efficient control.

For two-zone cascade control systems, the PID settings for both loops, the primary plus the secondary, must be optimized for good temperature control.

See *Chapter 4, Setup,* for information on tuning PID loops.

Ratio Control

Ratio control allows the process variable of one loop (master loop), multiplied by a ratio, to be the set point of another loop (ratio loop). You can assign any process variable to determine the set point of a ratio loop.

By adjusting the ratio control parameters, you can adjust the influence that the master loop process variable has on the set point of the ratio loop.

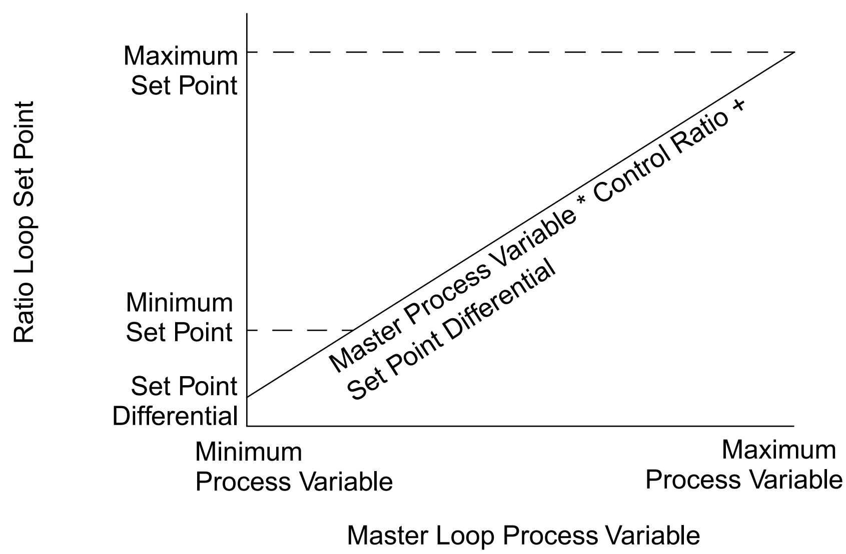


Figure 6.7 Relationship Between the Master Loop's Process Variable and the Ratio Loop's Set Point

NOTE! ***Ratio control cannot be used on the same control loop as cascade control. However, both features may be used in the same multi-loop controller.***

Setup Loop Ratio Control Menu

The ratio control parameters appear in the `SETUP LOOP RATIO CONTROL` menu.

```
LOOP      PROCESS   UNITS
SETUP LOOP 02
RATIO CONTROL?
ALARM  SETPOINT  STATUS  OUT%
```

Press **YES** to set up the ratio control parameters with loop number 2 as the ratio loop.

Master Loop

Enter the master loop which will provide the output to the internal controller set point calculation for the ratio loop set point.

```
LOOP      PROCESS   UNITS
02 RATIO CONTROL
MSTR LOOP? NONE
ALARM  SETPOINT  STATUS  OUT%
```

Selectable values: Any loop except the loop currently selected (in this case, loop 02). Choose `NONE` for no ratio control.

Minimum Set Point

Enter the lowest allowable set point for the ratio loop. This minimum set point overrides any ratio calculation calling for a lower set point. This value is expressed in the same engineering units as the ratio loop's process variable.

```
LOOP      PROCESS   UNITS
02 RATIO CONTROL
MIN SP? 25
ALARM  SETPOINT  STATUS  OUT%
```

Selectable values: Any value from the minimum value of the ratio loop's process variable to its maximum value.

Maximum Set Point

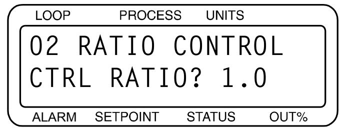
Enter the highest allowable set point for the ratio loop. This maximum set point overrides any ratio calculation calling for a higher set point. This value is expressed in the same engineering units as the ratio loop's process variable.

```
LOOP      PROCESS   UNITS
02 RATIO CONTROL
MAX SP? 25
ALARM  SETPOINT  STATUS  OUT%
```

Selectable values: Any value from the minimum value of the ratio loop's process variable to its maximum value.

Control Ratio

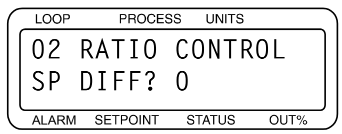
Enter the multiplier to apply to the master loop’s process variable.



Selectable values: `0.1` to `999.9`.

Set Point Differential

Enter the value to add or subtract from the ratio loop set point calculation before using it as the set point. This value is expressed in the same engineering units as the ratio loop’s process variable.



Selectable values: `-9999` to `9999` with the decimal placement determined by the `DISP FORMAT` setting for the ratio loop.

Ratio Control Example: Diluting KOH

A chemical process requires a formula of two parts water (H_2O) to one part potassium hydroxide (KOH) to produce diluted potassium hydroxide. The desired flow of H_2O is 10 gallons per second (gps), so the KOH should flow at 5 gps. Separate pipes for each chemical feed a common pipe. The flow rate of each feeder pipe is measured by a MLS300, with H_2O flow as process variable 1 and KOH flow as process variable 2. The outputs of loops 1 and 2 adjust motorized valves.

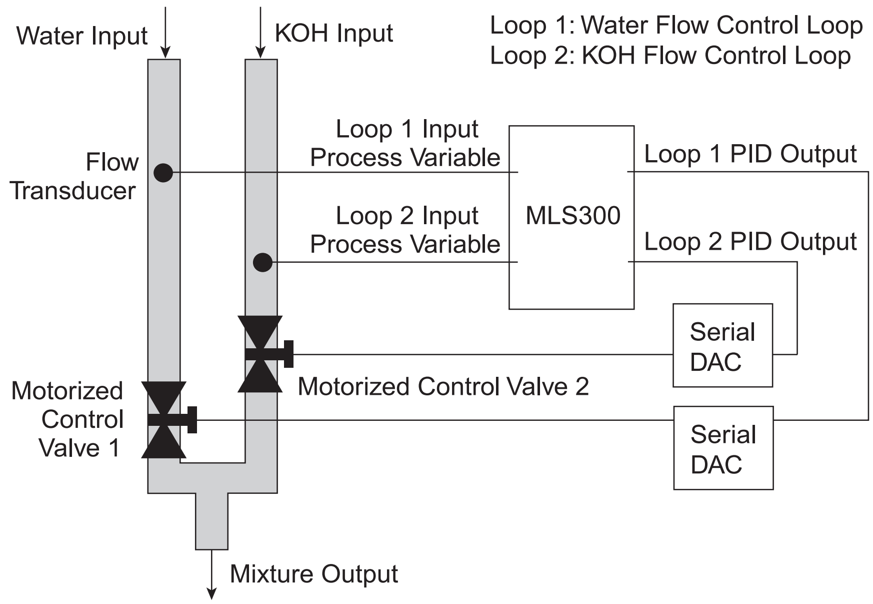


Figure 6.8 Application Using Ratio Control

To set up this application, you would do the following:

1. Adjust and tune loop 1 (H_2O) for optimal performance before implementing the ratio setup.
2. Switch the controller to display loop 2 (KOH), and then enter the three-key sequence (**ENTER**, then **ALARM ACK**, then **CHNG SP**) and go to the first screen in *Table 6.3*.
3. Follow the steps in *Table 6.3* to configure ratio control.

Table 6.3 Application Example: Setting Up Ratio Control

Display	User Input
LOOP PROCESS UNITS SETUP LOOP 02 RATIO CONTROL? ALARM SETPOINT STATUS OUT%	Press **YES** to set up the ratio control parameters for loop 02.
LOOP PROCESS UNITS 02 RATIO CONTROL MSTR LOOP? 01 ALARM SETPOINT STATUS OUT%	Assign loop 01 as the master loop. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL MIN SP? 0.0 ALARM SETPOINT STATUS OUT%	Enter the minimum ratio loop set point. For this example, we will use 0.0 gallons per second as a minimum. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL MAX SP? 7.0 ALARM SETPOINT STATUS OUT%	Enter the maximum ratio loop set point. For this example, we will use 7.0 gallons per second as a maximum. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL CTRL RATIO? 0.5 ALARM SETPOINT STATUS OUT%	Enter the control ratio, which is the multiple applied to the master. The H_2O fl w rate is multiplied by 0.5 to obtain the KOH fl w rate set point. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL SP DIFF.? 0 ALARM SETPOINT STATUS OUT%	Enter the set point differential (or offset). For this example we have no offset requirement and will use 0. Press **ENTER**.

4. Press **BACK** several times until the normal loop display appears. The set point of loop 2 will now be equal to one half of the process variable of loop 2.
5. To complete the ratio setup, configure both loops 1 and 2 for inputs, outputs, and alarms. See *Chapter 4, Setup,* for information on loop setup.

Remote Analog Set Point

The remote analog set point is set up identically to ratio control. To provide a set point remotely, typically a voltage or current source is connected to an analog input on the controller. This input is configured as a linear input type and the master loop for ratio control. All other input types are also usable as remote analog set point inputs.

Specify the loop to which the analog input is connected as the master loop and setup the rest of the ratio control parameters as outlined in *Setup Loop Ratio Control Menu on page 148*.

Remote Analog Set Point Example: Setting a Set Point with a PLC

Remote analog set point allows external equipment, such as a PLC or other control system, to change the set point of a loop.

Both the remote analog set point feature and the process variable retransmit feature can be used with PLC systems as the link between multiloop PID control systems and PLC systems.

For example, a 0 to 5 V dc signal representing 0 to 300˚F will be used as a remote set point input to the MLS300. The input signal will be received on loop 1 with the control being performed on loop 2. Note that proper scaling resistors must be installed on the input of loop 1 to allow it to accept a 0 to 5 V dc input.

To set up this application, you would do the following:

1. In the loop 1 SETUP LOOP INPUT menu, set the INPUT TYPE to LINEAR, set HI PV to 300, set LO PV to 0, set HI RDG to 100.0% and set LO RDG to 0.0%.
2. Change the display to loop 2, and then enter the setup parameters. Go to the first screen in *Table 6.4.*
3. Follow the steps in *Table 6.4* to configure the process variable retransmit option.

Table 6.4 Application Example: Setting Up Remote Set Point

Display	User Input
SETUP LOOP 02 RATIO CONTROL?	Press **YES** to set up the ratio control parameters for loop 2.
02 RATIO CONTROL MSTR LOOP? 01	Assign loop 01 to be the master loop. Press **ENTER**.
02 RATIO CONTROL MIN SP? 0	Enter the minimum ratio loop set point. For this example, we will use 0°F. Press **ENTER**.
02 RATIO CONTROL MAX SP? 300.0	Enter the maximum ratio loop set point. For this example, we will use 300.0°F as a maximum. Press **ENTER**.
02 RATIO CONTROL CTRL RATIO? 1.0	Enter the control ratio, which is the multiple applied to the master process variable. In this example the ratio is 1.0. Press **ENTER**.
02 RATIO CONTROL SP DIFF.? 0	Enter the set point differential (or offset). For this example we have no offset requirement and will use 0. Press **ENTER**.

4. Press **BACK** several times until the normal loop display appears. The set point of loop 2 will now be equal to the process variable of loop 1.
5. To complete the remote analog set point setup, loop 1 may be configured for outputs and alarms. Likewise, loop 2 must be configured for inputs, outputs, and alarms. See *Chapter 4, Setup,* for information on loop setup.

Differential Control

Differential control is a simple application of the ratio control option, used to control one process (ratio loop) at a differential, or offset, to another (master loop). To use differential control, set the ratio value to 1.0 to provide the desired offset.

Differential Control Example: Thermoforming

A thermal forming application requires that the outside heaters operate at a higher temperature than the center heaters. The differential control point is determined by the master loop which is using infrared (IR) sensors for temperature feedback. Secondary loops use thermocouples for feedback.

The loop using the IR sensor as an input is assigned to the master loop in the `SETUP LOOP RATIO CONTROL` menu. The secondary loop is the differential control loop. Setting the set point differential (`SP DIFF`) to the desired offset will produce the desired offset between the secondary and master loops.

For example, the master loop can be controlled at 325ºF and the secondary loop at 375ºF by using a differential of 50ºF.

Loop 1 must be set up for PID control of the set point at 325ºF.

To set up this application, you would do the following:

1. Change the display to loop 2, and then enter the setup parameters. Go to the first screen in *Table 6.5.*
2. Follow the steps in *Table 6.5* to configure the process variable retransmit option.

Table 6.5 Application Example: Setting Up Differential Control

Display	User Input
LOOP PROCESS UNITS SETUP LOOP 02 RATIO CONTROL? ALARM SETPOINT STATUS OUT%	Press **YES** to setup the ratio control parameters for loop 2.
LOOP PROCESS UNITS 02 RATIO CONTROL MSTR LOOP? 01 ALARM SETPOINT STATUS OUT%	Assign loop 01 to be the master loop. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL MIN SP? 300.0 ALARM SETPOINT STATUS OUT%	Enter the minimum ratio loop set point. For this example, we will use 300.0°F. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL MAX SP? 400.0 ALARM SETPOINT STATUS OUT%	Enter the maximum ratio loop set point. For this example, we will use 400.0°F. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL CTRL RATIO? 1.0 ALARM SETPOINT STATUS OUT%	Enter the control ratio, which is the multiple applied to the master process variable. In this example the ratio is 1.0. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL SP DIFF.? 50 ALARM SETPOINT STATUS OUT%	Enter the set point differential (or offset). For this example, we have an offset of +50. Press **ENTER**.

3. Press **BACK** several times until the normal loop display appears. The set point of loop 2 will now be equal to process variable of loop 1 plus 50˚F.
4. To complete the differential control setup, loop 1 and loop 2 must be configured for inputs, outputs, and alarms. See *Chapter 4, Setup* for information on loop setup.

7

Ramp/Soak

This chapter covers setup and operation of Ramp/Soak profiles in MLS300 series controllers.

These features are available in controllers that have the optional Ramp/Soak firmware installed.

The Ramp/Soak feature turns your controller into a powerful and flexible batch controller. Ramp/Soak lets you program the controller to change a process set point in a preset pattern over time. This preset pattern, or temperature **profile**, consists of several **segments**. During a segment, the temperature goes from the previous segment's set point to the current segment's set point.

- If the current segment's set point is higher or lower than the previous segment's set point, it is called a **ramp** segment.
- If the current segment's set point is the same as the previous segment's set point, it is called a **soak** segment.

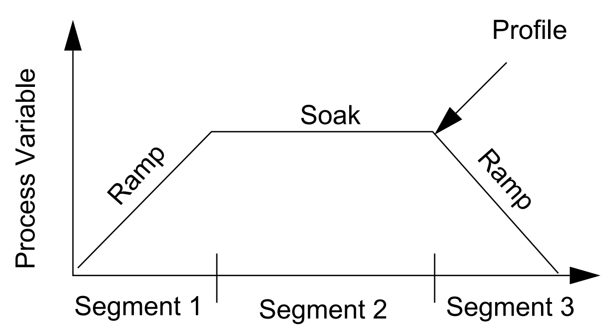


Figure 7.1 Sample Ramp/Soak Profile

Features

Ramp/Soak in the MLS300 includes the following features:

- **Ready segment sets loop up for profile:** Ready segment can control at set point until profile needs to run. Ready segment events set all available event outputs to desired states before profile starts.
- **Up to 20 segments per profile:** Controller can store up to 17 profiles each with up to 20 segments.
- **Multiple profiles run independently:** Each loop can run a different profile or the same profile can be run independently on more than one loop.
- **Up to two triggers per segment:** Triggers are digital inputs that can be programmed to start and hold segments based on the trigger's digital state. You can use any one of the eight digital inputs for triggers. You can also use the same trigger for more than one segment or more than one profile.
- **Up to four events per segment:** Digital outputs controlled by the Ramp/Soak profile. Events outputs are set at the end of a segment. You can use any of the digital outputs that are not used for control or for the SDAC clock for events.
- **Tolerance hold ensures time at temperature:** Set a limit on how far the process variable can vary above or below set point. The profile clock only runs when the process variable is within the limit.
- **Tolerance alarm indicates process not tracking set point:** Set a maximum amount of time for the tolerance hold to wait for a process deviation before notifying the operator. Operator can acknowledge alarm and proceed if desired.
- **User-configurable time base:** Program profiles to run for hours and minutes or for minutes and seconds.
- **Repeatable profiles:** Set any profile to repeat from 1 to 99 times or continuously.
- **Fast setup for similar profiles:** Set up one profile, then copy it and alter it to set up the rest.
- **External reset:** Select a digital input you can use to hold a profile in the Start state and restart it.

Table 7.1 MLS300 Ramp/Soak Summary

Number of possible profile	17
Number of times to repeat a profil	1 to 99 or Continuous
Number of segments per profil	1 to 20
Number of triggers per segment	Up to 2
Type of triggers	ON, ON Latched, OFF, OFF Latched
Number of possible inputs for triggers	8
Number of events per segment	up to 4
Number of possible outputs for events (At least one of these outputs must be used for control)	34

Setup Ramp/Soak Profile Menu

The Setup Ramp/Soak Profile menu appears between the Setup Loop Alarms and Manual I/O Test menus. *Figure 7.2 on page 160* shows the Ramp/Soak setup menu tree.

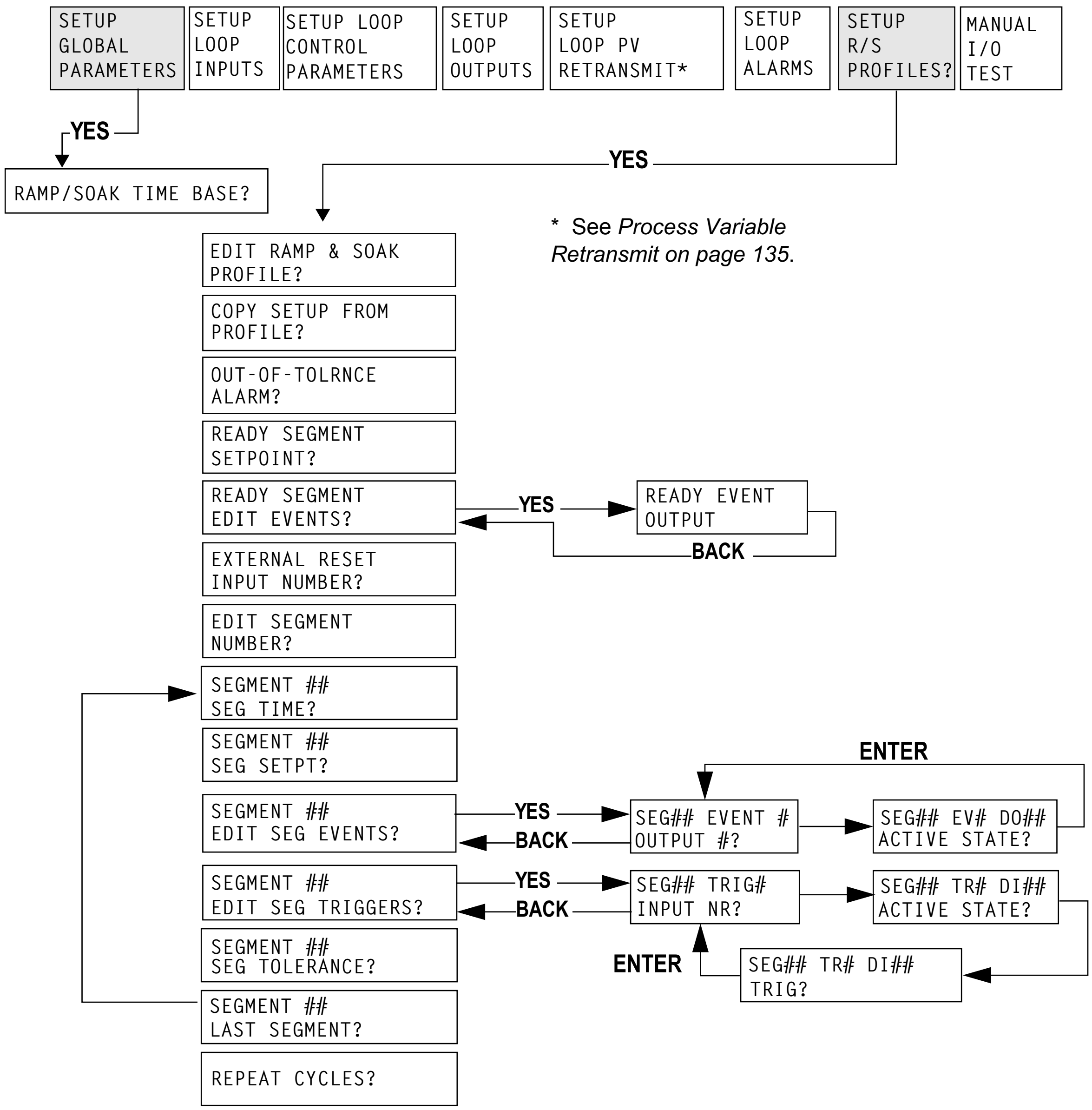
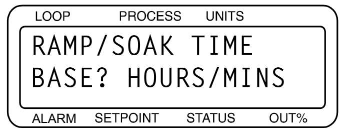


Figure 7.2 Ramp/Soak Menus

Ramp/Soak Time Base

The Ramp/Soak time base parameter is in the SETUP GLOBAL PARAMETERS menu.

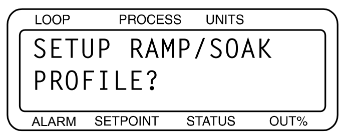
Use this parameter to set the time base in all your Ramp/Soak profiles. When set to HH:MM, the set point is updated once every minute. When set to MM:SS, the set point is updated once every second.



Selectable Values: HOURS/MINS or MINS/SECS.

Setup Ramp/Soak Profile Menu

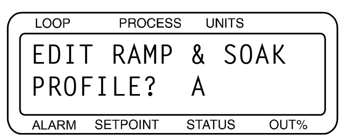
You can reach the rest of the parameters in this section from the SETUP RAMP/SOAK PROFILE menu. This menu is located between the SETUP LOOP ALARMS and the MANUAL I/O TEST menus if the Ramp/Soak option is installed.



Press **YES** to setup or edit Ramp/Soak profiles.

Edit Ramp/Soak Profile

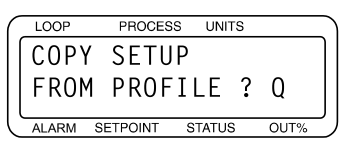
Use this parameter to choose a profile to set up or edit.



Selectable Values: A to Q (17 profiles).

Copy Setup From Profile

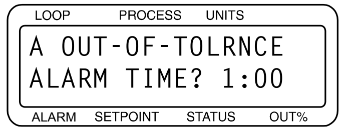
Use this parameter to set up similar profiles quickly, by copying a profile to another one.



Selectable Values: A to Q.

Tolerance Alarm Time

Use this parameter to set a limit on how long the process variable can be outside the tolerance set for the segment before the tolerance alarm occurs.



If the process variable does not return within the tolerance, the tolerance alarm will recur after the tolerance alarm time elapses again.

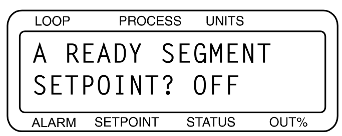
If the alarm persists, you may want to reset the profile.

Selectable Values: `0:00` to `99:59` (minutes or hours, depending on the time base setting).

Ready Segment Set Point

When you assign a profile to a loop, the profile doesn’t start immediately; instead, it goes to the ready segment (segment 0) and stays there until you put the profile in Run mode.

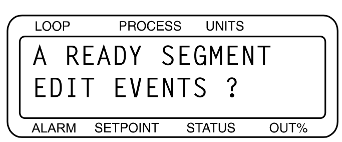
You can set a set point, assign events, and set event states for the ready segment. Use this parameter to set the ready segment set point. Setting the set point to `OFF` ensures that control outputs for the loop running the profile will not come on.



Selectable Values: `-999` to `9999`, or `OFF`. See *Set Points and Tolerances for Various Input Types on page 168.*

Ready Segment Edit Event

Use this parameter to set the state for all outputs that are not used for control or for the SDAC clock. When you assign a profile, the controller starts the ready segment: it goes to the set point and puts all the outputs in the state you set here. The outputs stay in the states they are set to until their states are changed at the end of subsequent segments.



Press **NO** if you don’t want to edit the ready segment events.

Press **YES** to display the ready segment editor screen:

```
LOOP      PROCESS   UNITS
A READY EVENT
OUTPUT 15? OFF
ALARM  SETPOINT  STATUS  OUT%
```

Press **NO** to increment the output number or **YES** to set the event state.

Selectable Values: You can toggle inputs that are not in use to ON or OFF.

Press **BACK** to get out of the ready segment editor screen.

External Reset Input Number

Use this parameter to select one of the eight digital inputs as an external reset. When the reset input is on, the profile is set to RUN mode at the beginning of the first segment. As long as the reset input is on, the profile is held at the beginning of the first segment. Once the reset input turns off the profile begins to run.

```
LOOP      PROCESS   UNITS
A EXTERNAL RESET
INPUT NUMBER? N
ALARM  SETPOINT  STATUS  OUT%
```

Selectable Values: 1 to 8, or N (for no external reset).

Edit Segment Number

Each profile is made up of several segments (up to 20). Use this parameter to choose the segment to edit.

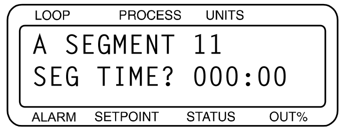
```
LOOP      PROCESS   UNITS
A EDIT SEGMENT
NUMBER?  15
ALARM  SETPOINT  STATUS  OUT%
```

Selectable Values: 1 to 20.

The first time you use this parameter, it defaults to segment 1. When you have finished editing a segment, the controller returns you to this parameter and goes to the next segment. This loop continues until you make a segment the last segment of a profile.

Segment Time

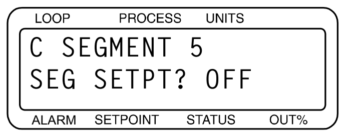
Use this parameter to change the segment time.



Selectable Values: `0:00` to `999:59` (hours and minutes or minutes and seconds, depending on the selected time base).

Segment Set Point

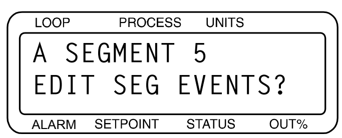
Use this parameter to set the ending set point for the segment you are editing. For a ramp, the set point changes steadily from the end set point of the previous segment to the value set here over the segment time. For a soak, set the value here equal to the end set point of the previous segment.



Selectable Values: `-999` to `9999`, or `OFF` (no output during segment). See *Set Points and Tolerances for Various Input Types on page 168*.

Edit Segment Events

You can assign up to four digital outputs, or events, to each segment. When the segment ends, the outputs you select are set to the state you specify. Use this parameter to select outputs and specify their states.



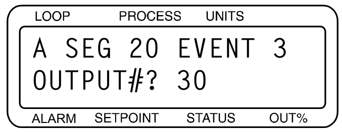
Selectable Values: `YES` or **`NO`**.

Starting a Segment with an Event

If you want a segment to start with an event (events are set at the end of segments), program the event in the previous segment. You can also create a segment with zero time preceding the segment during which you want the event on.

Edit Event Outputs

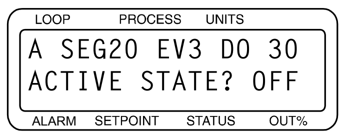
This parameter appears only if you answered **YES** to the previous parameter. Use it to select digital outputs for events. Assign digital outputs that are not being used for PID control or for SDAC clock.



Selectable Values: Any digital output from `1` to `34`, except those in use, or `NONE` (no event).

Segment Events Active States

Use this parameter to assign a state to each event: `ON` (Low) or `OFF` (High). At the end of the segment, the output goes to the state you assign here.

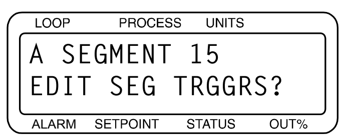


Selectable Values: `OFF` (High) or `ON` (Low).

Edit Segment Triggers

Each segment may have up to two triggers (digital inputs). All triggers must be true in order for the segment to run. If a trigger is not true, the profile goes into the trigger wait state.

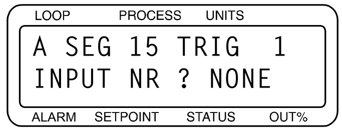
Use this parameter to edit triggers for the current segment.



Selectable Values: Press **YES** (to edit triggers of current segment), or **NO** (to advance to the `EDIT SEGMENT TOLERANCE` parameter).

Trigger Input Number

This parameter appears only if you answered **YES** to the `EDIT SEGMENT TRIGGERS` parameter. Use it to assign one of the controller's eight digital inputs to a segment trigger. You can assign any digital input to any trigger. You can also assign the same digital input as a trigger in more than one segment and more than one profile.

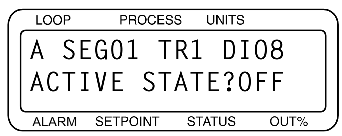


Selectable Values: Any digital input from 1 to 8, or NONE (no input assigned). Setting a trigger to NONE disables it.

Trigger Active State

Use this parameter to set the state, ON or OFF, that will satisfy the trigger condition. This parameter appears only if you answered **YES** to the EDIT SEGMENT TRIGGERS parameter.

- A trigger input is ON when pulled low by an external device.
- A trigger input is OFF when no external device creates a path to ground.



Selectable Values: OFF or ON.

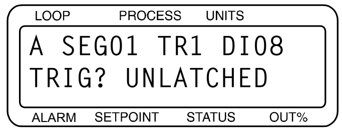
Trigger Latch Status

Use this parameter to make a trigger latched or unlatched.

- A latched trigger is checked once, at the beginning of a segment.
- An unlatched trigger is checked constantly while a segment is running. If an unlatched trigger becomes false, the segment timer stops and the loop goes into trigger wait state.

When using two triggers with a segment, the following logic applies:

Trigger Settings	Trigger Logic
Both Triggers Latched	OR'd Triggers start the segment.
Both Triggers Unlatched	AND'd Triggers start/continue the segment.
One Trigger Latched One Trigger Unlatched	• The unlatched trigger starts/continues a segment. • The latched trigger has no effect.



Selectable Values: LATCHED or UNLATCHED.

Segment Tolerance

Use this parameter to set a positive or negative tolerance value for each segment.

Tolerance works as shown in the following diagram.

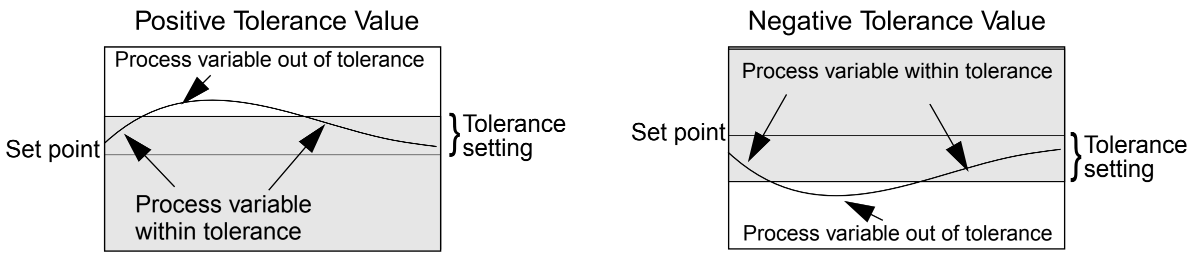
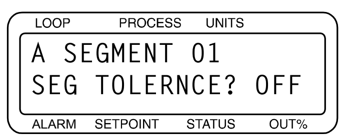


Figure 7.3 Positive and Negative Tolerances

If you enter a positive tolerance, the process is out of tolerance when the process variable goes above the set point plus the tolerance.

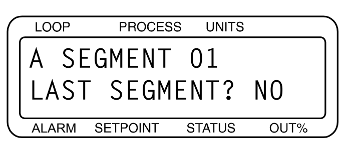
If you enter a negative tolerance, the process goes out of tolerance when the process variable goes below the set point minus the tolerance.



Selectable Values: -99 to 99, or OFF (no tolerance limit). See *Set Points and Tolerances for Various Input Types on page 168*.

Last Segment

Use this parameter to make the current segment the last one in the profile.

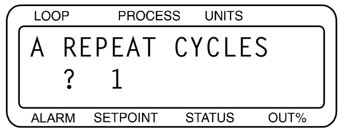


Selectable Values: NO or YES.

Repeat Cycles

Use this parameter to set the number of times you want a profile to repeat or cycle.

The profile returns to `START` mode after completing the number of cycles specified here.



Selectable Values: `1` to `99`, or `C` (continuous cycling).

Set Points and Tolerances for Various Input Types

Set points and tolerances are set in segments before the profile is assigned to a particular loop. When the profile is used with a loop in the `INPUT TYPE` and `DISPLAY FORMATS` settings are applied to the following parameters:

- Ready set point
- Segment set point
- Segment tolerance

Refer to *Table 7.2 on page 168* to determine how these parameters are affected for the various `INPUT TYPES` and `DISPLAY FORMAT` settings.

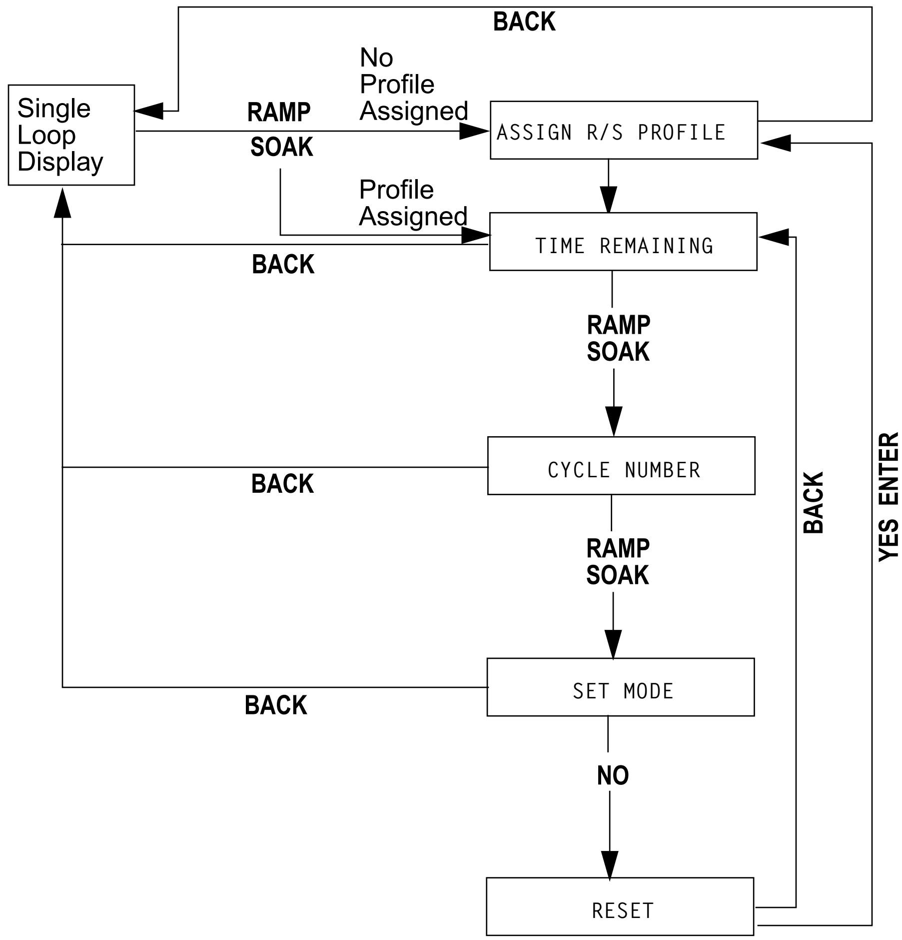
Table 7.2 Display Formats

Input Type	Display Format	Effect on Parameter
All Thermocouples	N/A	No decimal shift
RTDs	N/A	Settings divided by 10
Linear	-999 to 3000	No decimal shift
	-9999 to 30000	Setting multiplied by 10
	-999.9 to 3000.0	No decimal shift. Additional tenth of units in display
	-99.9 to 300.0	Settings divided by 10
	-9.999 to 30.000	Settings divided by 100
	0.999 to 3.000	Settings divided by 1000

Using Ramp/Soak

This section explains how to assign a profile to a loop, how to put a profile in RUN or HOLD mode, how to reset a profile, and how to display profile statistics.

The following diagram shows the Ramp/Soak screens:



From the RAMP/SOAK RESET display:

- Press **NO** to return to Single Loop display.
- Press **BACK** to return to the Time Remaining display.

Ramp/Soak Displays

The Single Loop and Bar Graph displays show additional codes when Ramp/Soak firmware is installed.

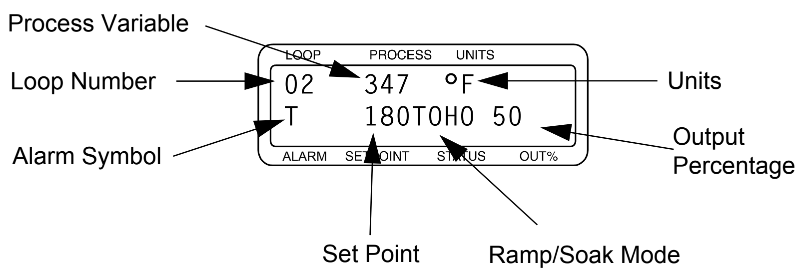
Single Loop Display

When the controller is running a profile, the Single Loop display shows the Ramp/Soak mode where it would usually show `MAN` or `AUTO`. *Table 7.3* described the modes.

Table 7.3 Ramp/Soak Single Loop Display

Ramp/Soak Mode	Description
`STRT`	The profile is in the Ready segment
`RUN`	The profile is unning.
`HOLD`	The user has put the profile in Hold mod .
`TOHO`	The profile is in tole ance hold.
`WAIT`	The profile is in t igger wait state.

This is the Single Loop display when a profile is running.



Ramp/Soak Alarms

When the tolerance alarm occurs, the controller displays the single loop display with a flashing `T` in the alarm symbol position.

Bar Graph Display

The Ramp/Soak mode is also displayed on the Bar Graph display.

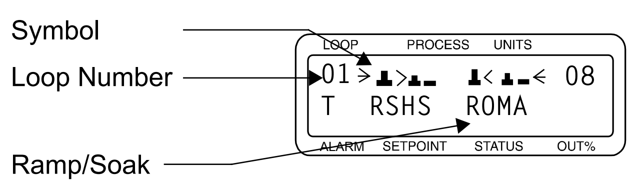


Table 7.4 on page 171 describes the control mode symbols used for loops with Ramp/Soak profiles assigned.

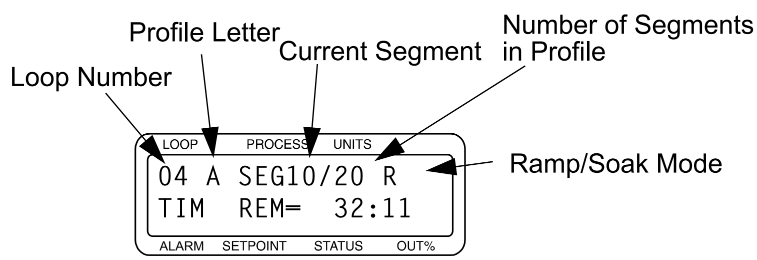
Table 7.4 Ramp/Soak Control Mode Symbols

Ramp/Soak Symbol	Description
R	A profile is unning.
H	A profile is holding
S	A profile is in Ready stat .
O	A profile is in tole ance hold.
W	A profile is in t igger wait.

Time Remaining Display

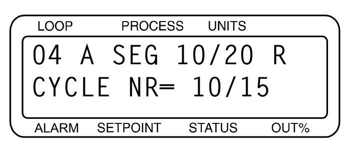
From the Single Loop display, press the **RAMP/SOAK** key **once**.

This screen shows how much time remains to complete the profile. All the screens you reach with the **RAMP/SOAK** key have the same information on the top line.



Cycle Number Display

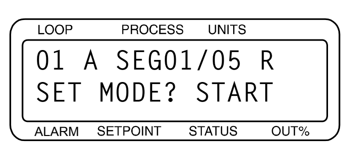
From the Single Loop display, press the **RAMP/SOAK** key **twice**. This screen displays the number of times the profile has run out of the total number of cycles. In this example, the Ramp/Soak profile is on the 10th of 15 cycles to be performed.



Set Mode Screen

From the Single Loop display, press the **RAMP/SOAK** key three times.

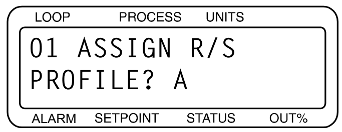
This screen allows you to change the Ramp/Soak mode.



See *Running a Profile on page 172* and *Holding a Profile or Continuing from Hold on page 173* for instructions on changing the Ramp/Soak mode.

Assigning a Profile to a Loop

Use this parameter to assign a profile to a loop.



Selectable Values: A to Q or NONE

Assigning a Profile the First Time

To assign a profile to a loop that doesn’t have a profile currently assigned:

1. In the Single Loop display, switch to the loop you want to assign a profile to.
2. Press the **RAMP/SOAK** key. The assigning screen appears. (See screen in previous page)
3. Choose one of the available profiles and press **ENTER**
   - or -
   press **BACK** if you wish to return to Single Loop display without sending profile data to the controller.

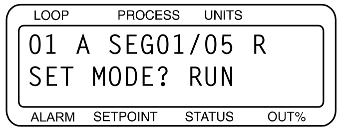
Assigning, Changing and Un-assigning a Profile

To assign a new profile to a loop that already has one assigned:

1. In the Single Loop display, switch to the loop in which you want to change or unassign the profile.
2. Press the **RAMP/SOAK** key three times.
3. Press the **NO** key. You will see the RESET PROFILE parameter. See *Resetting a Profile on page 175.*
4. Press **YES** then **ENTER** to reset the profile. You will see the ASSIGN PROFILE parameter. See *Assigning a Profile to a Loop on page 172.*
5. Choose one of the available profiles or NONE to (un-assign) and press **ENTER**.
6. Press **BACK** if you wish to return to Single Loop display without changing the profile assignments.

Running a Profile

When you assign a profile, it does not start running immediately; instead, the loop is in the START mode and the READY segment (segment 0). Use this menu to start a profile (put it in RUN mode).



Starting a Profile

You can start a profile only when it's in the ready segment.

1. In the Single Loop display, switch to the loop you want to start.
2. Press the **RAMP/SOAK** key three times. The SET MODE screen appears.
3. Press **YES** and **ENTER** to start the profile. While the profile is in START mode, the only mode available is the RUN mode.

Running Several Profiles Simultaneously

To run several profiles simultaneously, follow these steps:

1. Setup the profiles so that segment 1 of each profile has the same latched trigger.
2. Assign the profiles to the appropriate loops. The loops will go to the READY segment of each profile.
3. Set each profile to RUN mode.
4. Trip the trigger.

Editing a Profile While It Is Running

You can edit a profile while it is running. Changes made to segments after the current segment will take effect when the segment is reached. Changes made to the segments that have already been completed will take effect the next time the profile is run. Do not edit the current segment. Changes to the current segment can have unexpected consequences.

Holding a Profile or Continuing from Hold

Use the SET MODE screen to select the Ramp/Soak profile mode. The next table shows the available modes.

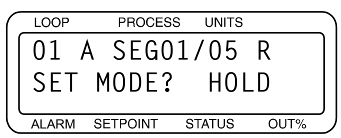
Table 7.5 Modes Available Under the Ramp/ Soak Profile Mode

Current Mode	Available Mode	Description
START	RUN	Begin running the assigned profil .
HOLD	CONT	Continue from user-selected hold. Profile uns from the point when you put the profile in HOLD mode. (You cannot continue from a toler-ance hold or a trigger wait.) After you choose this mode, the controller switches back to RUN mode.
RUN	HOLD	Hold the profil .

Holding a Profile

In HOLD mode, all loop parameters stay at their current settings until you change the mode or reset the profile. To put a profile in HOLD mode, follow these steps:

1. In the Single Loop display, switch to the loop you want to hold.
2. Press the **RAMP/SOAK** key three times to see the SET MODE screen:



3. Press **YES** to set the mode. While the profile is running, the only mode you will be able select is HOLD.
4. Press **ENTER** to hold the profile.

Continuing a Profile

To resume or continue a profile that is holding:

1. In the Single Loop display, switch to the loop you want to run.
2. Press the **RAMP/SOAK** key three times. The SET MODE screen appears.
3. Press **YES** to set the mode. While the profile is holding, the only mode you will be able select is CONT (Continue).
4. Press **ENTER** to run the profile.

Responding to a Tolerance Alarm

A tolerance can be set for each segment. The following occurs when the process variable goes outside this tolerance:

- The profile goes into tolerance hold.
- The segment timer holds.
- The loop's Single Loop display shows TOHO.
- The tolerance alarm timer starts.

If the process variable returns within the segment tolerance before the tolerance alarm time elapses, the profile returns to **RUN** mode and the tolerance alarm timer resets.

The following occurs if the profile remains out of tolerance for longer than the tolerance alarm time:

- The controller displays the Single Loop display with the tolerance alarm (a flashing T).
- The global alarm output turns on.

Press **ALARM ACK** to:

- Turn off the global alarm output.
- Reset the tolerance alarm timer.
- Clear the tolerance alarm.

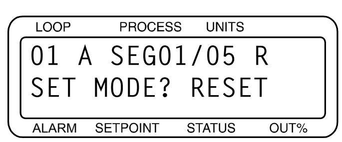
If the process variable does not return within the tolerance, the tolerance alarm will recur after the tolerance alarm time elapses again.

If the alarm persists you may want to reset the profile.

Resetting a Profile

To reset a profile, follow these steps:

1. In the Single Loop display, switch to the loop you want to reset.
2. Press the **RAMP/SOAK** key three times to see the SET MODE screen.
3. Press the **NO** key. The following will be displayed:



4. Press **YES** to reset the profile, and then **ENTER** to confirm your choice.

When you reset a profile, the following happens:

- The profile returns to the ready segment. The set point goes to the ready set point, and the ready segment event outputs go to the state you specified in the EDIT READY EVENT STATE parameter.
- The controller shows you the Assign Profile parameter in case you would like to assign a different profile to the loop or select **NONE** to un-assign the profile.

In Case of a Power Failure

If the power fails or the controller is otherwise powered down while running a ramp/soak profile, by default the profile is set to the START mode when power is restored.

If the POWER OUTPUT STATUS parameter in the SETUP GLOBAL PARAMETERS menu is set to MEMORY, then after a power failure, the profile will resume operation at the elapsed time of the segment that was active when the power failure occurred.

8

Tuning and Control

This chapter describes the different methods of control available with the your controller. This section covers:

- On/Off Control
- Proportional Control
- Proportional and Integral Control
- Proportional, Integral and Derivative (PID) Control
- Control Outputs
- Tuning PID Loops
- PID Constants by Application

Introduction

This chapter explains PID control and supplies some starting PID values and tuning instructions to help appropriately set control parameters in the MLS300 system. For more information on PID control, consult the *Watlow Anafaze Practical Guide to PID*.

The control algorithm dictates how the controller responds to an input signal. Do not confuse control algorithms with control output signals (for example, analog or pulsed DC voltage). There are several control algorithms available:

- On/Off,
- Proportional (P)
- Proportional and Integral (PI)
- Proportional with Derivative (PD)
- Proportional with Integral and Derivative (PID)

P, PI, or PID control are necessary when process variable cycling is unacceptable or if the load or set point varies.

NOTE! ***For any of these control modes to function, the loop must be in automatic mode.***

Control Algorithms

The next sections explain the algorithms available for controlling a loop.

On/Off Control

On/Off control is the simplest way to control a process; a controller using On/Off control turns an output on or off when the process variable reaches limits around the desired set point. This limit is adjustable; Watlow Anafaze controllers use an adjustable spread.

For example, if the set point is 1000ºF, and the spread is 20ºF, the heat output switches On when the process variable drops below 980ºF and Off when the process rises above 1000ºF. A process using On/Off control cycles around the set point. *Figure 8.1 on page 178* illustrates this example.

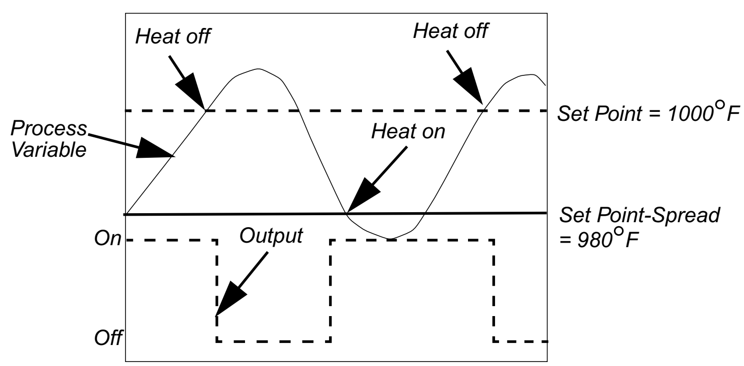


Figure 8.1 On/Off Control

Proportional Control

Proportional control eliminates cycling by increasing or decreasing the output proportionally with the process variable's deviation from the set point.

The magnitude of proportional response is defined by the Proportional Band (PB); outside this band, the output is either 100% or 0%. Within the proportional band the output power is proportional to the process variable’s deviation from the set point.

For example, if the set point is 1000ºF and the PB is 20ºF, the output is:

- 0% when the process variable is 1000ºF or above
- 50% when the process variable is 990ºF
- 75% when the process variable is 985ºF
- 100% when the process variable is 980ºF or below

However, a process which uses only proportional control will settle at a point above or below the set point; it will never reach the set point by itself. This behavior is known as offset or droop.

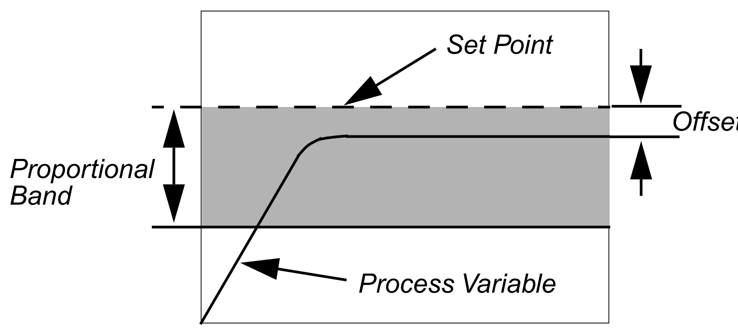


Figure 8.2 Proportional Control

Proportional and Integral Control

With proportional and integral control, the integral term corrects for offset by repeating the proportional band’s error correction until there is no error. For example, if a process tends to settle about 5ºF below the set point, appropriate integral control brings it to the desired setting by gradually increasing the output until there is no deviation.

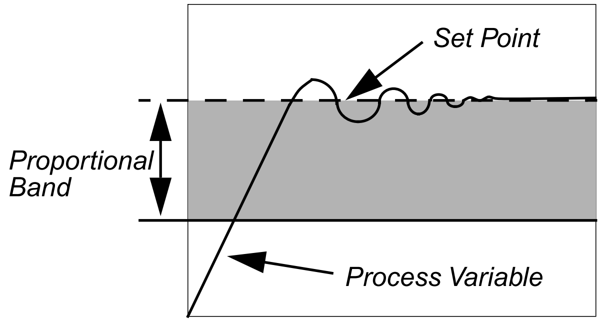


Figure 8.3 Proportional and Integral Control

Proportional and integral action working together can bring a process to set point and stabilize it. However, with some processes the user may be faced with choosing between parameters that make the process very slow to reach set point and parameters that make the controller respond quickly, but introduce some transient oscillations when the set point or load changes.

Proportional, Integral and Derivative Control

Derivative control corrects for overshoot by anticipating the behavior of the process variable and adjusting the output appropriately. For example, if the process variable is rapidly approaching the set point from below, derivative control reduces the output, anticipating that the process variable will reach set point. Use it to reduce overshoot and oscillation of the process variable common to PI control. *Figure 8.4 on page 180* shows a process under full PID control.

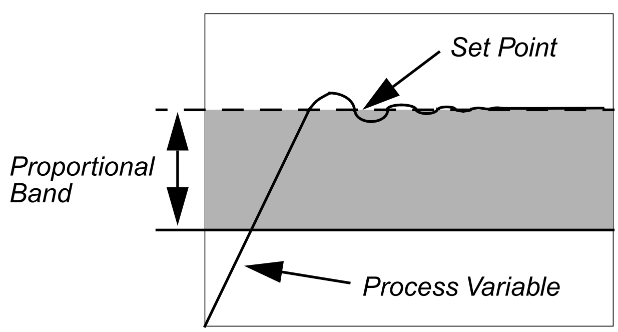


Figure 8.4 Proportional, Integral and Derivative Control

Heat and Cool Outputs

Each loop may have one or two outputs. Often a heater is controlled according to the feedback from a thermocouple, in which case only one output is needed.

In other applications, two outputs may be used for control according to one input. For example, a system with a heater and a proportional valve that controls cooling water flow can be controlled according to feedback from one thermocouple.

In such systems, the control algorithm avoids switching too frequently between heat and cool outputs. The on/off algorithm uses the `SPREAD` parameter to prevent such oscillations (see Spread on page 94). When PID control is used for one or both loop outputs, both the `SPREAD` parameter and PID parameters determine when control switches between heating and cooling.

Control Outputs

The controller provides open collector outputs for control. These outputs normally control the process using solid-state relays.

Open collector outputs can be configured to drive a Serial Digital-to-Analog Converter (SDAC), that in turn, can provide 0 to 5 Vdc, 0 to 10 Vdc or 4 to 20 mA control signals to operate field output devices.

Output Control Forms

The following sections explain the different control output signals available.

On/Off

When On/Off control is used, the output is on or off depending on the difference between the set point and the process variable. PID algorithms are not used with On/Off control. The output variable is always off or on. (0 or 100%)

Time Proportioning (TP)

With time proportioning outputs, the PID algorithm calculates an output between 0 and 100%, which is represented by turning on an output for that percent of a fixed, user-selected time base or cycle time. The cycle time is the time over which the output is proportioned, and it can be any value from 1 to 255 seconds. For example, if the output is 30% and the Cycle Time is 10 seconds, then the output will be on for 3 seconds and off for 7 seconds. *Figure 8.5 on page 182* shows example TP and Distributed Zero Crossing (DZC) waveforms.

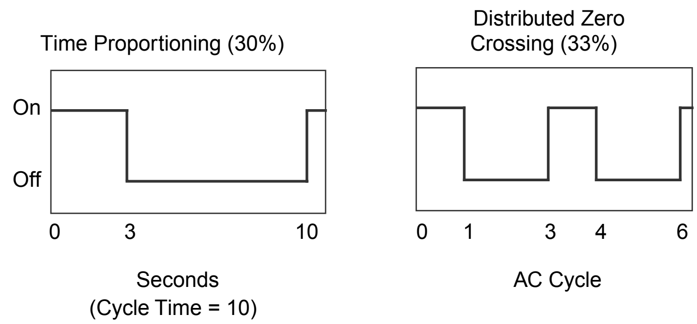


Figure 8.5 Example Time Proportioning and Distributed Zero Crossing Waveforms

Distributed Zero Crossing (DZC)

With DZC outputs, the PID algorithm calculates an output between 0 and 100%, but the output is distributed on a variable time base. For each AC line cycle the controller decides whether the power should be on or off. There is no fixed cycle time since the decision is made for each line cycle. When used in conjunction with a zero crossing device, such as a solid-state relay, switching is done only at the zero crossing of the AC line, which helps reduce electrical noise.

Using a DZC output should extend the life of heaters. Since the time period for 60 Hz power is 16.6 ms, the switching interval is very short and the power is applied uniformly. It should be used with solid-state relays. Do not use DZC output for electromechanical relays.

The combination of DZC output and a solid-state relay can inexpensively approach the effect of analog, phase-angle fired control. Note, however, DZC switching does not limit the current and voltage applied to the heater as phase-angle firing does.

Three-Phase DZC (3P DZC)

This output type performs exactly the same as DZC except that the minimum switching time is three AC line cycles. This may be advantageous in some applications using three-phase heaters and three-phase power switching.

Analog Outputs

For analog outputs, the PID algorithm calculates an output between 0 and 100%. This percentage of the analog output range can be applied to an output device via a DAC or an SDAC.

Output Filter

The output filter digitally smooths PID control output signals. It has a range of 0 to 255 scans, which gives a time constant of 0 to 170 seconds for an MLS316 or 0 to 340 seconds for an MLS332. Use the output filter if you need to filter out erratic output swings due to extremely sensitive input signals, like a turbine flow signal or an open air thermocouple in a dry air gas oven.

The output filter can also enhance PID control. Some processes are very sensitive and would otherwise require a large PB, making normal control methods ineffective. Using the output filter allows a smaller PB to be used, achieving better control.

Also, use the filter to reduce the process output swings and output noise when a large derivative is necessary, or to make badly tuned PID loops and poorly designed processes behave properly.

Reverse and Direct Action

With reverse action an increase in the process variable causes a decrease in the output. Conversely, with direct action an increase in the process variable causes an increase in the output. Heating applications normally use reverse action and cooling applications usually use direct action.

Setting Up and Tuning PID Loops

After installing your control system, tune each control loop and then set the loop to automatic control. When tuning a loop, choose PID parameters that will best control the process. This section gives PID values for a variety of heating and cooling applications.

NOTE! ***Tuning is a slow process. After adjusting a loop, allow about 20 minutes for the change to take effect.***

Proportional Band (PB) Settings

Table 8.1 Proportional Band (PB) Settings

Temperature Set Point (Fahrenheit)	PB	Temperature Set Point (Fahrenheit)	PB	Temperature Set Point (Fahrenheit)	PB
-100 to 99	20	1100 to 1199	75	2200 to 2299	135
100 to 199	20	1200 to 1299	80	2300 to 2399	140
200 to 299	30	1300 to 1399	85	2400 to 2499	145
300 to 399	35	1400 to 1499	90	2500 to 2599	150
400 to 499	40	1500 to 1599	95	2600 to 2699	155
500 to 599	45	1600 to 1699	100	2700 to 2799	160
600 to 699	50	1700 to 1799	105	2800 to 2899	165
700 to 799	55	1800 to 1899	110	2900 to 2999	170
800 to 899	60	1900 to 1999	120	3000 to 3099	175
900 to 999	65	2000 to 2099	125	3100 to 3199	180
1000 to 1099	70	2100 to 2199	130	3200 to 3299	185

As a general rule, set the PB to 10% of the set point below 1000ºF and 5% of the set point above 1000ºF. This setting is useful as a starting value.

Integral Settings

The controller's Integral parameter is set in seconds per repeat. Some other products use an integral term called Reset, in units of repeats per minute.

Table 8.2 Integral Term and Equivalent Reset Values

Integral (Seconds/Repeat)	Reset (Repeats/Minute)	Integral (Seconds/Repeat)	Reset (Repeats/Min)
30	2.0	210	0.28
45	1.3	240	0.25
60	1.0	270	0.22
90	0.66	300	0.20
120	0.50	400	0.15
150	0.40	500	0.12
180	0.33	600	0.10

As a general rule, use 60, 120, 180, or 240 as a starting value for the Integral.

Derivative Settings

The controller's Derivative parameter is programmed in seconds. Some other products use a derivative term called Rate programmed in minutes. Use the table or the formula to convert parameters from one form to the other (Rate = Derivative/ 60).

Table 8.3 Derivative Term and Equivalent Rate Values

Derivative (seconds)	Rate (minutes)	Derivative (seconds)	Rate (minutes)
5	0.08	35	0.58
10	0.16	40	0.66
15	0.25	45	0.75
20	0.33	50	0.83
25	0.41	55	0.91
30	0.50	60	1.0

As a general rule, set the Derivative to 15% of Integral as a starting value.

NOTE!

While the basic PID algorithm is well-defined and widely recognized, various controllers implement it differently such that parameters may not be taken from one controller and applied to another with optimum results even if the above unit conversions are performed.

General PID Constants by Application

This section gives PID values for many applications. They are useful as control values or as starting points for PID tuning.

Proportional Band Only (P)

Set the Proportional Band to 7% of the Set Point.
(Example: Set Point = 450: Proportional Band = 31).

Proportional with Integral (PI)

Set the Proportional Band to 10% of Set Point.
(Example: Set Point = 450: Proportional Band = 45).

Set Integral to 60.
Set Derivative to Off.
Set the Output Filter to 2.

PI with Derivative (PID)

Set the Proportional Band to 10% of the Set Point.
(Example: Set Point = 450: Proportional Band = 45).

Set the Integral to 60.
Set the Derivative to 15% of the Integral.
(Example: Integral = 60: Derivative = 9).
Set the Output Filter to 2.

Table 8.4 General PID Constants By Application

Application	Proportional Band	Integral	Derivative	Fil-ter	Output Type	Cycle Time	Action
Electrical heat with solid-state relay	50°F	60	15	4	DZC	-	Reverse
Electrical heat with electromechanical relays	50°F	60	15	6	TP	20	Reverse
Cool with solenoid valve	70°F	500	90	4	TP	10	Direct
Cool with fans	10°F	off	10	4	TP	10	Direct
Electric heat with open heat coils	30°F	20	off	4	DZC	-	Reverse
Gas heat with motorized valves Set Point > 1200	60°F 100°F	120 240	25 40	8	Analog	-	Reverse

9

Troubleshooting and Reconfiguring

When There Is a Problem

The controller is only one part of your control system. Often, what appears to be a problem with the controller is really a problem with other equipment, so check these things first:

- Controller is installed correctly. (See *Chapter 2, Installation* for help.)
- Sensors, such as thermocouples and RTDs, are installed correctly and working.

NOTE! ***If you suspect your controller has been damaged, do not attempt to repair it yourself, or you may void the warranty.***

- If the troubleshooting procedures in this chapter do not solve your system's problems, call the Application Engineering department for additional troubleshooting help. If you need to return the unit to Watlow Anafaze for testing and repair, Customer Service will issue you an RMA number. See *Returning Your Unit on page 188*.

WARNING! ***Before trying to troubleshoot a problem by replacing your controller with another one, first check the installation. If you have shorted sensor inputs to high voltage lines or a transformer is shorted out, and you replace the controller, you will risk damage to the new controller.***

If you are certain the installation is correct, you can try replacing the controller. If the second unit works correctly, then the problem is specific to the controller you replaced.

Returning Your Unit

Before returning a controller, contact your supplier or call Watlow Anafaze at (507) 494-5656 for technical support.

Controllers purchased as part of a piece of equipment must be serviced or returned through the equipment manufacturer. Equipment manufacturers and authorized distributors should call customer service to obtain a return materials authorization (RMA) number. Shipments without an RMA will not be accepted. Other users should contact their suppliers for instructions on returning products for repair.

Troubleshooting Controllers

A problem may be indicated by one or more of several types of symptoms:

- A process or deviation alarm
- A failed sensor alarm
- A system alarm
- Unexpected or undesired behavior

The following sections list symptoms in each of these categories and suggest possible causes and corrective actions.

Process and Deviation Alarms

When a process or deviation alarm occurs, the controller switches to the single loop display for the loop with the alarm and displays the alarm code on the screen. Software such as AnaWin or WatView displays a message on the alarm screen and logs the alarm in the event log.

Table 9.1 Controller Alarm Codes for Process and Deviation Alarms

Code	Alarm	Description
HP	High Process	Process variable has risen above the high process alarm set point.
HD	High Deviation	Process variable has risen above the set point by more than the deviation alarm value.
LD	Low Deviation	Process variable has dropped below the set point by more than the deviation alarm value.
LP	Low Process	Process variable has dropped below the low process alarm set point.

Responding to Process and Deviation Alarms

In a heating application, a low process or low deviation alarm may indicate one of the following:

- The heater has not had time to raise the temperature.
- The load has increased and the temperature has fallen.
- The control mode is set to manual instead of automatic.
- The heaters are not working due to a hardware failure.
- The sensor is not placed correctly and is not measuring the load's temperature.
- The deviation limit is too narrow.
- The system is so poorly tuned that the temperature is cycling about set point by more than the alarm limit.

NOTE! ***In cooling applications, similar issues cause high process and high deviation alarms.***

In a heating application, a high process alarm or high deviation alarm may indicate one of the following:

- The set point and high process limit have been lowered and the system has not had time to cool to within the new alarm limit.
- The control mode is set to manual and the heat output is greater than 0%.
- The load has decreased such that the temperature has risen.
- The heater is full-on due to a hardware failure.
- The system is so poorly tuned that the temperature is cycling about set point by more than the alarm limit.

Resetting a Process or Deviation Alarm

Your response to an alarm depends upon the alarm type setting, as explained in *Table 9.2* below.

Table 9.2 Operator Response to Alarms

Alarm Type	Operator Response
Control	The operator does not need to do anything. The alarm clears automatically when the process variable returns within limits.
Alarm	Acknowledge the alarm by pressing **ALARM ACK** on the controller or by using software. The alarm clears after the process variable returns within the limits and the operator has acknowledged it.

Failed Sensor Alarms

When a failed sensor alarm occurs, the controller switches to the single loop display for the loop with the alarm and displays an alarm code on the screen. AnaWin or WatView displays a message on the alarm screen and logs the alarm in the event log.

Table 9.3 Failed Sensor Alarm Codes

Code	Alarm	Description
FS	Failed Sensor	Open thermocouple.
RT	Reversed Thermocouple	Temperature changed in the opposite direction than expected.
ST	Shorted Thermocouple	Temperature failed to change as expected.
RO	RTD Open	Positive or negative lead is broken or disconnected.
RS	RTD Shorted	Positive and negative leads are shorted.

A failed sensor alarm clears once it has been acknowledged and the sensor is repaired.

System Alarms

If the controller detects a hardware problem, it displays a message. The message persists until the condition is corrected.

Table 9.4 Hardware Error Messages

Message	Possible Cause	Recommended Action
LOW POWER	Power supply failed.	See *Low Power on page 193*.
BATTERY DEAD	RAM battery is dead.	See *Battery Dead on page 194*.
AW	Ambient warning. Ambient temperature exceeds operating limits by less than 5°C or more.	*See Ambient Warning on page 194.*
H/W AMBIENT FAILURE	Ambient temperature exceeds operating limits by 5°C. Hardware failed due to excessive voltage on inputs.	See *H/W Ambient Failure on page 195*.
H/W GAIN FAILURE	Hardware failed due to excessive voltage on inputs.	See *H/W Gain or Offset Failure on page 195*.
H/W OFFSET FAILURE	Hardware failed due to excessive voltage on inputs.	See *H/W Gain or Offset Failure on page 195*.

Other Behaviors

The following table indicates potential problems with the system or controller and recommends corrective actions.

Table 9.5 Controller Problems and Corrective Actions

Symptom	Possible Causes	Recommended Action
Indicated temperature not as expected.	Controller not communicating. Sensor wiring incorrect. Noise.	See *Checking Analog Inputs on page 196.*
MLS300 display is not lit.	Power connection incorrect.	Check wiring and service. See Testing Power Connections to PM and AIM on page 39 or Testing Power Connections to PM and CIM300 on page 41.
	No EPROM or bad EPROM.	Replace the EPROM. See *Replacing the EPROM on page 203.*
	MLS300 damaged or failed.	Return the MLS300 for repair. See *Returning Your Unit on page 188*.
MLS300 display is lit, but keys do not work.	Keypad is locked.	See *Keys Do Not Respond on page 196*.
	MLS300 damaged or failed.	Return the MLS300 for repair. See *Returning Your Unit on page 188*.
Control mode of one or more loops changes from automatic to manual.	Failed sensor.	Check the display or software for a failed sensor message.
	Digital job select feature is enabled and has changed jobs.	Set `JOB SELECT DIG INPUTS` to `NONE`. This parameter is only accessible using the controller's keypad and display. See *Job Select Digital Inputs on page 95*.
All loops are set to manual 0%.	Power is intermittent.	Check wiring and service. See Testing Power Connections to PM and AIM on page 39 or Testing Power Connections to PM and CIM300 on page 41. Use a separate dc supply for the controller. Provide backup power (UPS). Set `POWER UP OUTPUT STATUS` to `MEMORY`. See *Power Up Output Status on page 98*.
	Analog reference voltage is overloaded.	Disconnect any wiring from the +5V Ref connection on TB1.
	Hardware failure.	Check the controller front panel for a hardware alarm. See *System Alarms on page 191*.

Symptom	Possible Causes	Recommended Action
Controller does not behave as expected.	Corrupt or incorrect values in RAM.	Perform a **NO**-key reset. See *NO-Key Reset on page 203*.
Yellow LED on MLS300-AIM is lit.	AIM reference voltage pulled low by excessive load or short.	See *Checking Analog Inputs on page 196*.
Green LED on MLS300-AIM card(s) or CIM300 not blinking.	AIM is not functioning correctly.	Cycle power to the controller.
	AIM is not properly wired.	Check AIM installation. See *Connecting Power to AIM-TB on page 38*, *Testing Power Connections to PM and AIM on page 39*, and Testing Power Connections to PM and CIM300 on page 41.
	MLS300 damaged/failed.	Perform a **NO**-key reset. See *NO-Key Reset on page 203*. Return AIM for repair. See *Returning Your Unit on page 188*.
AIM COMM FAILURE or AIM FAIL	AIM or CIM300 not properly wired.	See AIM Comm Failure / AIM Fail on page 197.
	AIM cable disconnected.	
	Corrupt or incorrect values in RAM.	

Corrective and Diagnostic Procedures

The following sections detail procedures you may use to diagnose and correct problems with the controller.

Low Power

If the controller displays `LOW POWER` or the display is not lit:

1. Acknowledge the alarm.
2. If the error message remains, turn the power to the controller off, then on again. If the error message returns, check that the power supplied to the controller is at least 12.0 Vdc @ 1 A. See Testing Power Connections to PM and AIM on page 39 or Testing Power Connections to PM and CIM300 on page 41.
3. If the error message returns again, make a record of the settings if possible (using software). Then, perform a **NO**-key reset (see *NO-Key Reset on page 203*).
4. If the error is not cleared, contact your supplier for further troubleshooting guidance. See *Returning Your Unit on page 188*.

Battery Dead

The dead battery alarm indicates that the MLS300 battery is not functioning correctly or has low power or no power. If this alarm occurs, parameters have been reset to factory defaults.

NOTE! ***The controller will retain its settings when powered. The battery is required to keep the settings in memory only when the controller is powered down.***

If the controller displays `BATTERY DEAD`:

1. Acknowledge the alarm.
2. If the error message remains, turn the power to the controller off, then on again.
3. If the error message returns when power is restored, perform a **NO**-key reset. See *NO-Key Reset on page 203.*
4. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Returning Your Unit on page 188.*

Ambient Warning

The ambient warning alarm indicates that the ambient temperature of the controller is too hot or cold. Ambient warning occurs when the controller's temperature is in the range of 23 to 32°F or 122 to 131°F. The operating limits are 32 to 122°F.

If the controller displays `AW` in the lower left corner of the display:

1. Acknowledge the alarm.
2. If the error message remains, check the ambient air temperature near the controller. Adjust ventilation, cooling or heating to ensure that the temperature around the controller is 32 to 122°F. If the unit is functioning correctly, the error will clear automatically when the ambient temperature is within range and the alarm has been acknowledged.
3. If the error persists, make a record of the settings, then perform a **NO**-key reset. See *NO-Key Reset on page 203*.
4. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Returning Your Unit on page 188*.

H/W Ambient Failure

The hardware ambient failure alarm indicates that the ambient sensor in the MLS300 is reporting that the temperature around the controller is outside of the acceptable range of 32 to 122°F by more than 9°F. This error can also occur when there is a hardware failure.

If the controller displays `H/W AMBIENT FAILURE`:

1. Acknowledge the alarm.
2. If the error message remains, check the ambient air temperature near the controller. Adjust ventilation, cooling or heating to ensure that the temperature around the controller is 32 to 122°F. If the unit is functioning correctly, the error will clear automatically when the ambient temperature is within range, and the alarm has been acknowledged.
3. If the error persists, make a record of the settings, then perform a **NO**-key reset. See *NO-Key Reset on page 203.*
4. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Returning Your Unit on page 188.*

NOTE! ***If the controller has failed, it is likely that it was damaged by excessive voltage or noise. Before replacing the controller, troubleshoot for noise and ground loops.***

H/W Gain or Offset Failure

If the controller displays `H/W GAIN FAILURE` or `H/W OFFSET FAILURE`:

1. Acknowledge the alarm.
2. If the error message remains, turn the power to the controller off, the on again.
3. If the error persists, make a record of the settings (using software), then perform a **NO**-key reset. See *NO-Key Reset on page 203.*
4. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Returning Your Unit on page 188.*

NOTE! ***If the controller has failed, it is likely that it was damaged by excessive voltage or noise. Before replacing the controller, troubleshoot for noise and ground loops.***

Keys Do Not Respond

If the MLS300 seems to function but the **MAN/AUTO**, **CHNG SP**, **ALARM ACK**, and **RAMP/SOAK** keys do not respond when you press them, the keypad is probably locked. Unlock the keypad according to the instructions in *Keyboard Lock Status on page 98*.

Checking Analog Inputs

Use the following procedures to diagnose and correct problems analog inputs including incorrect process variable readings.

1. If the process variable indicated on the controller display is incorrect:
   (a) Verify that you have selected the correct input type for the affected loops.
   (b) Verify that sensors are properly connected.
2. If the sensors are correctly connected, with power on to the heaters check for high common mode voltage:
   (a) Set a voltmeter to measure volts ac.
   (b) Connect the negative lead to a good earth ground.
   (c) One by one, check each input for ac voltage by connecting the positive lead on the voltmeter to the positive and negative sensor input connections. The process variable should indicate ambient temperature. If it does not, contact your supplier to return the unit for repair. See *Returning Your Unit on page 188.*

NOTE! ***Noise in excess of 1 Vac should be eliminated by correctly grounding the AIM or CIM300. See Power Connections on page 36.***

3. Verify the sensors:
   - For thermocouples, remove the thermocouple leads and use a digital voltmeter to measure the resistance between the positive and negative thermocouple leads. A value of 2 to 20 Ω is normal. Readings in excess of 200 Ω indicate a problem with the sensor.
   - For RTDs, measure between the IN+ and IN- terminals of TB1. RTD inputs should read between 20 and 250 Ω.
4. To verify that the controller hardware is working correctly, check any input (except the pulse input or an RTD) as follows:
   (a) Disconnect the sensor wiring.
   (b) Set the `INPUT TYPE` to `J T/C` in the `SETUP LOOP INPUT` menu.
   (c) Place a short across the input. The controller should indicate the ambient temperature on the channel you are testing.
5. If the number of inputs recognized by the MLS300-PM does not agree with the number of inputs in the MLS300-AIM or CIM300 do the following:
   (a) Disconnect any EIA/TIA-232 or 485 connections.
   (b) Ensure the AIM or CIM300 is properly connected.
   (c) If the problem persists perform a NO-key reset, see *NO-Key Reset on page 203*.
6. If the yellow LED on the AIM is illuminated, the current is overloaded. The reference voltage is used for RTDs and bridge sensors. The signal is also available at MLS300-AIM connector TB3, labeled REF V. The reference voltage is not available on CIM300.

AIM Comm Failure / AIM Fail

After communications have been established between the MLS300-PM and MLS300-AIM or CIM300, the controller continuously checks communications. If communications stop for more than five seconds, the MLS300-PM displays `AIM COMM FAILURE` at the Bar Graph Display or `AIM FAIL` at the Single Loop Display, the PID mode changes to Manual, and the controller sets every output to the output override percentage. In addition, the Global Alarm is activated. If a digital output from the `SETUP GLOBAL PARAMETERS` menu was selected, an AIM communications failure activates the output.

If you power up the MLS300-PM and the message `AIM COMM FAILURE` appears, or if the LED on the AIM is not blinking:

1. Acknowledge the alarm.
2. If the error message remains, make sure power supply connections are correct. See *Power Connections on page 36*.
3. If the error message remains, make sure the AIM Communications cable is plugged into the AIM or CIM300 and the connector labeled `TO AIM` on the MLS300-PM.
4. If the failure message still appears, perform a **NO**-key controller reset. If the MLS300 still does not power up with the Bar Graph Display, return the unit to Watlow Anafaze for repair. See *Returning Your Unit on page 188*.

WARNING! ***PID outputs remain in manual mode after an AIM communications failure. Change the PID control status back automatic mode for each control loop after the error is corrected.***

Earth Grounding

If you suspect a problem with the ac ground or a ground loop:

- Measure for ac voltage between ac neutral and panel chassis ground. If ac voltage above 2 Vac is observed, then there may be a problem with the ac power wiring. This should be corrected per local electrical codes.
- With ac power on, measure for ac voltage that may be present between control panels' chassis grounds. Any ac voltage above 2 Vac may indicate problems with the ac ground circuit.
- Check for ac voltage on thermocouples with the heater power on. A control output providing power to the heaters will increase the ac voltage if there is heater leakage and an improper grounding circuit. Measure from either positive or negative thermocouple lead to ac ground. AC voltage above 2 Vac may indicate the ground lead is not connected to the MLS300 TB2 ground terminal.

If the above tests indicate proper ac grounding but the controller is indicating incorrect temperatures or process readings:

- Verify which type of sensor is installed and that the `INPUT TYPE` parameter is set accordingly.

- For an RTD or linear voltage or current input, check that the correct input scaling resistors are installed (*Installing Scaling Resistors on page 208*) and check the *Linear Scaling Parameters on page 106.*
- If readings are erratic, look for sources of electrical noise. See *Noise Suppression on page 33*.
- Eliminate possible ground loops. See *Avoiding Ground Loops on page 35*.
- Contact your supplier for further troubleshooting guidance. See *Returning Your Unit on page 188.*

Checking Control Outputs

To check control outputs:

- Set the loop you want to check to manual mode.
- Set the output power percentage to the desired level.
- Set the output type to ON/OFF or TP (see *Chapter 4, Setup*).

If the control output is not connected to an output device like an SSR, connect an LED in series with a 1 kΩ resistor from +5 V to the output. (Tie the anode of the LED to +5V.) The LED should be off when the output is 0% and on when the output is 100%.

Testing Control Output Devices

Connect the solid-state relay (SSR) control terminals to the MLS300 control output and connect a light bulb (or other load that can easily be verified) to the output terminals on the SSR. Put the loop in manual mode and set the output to 100%. The ac load should turn on.

Do not attempt to measure ac voltage at the SSR’s output terminals. Without a load connected, the SSR’s output terminals do not turn off. This makes it difficult to determine whether the SSR is actually working. Measure the voltage across a load or use a load that can be visually verified, such as a light bulb.

Testing the TB50

1. Turn on power to the controller.
2. Measure the +5 Vdc supply at the TB50. The voltage should be +4.75 to +5.25 Vdc:
   (a) Connect the voltmeter’s common lead to the TB50 screw terminal 3.
   (b) Connect the voltmeter’s positive lead to the TB50 screw terminal 1.

Testing Control and Digital Outputs

1. Turn off power to the controller.
2. Disconnect any process output wiring on the output to be tested.
3. Connect a 500 Ω to 100 kΩ resistor between the +5V terminal (TB50 screw terminal 1) and the output terminal you want to test.
4. Connect the voltmeter's common lead to the output terminal, and connect the voltmeter's positive lead to the +5V terminal.
5. Restore power to the controller.
6. If you are testing a PID control output, use the **MAN/AUTO** key to turn the output on (100%) and off (0%). When the output is off, the output voltage should be less than 1V. When the output is on, the output voltage should be between +3.75 and +5.25V.
7. If you are testing a digital output not used for control, use the MANUAL I/O TEST menu to turn the output on and off. See *Manual I/O Test Menu on page 124*.

Testing Digital Inputs

1. Turn off power to the controller.
2. Disconnect any system wiring from the input to be tested.
3. Restore power to the controller.
4. Go to the DIGITAL INPUTS parameter in the MANUAL I/O TEST menu. This parameter shows whether the digital inputs are H (high, or open) or L (low, or closed).
5. Attach a wire to the terminal of the digital input to test. When the wire is connected only to the digital input terminal, the DIGITAL INPUTS parameter should show that the input is H (high). When you connect the other end of the wire to controller common (TB50 terminal 3), the DIGITAL INPUTS parameter should show that the input is L (low).

Additional Troubleshooting for Computer Supervised Systems

These four elements must work properly in a computer-supervised system:

- The controller
- The computer and its EIA/TIA-232 or EIA/TIA-485 serial interface
- The EIA/TIA-232 or EIA/TIA-485 communication lines
- The computer software

For troubleshooting, disconnect the communications line from the computer and follow the troubleshooting steps in the first section of this chapter. The next few sections explain troubleshooting for the other elements of computer supervised systems.

Computer Problems

If you are having computer or serial interface problems, check the following:

- Check your software manual and make sure your computer meets the software and system requirements.
- Check the communications interface, cables, and connections. Make sure the serial interface is set according to the manufacturer's instructions.
- To test an EIA/TIA-232 interface, purchase an EIA/TIA-232 tester with LED indicators. Attach the tester between the controller and the computer. When the computer sends data to the controller, the tester's TX LED should blink. When the computer receives data from the controller, the RX LED should blink.
- You can also connect an oscilloscope to the transmit or receive line to see whether data is being sent or received. If the serial port does not appear to be working, the software setup may need to be modified or the hardware may need to be repaired or replaced.

Communications

Most communications problems are due to incorrect wiring or incorrectly set communications parameters. Therefore, when there is a problem, check the wiring and communications settings first. Verify the following:

- Communications port: Software must be configured to use the communications port to which the controller is connected.

- Software protocol: Set the controller to MOD (Modbus) for AnaWin or WatView, ANA (Anafaze) for Anasoft or Anascan.
- Controller address: Configure software to look for the controller at the correct address. In a multiple-controller installation, each controller must have a unique address.
- Baud rate: Software and controller must be set the same.
- Error checking (ANA protocol only): Software and controller must be set the same (CRC or BCC).
- Hardware protocol: PC and controller must use the same protocol, or a converter must be used. The controller is typically configured for EIA/TIA-232 when it is shipped. See *Changing Communications on page 206* to change between EIA/TIA-232 and EIA/TIA-485. To communicate with more than one controller, or when more than 50 feet of cable is required, use EIA/TIA-485. Even for a single controller, you may use EIA/TIA-485 and an optically isolating converter to eliminate ground loops.
- Converter: Make sure that the EIA/TIA-232-to-485 converter is powered, configured and wired correctly.
- Cables: Check continuity by placing a resistor across each pair of wires and measuring the resistance with an ohmmeter at the other end.

Ground Loops

Many PC communications ports have their common wires connected to chassis ground. Once connected to the controller, this can provide a path to ground for current from the process that can enter the controller through a sensor (such as a thermocouple). This creates a ground loop that can affect communications and other controller functions. To eliminate a ground loop, either use an optically isolated communications adapter or take measures to ensure that sensors and all other connections to the controller are isolated and not conducting current into the unit.

Software Problems

If the controller and serial communications connections seem to be working correctly, but you are still not getting the result you expect, consult the resources you have available for the software program you are using.

WatView, AnaWin or Anasoft

Consult the AnaWin or Anasoft User's Guide for help with the user interface. WatView comes with a context-sensitive help explaining operation of the software. Context-sensitive means that you can press the F1 key to get help related to the part of the program you are using.

User-Written Software

You can request a communications specification from Watlow Anafaze if you want to write your own software. Watlow Anafaze will answer technical questions that arise during your software development process, but does not otherwise support user-developed or third-party software in any way.

NO-Key Reset

Performing a **NO**-key reset returns all controller settings to their defaults. All recipes are also cleared.

To perform a **NO**-key reset:

1. Make a record of the controller’s settings.
2. Turn off power to the unit.
3. Press and hold the **NO** key on the keypad.
4. Turn on power to the controller still holding the **NO** key.
5. When prompted `RESET WITH DEFAULTS?`, release the **NO** key and press the **YES** key.
6. If you do not see the `RESET WITH DEFAULTS?` prompt or do not get a chance to press **YES**, repeat the procedure.
7. Restore the controller settings.

If you have a stand-alone system, there is no way to recover your original parameters. If you have a computer-supervised system with AnaWin or WatView, a copy of your parameters can be saved to a snapshot file.

Replacing the EPROM

Replacing the EPROM involves minor mechanical disassembly and reassembly of the controller. You will need a Phillips screwdriver and a small flathead screwdriver.

WARNING! ***The EPROM and other components are sensitive to damage from electrostatic discharge (ESD). To prevent ESD damage, use an ESD wrist strap or other antistatic device.***

NOTE! ***Replacing the EPROM with another version results in full erasure of RAM. Make a record of all parameters before changing the EPROM.***

1. Make a record of system parameters.
2. Power down the controller.
3. Remove the four screws from the sides of the controller front panel.
4. Remove the electronics assembly from the case, as shown in *Figure 9.1*.

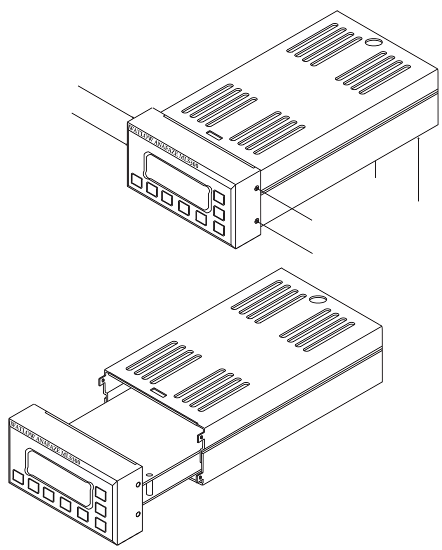


Figure 9.1 Removal of Electronics Assembly from Case

5. Unscrew the four screws at the corners of the top board and carefully unplug this board to access the bottom

board (processor board). *Figure 9.2* shows the screws to remove:

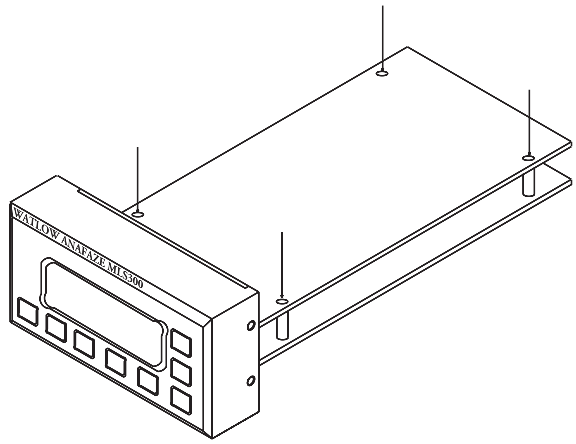


Figure 9.2 Screws Locations on PC Board

6. Locate the EPROM on the circuit board. The EPROM is a 32-pin socketed chip that is labeled with the model, version and checksum.

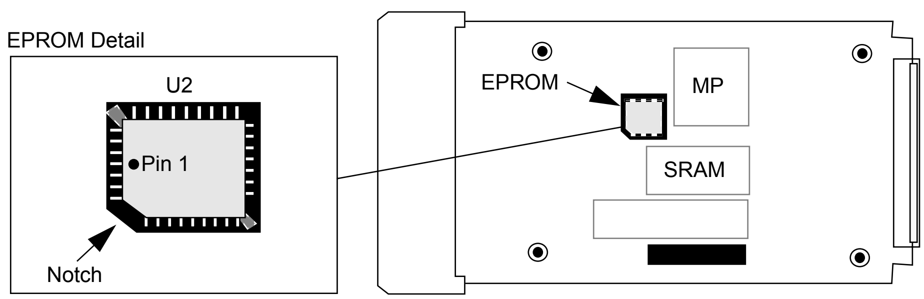


Figure 9.3 EPROM Location

7. Remove the existing EPROM from its socket with an IC extraction tool or a jeweler's flathead screwdriver.

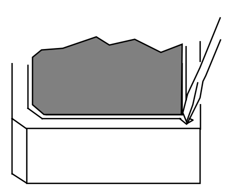


Figure 9.4 Remove EPROM

8. Carefully insert the new EPROM into the EPROM socket. Make sure that the chip is oriented so that its notch fits in the corresponding corner of the socket.
9. Reverse steps 2 through 4 to reassemble the unit.
10. Power up the controller.
11. Re-enter parameters.

Changing Communications

Follow these instructions to change the unit's communications between EIA/RS-485 and EIA/RS-232:

1. Unplug the cables connected to the MLS300-PM.
2. If you already installed the MLS300-PM in a panel, remove it.
3. Remove the four screws from the sides of the controller front panel and remove the two screws from the bottom of the case.
4. Remove the electronics assembly from the case, as shown in *Figure 9.1 on page 204*.
5. Move jumpers **JU2** and **JU4** on the upper PC board to the **B** position for 485 communications, or to the **A** position for 232 communications. Refer to *Figure 9.1 on page 204* and *Figure 9.2 on page 205.*
6. For 485 communications with the last unit on the serial communications line, move jumper **JU3** to the **B** (or **TERM**) position. Installing the jumper in this position places a 200 ohm impedance on the line. Refer to *Figure 9.3 on page 205.*
7. Reverse instructions 1 to 3 to reinstall the unit.

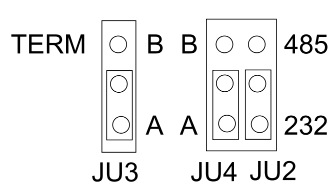


Figure 9.5 EIA/RS-232 Configuration

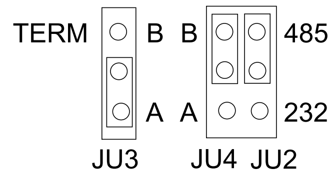


Figure 9.6 EIA/RS-485 Configuration

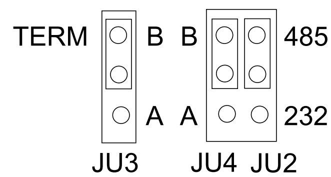


Figure 9.7 Last Controller in System Configured for EIA/RS-485

Installing Scaling Resistors

Resistors are installed for all inputs on the MLS300-AIM TB or CIM300. Inputs with signal ranges between -10 and +60 mV use 0 Ω resistors in the RC position only. All other input signals require special input scaling resistors.

WARNING! ***Scaling resistors are soldered to the circuit board. Only qualified technicians should attempt to install or remove these components. Improper techniques, tools or materials can result in damage to the controller that is not covered by the warranty.***

Input Scaling

You can connect thermocouples, 4 to 20 mA current inputs, voltage inputs, and 2- or 3-wire RTD inputs to the MLS300. If you need to scale input voltages or convert milliamp inputs to match the -10 to +60 mV input range, install scaling resistors. Generally, these resistors are installed at the factory when requested. However, Watlow Anafaze can supply a kit that a qualified technician may use to install scaling resistors.

Figure 9.8 on page 209 illustrates the locations of the scaling resistors on the AIM TB. The location of scaling resistors on the CIM300 are clearly labeled on the CIM300 circuit boards. The following tables list the resistor values used for various input ranges.

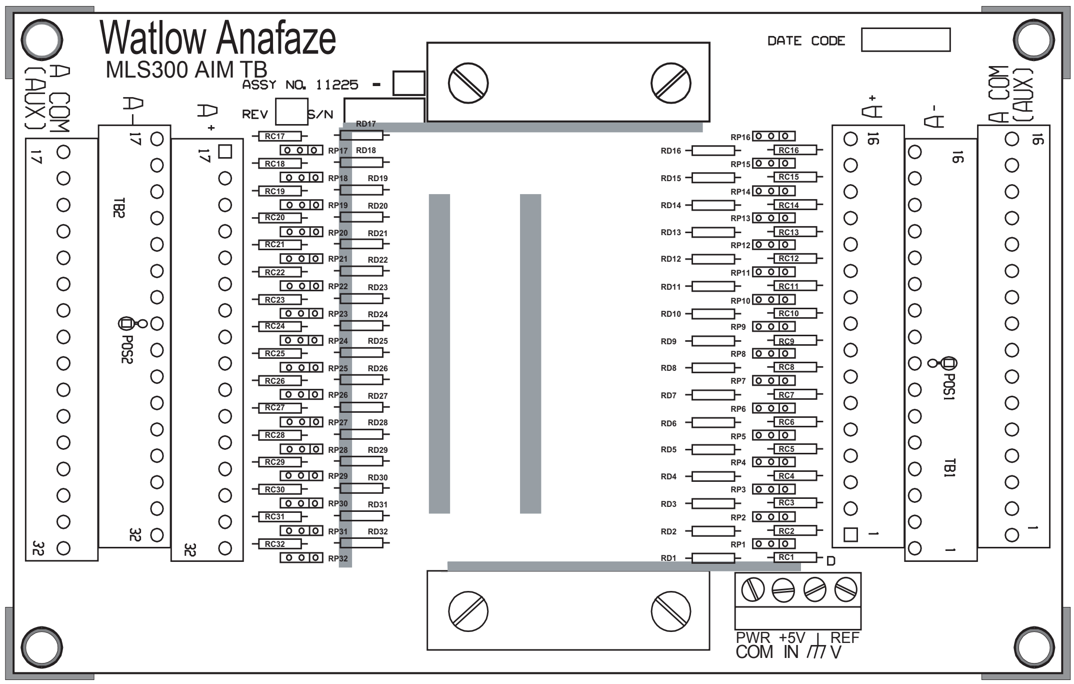


Figure 9.8 MLS300-AIM Scaling Resistors

Scaling Resistors

Watlow Anafaze uses resistors with precise tolerances for scaling resistors To ensure measurement accuracy, use only resistors that meet the following criteria:

- For RTD inputs, RP contains a matched pair of resistors. Their matching tolerance is 0.02% (2 ppm/°C) and their absolute tolerance is 0.1% (10 ppm/°C). RC has 0.05% tolerance.
- For linear mVdc, Vdc and mA dc ranges, use 0.1% tolerance resistors.

Figure 9.9 on page 210 shows an input circuit using the RP, RC, and RD scaling resistor locations as printed on the MLS300-AIM or CIM300's terminal board. RP (resistor pair) is a matched pair of resistors in a single package.

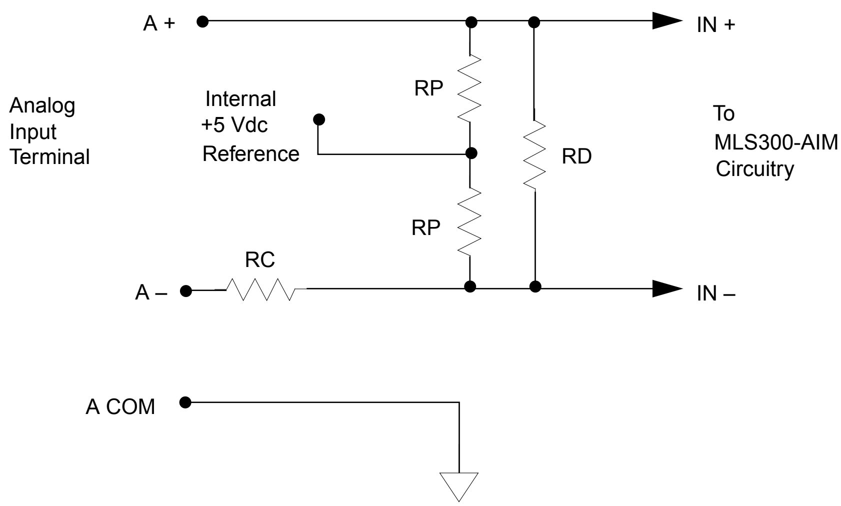


Figure 9.9 Input Circuit

Table 9.6 Scaling Resistor Values

Input Range	RP	RC	RD
All Thermocouple, 0 to 60 mVdc		Jumper	
RTD1 -100.0 to 300.0°C RTD2, -120 to 840°C	10 kΩ 25 kΩ	80 Ω 100 Ω	
0 to 10 mA dc 0 to 20 mA dc (4 to 20 mA)		Jumper Jumper	6.0 3.0
0 to 100 mV dc 0 to 500 mV dc 0 to 1 Vdc 0 to 5 Vdc 0 to 10 Vdc 0 to 12 Vdc		499 Ω 5.49 kΩ 6.91 kΩ 39.2 kΩ 49.9 kΩ 84.5 kΩ	750 Ω 750 Ω 442 Ω 475 Ω 301 Ω 422 Ω

NOTE! ***See Chapter 10, Linear Scaling Examples for information on how to configure linear inputs.***

Configuring DAC Outputs

DAC modules ship with both outputs configured for the signal type and span ordered. The module contains two independent circuits (DAC1 and DAC2). These circuits can be configured for different output types. Remove the board from the housing and set the jumpers. The odd numbered jumpers determine the signal from DAC1; the even numbered jumpers determine the output from DAC2.

Table 9.7 DAC Jumper Settings

Output Type	Jumper Settings						
	1/2	**3/4**	**5/6**	**7/8**	**9/10**	**11/12**	**13/14**
0 to 5 Vdc	B	A	A	O	B	A	O
0 to 10 Vdc	B	A	A	O	B	O	O
4 to 20 mA	O	A	B	A	A	O	A

Legend:

A = Load jumper in the “**A**” position, or load jumper if header has only two pins.

B = Load jumper in the “**B**” position.

O = Open; do not load jumper.

1. Power down the system (if DAC is already installed and wired).
2. Ensure the DAC1 and DAC2 terminal blocks or associated wires are labeled such that you will know which terminal block connects to which side of the board if the module is already installed and wired.
3. Unplug the two terminal blocks.
4. Depending on the installation, you may need to unmount the DAC module before proceeding. Remove the four screws from the end plate on the opposite side of the module from the terminal blocks.
5. If necessary, remove the two mounting screws holding the loosened end plate in place.
6. Slide the board out of the housing.
7. Set the jumpers for the two outputs as desired. See *Table 9.7 on page 211*.
8. Replace the board such that the connectors extend through the opposite end plate. The board fits in the third slot from the bottom.

9. Reconnect the two terminal blocks to the DAC1 and DAC2 connectors.
10. Replace the end plate, end plate screws and, if necessary, mounting screws.
11. Check the wire connections to the DAC1 and DAC2 terminal blocks.
12. If necessary, change the wiring connections to the correct configuration for the new output type. See *Wiring the DAC on page 59*.
13. Restore system power if the system was powered down in *Step 1*.

Configuring SDAC Outputs

14. The SDAC's voltage and current output is jumper selectable. Refer to *Figure 9.10 on page 212*. Configure the jumpers as indicated on the SDAC label.

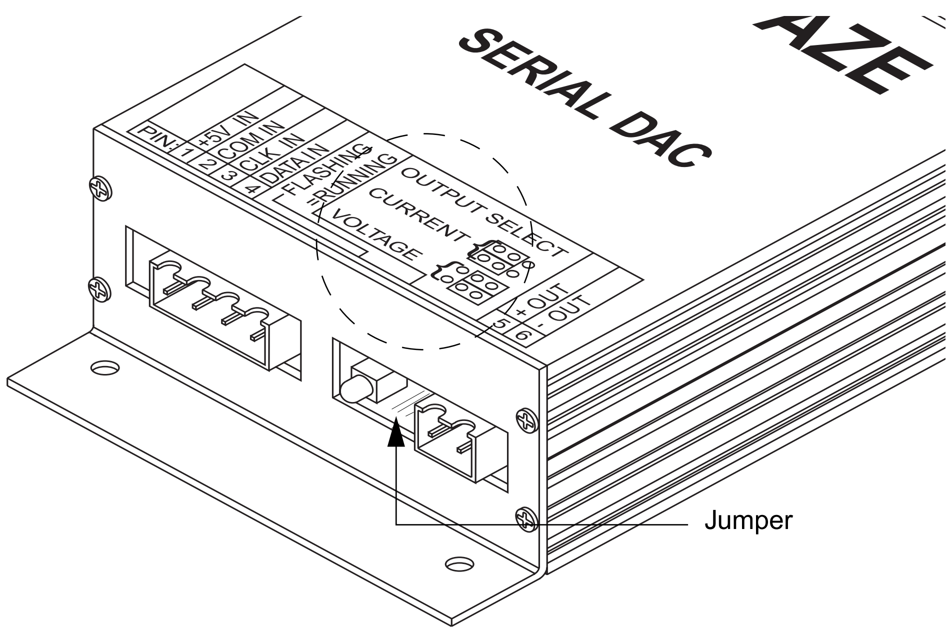


Figure 9.10 Voltage/Current Jumper Positions

10

Linear Scaling Examples

This chapter provides three linear scaling examples. The examples describe:

- A pressure sensor generating a 4 to 20 mA signal
- A flow sensor generating a 0 to 5 V signal
- A pulse encoder generating 900 pulses per inch of movement

Example 1: A 4 to 20 mA Sensor

Situation

A pressure sensor that generates a 4 to 20 mA signal is connected to the controller. The specifications of the sensor state it generates 4 mA at 0.0 psi and 20 mA at 50.0 psi.

Setup

The sensor is connected to a loop input set up with a resistor scaling network producing 60 mV at 20 mA.

The sensor measures psi in tenths, so the appropriate display format is -999.9 to +3000.0.

Table 10.1 Input readings

Process Variable Displayed	Sensor Input	Reading (%FS)
50.0 psi	20 mA	100%
0.0 psi	4 mA	100% x (4 mA/20 mA) = 20%

The scaling values setup in the `SETUP LOOPS INPUT` menu are shown in *Table 10.2*.

Table 10.2 Scaling Values

Parameter	Menu	Value
High Process Variable	High PV	50.0 psi
High Sensor Reading	High Rdg	100.0%
Low Process Variable	Lo PV	0.0 psi
Low Sensor Reading	Lo Rdg	20.0%

Example 2: A 0 to 5 Vdc Sensor

Situation

A flow sensor connected to the controller measures the flow in a pipe. The sensor generates a 0 to 5 V signal. The sensor's output depends on its installation. Independent calibration measurements of the flow in the pipe indicate that the sensor generates 0.5 V at three gallons per minute (GPM) and 4.75 V at 65 GPM. The calibration instruments are accurate to within 1 gallon per minute.

Setup

The sensor is connected to a loop input set up with a resistor voltage divider network producing 60 mV at 5 V.

The calibrating instrument is precise to ±1 gallon per minute, so the appropriate display format is -999 to +3000.

This table shows the input readings and the percentage calculation from the 60 mV full scale input.

Table 10.3 Input Readings and Calculations

Process Variable Displayed	Sensor Input	Reading (%FS)
65 GPM	4.75	(4.75 V / 5.00 V) x 100% = 95%
3 GPM	0.5	(0.5 V / 5.00 V) x 100% = 10%

Table 10.4 Scaling Values

Parameter	Menu	Value
High process variable	High PV	65 GPM
High Sensor Reading	High Rdg	95.0%
Low Process Variable	Lo PV	0.0 GPM
Low Sensor Reading	Lo Rdg	10.0%

Example 3: A Pulse Encoder

Situation

A pulse encoder which measures the movement of a conveyor is connected to the controller. The encoder generates 900 pulses for every inch the conveyor moves. You want to measure conveyor speed in feet per minute (f/m).

Setup

The encoder input is connected to the controller's pulse input. A one-second sample time gives adequate resolution of the conveyor's speed. The resolution is:

$$\frac{1\ \text{pulse}}{1\ \text{second}} \times \frac{60\ \text{seconds}}{1\ \text{minute}} \times \frac{1\ \text{inch}}{900\ \text{pulses}} \times \frac{1\ \text{foot}}{12\ \text{inches}} = 0.006\ \text{f/m}$$

A display format of -99.99 to +300.00 is appropriate.

The input readings are as follows:

At the maximum pulse rate of the MLS300 (2000 Hz):

$$\frac{200\ \text{pulses}}{1\ \text{second}} \times \frac{60\ \text{seconds}}{1\ \text{minute}} \times \frac{1\ \text{inch}}{900\ \text{pulses}} \times \frac{1\ \text{foot}}{12\ \text{inches}} = 11.11\ \text{f/m}$$

At zero hertz, the input reading will be 0.00 f/m.

Table 10.5 Scaling Values

Parameter	Menu	Value
High Process Variable	High PV	11.11 f/m
High Sensor Reading	High Rdg	2000 Hz
Low Process Variable	Lo PV	0 f/m
Low Sensor Reading	Lo Rdg	0 Hz

11

Specifications

This chapter contains specifications for the MLS300 series controllers, digital-to-analog converter (DAC) module, Serial DAC module and the MLS power supply.

MLS300 System Specifications

This section contains MLS300 series controller specifications for environmental specifications and physical dimensions, inputs, outputs, the serial interface and system power requirements.

The controller described consists of a processor module MLS300-PM), an analog input module (MLS300-AIM) and a 50-pin terminal block (TB50).

Table 11.1 Agency Approvals / Compliance

CE Directive	Electromagnetic Compatibility (EMC) directive 89/336/EEC
UL© and cUL©	UL© 916 Standard for Energy Management Equipment File E177240

MLS300 Processor Physical Specifications

Table 11.2 MLS300 Processor Environmental Specifications

Storage Temperature	-4 to 140°F (-20 to 60°C)
Operating Temperature	32 to 122°F (0 to 50°C)
Humidity	10 to 95% non-condensing
Environment	The controller is for indoor use only.

Table 11.3 MLS300 Processor Physical Dimensions

Weight	1.6 lb	0.7 kg
Length	8.4 in	213 mm
Width	3.78 in	96 mm
Height	1.96 in	50 mm

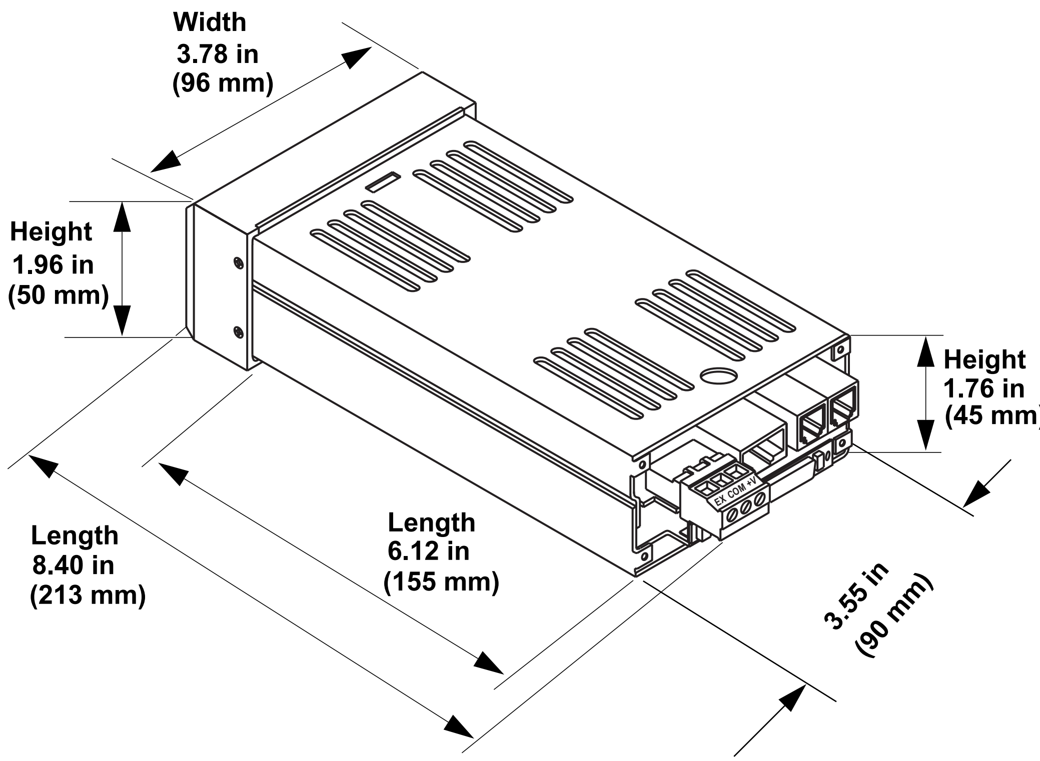


Figure 11.1 MLS300 Processor Module Dimensions

Table 11.4 MLS300 Processor with Straight SCSI

Length	10.0 in	254 mm
Width	3.78 in	96 mm
Height	1.96 in	50 mm

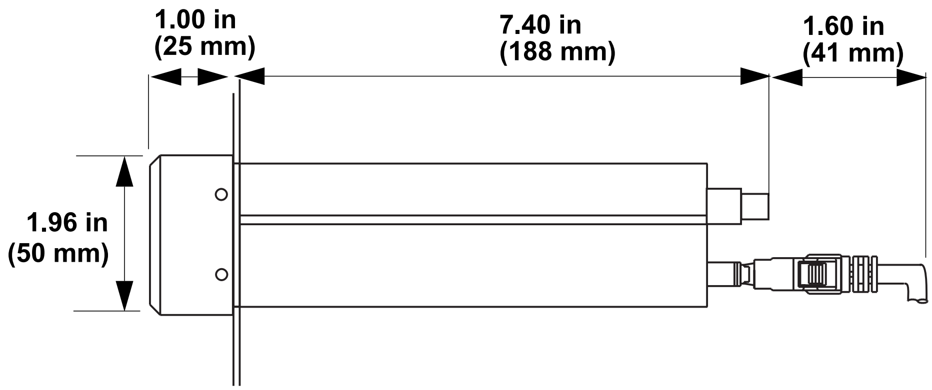


Figure 11.2 MLS300 Clearances with Straight SCSI Cable

Table 11.5 MLS300 Processor with Right-Angle SCSI

Length	9 in	229 mm
Width	3.78 in	96 mm
Height	1.96 in	50 mm

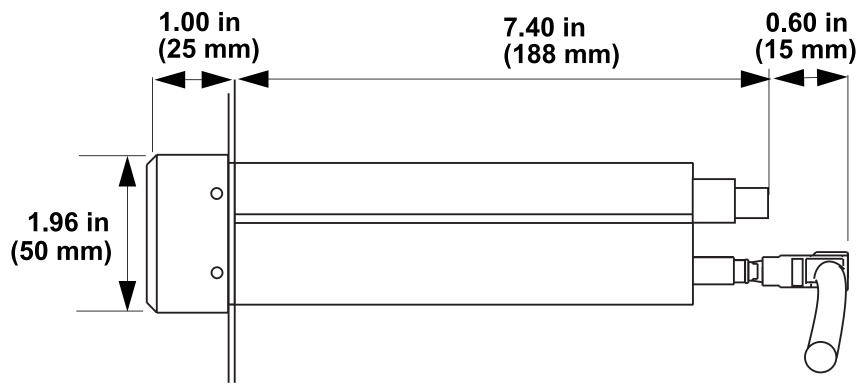


Figure 11.3 MLS300 Clearances with Right-Angle SCSI Cable

Table 11.6 MLS300 Processor Module Connections

Power Terminals (TB1)	Captive screw cage clamp
Power Wire Gauge (TB1)	22 to 18 AWG (0.5 to 0.75 mm^2)
Power Terminal Torque (TB1)	4.4 to 5.3 in-lb (0.5 to 0.6 Nm)
AIM/CIM300 Connector	RJ45
RS232 RS485 Connector	RJ12
RS485 Connector	RJ12
SCSI Connector	SCSI-2 female

MLS300-AIM Physical Dimensions

Table 11.7 MLS300-AIM Environmental Specifications

Storage Temperature	-4 to 140°F (-20 to 60°C)
Operating Temperature	32 to 122°F (0 to 50°C)
Humidity	10 to 95% non-condensing

Table 11.8 MLS300-AIM Physical Dimensions

Weight	1.5 lb	0.7 kg
Length	6.5 in	165 mm
Width	5.0 in	127 mm
Height to top of boards	5.75 in	146 mm
Height to top of AIM cable	6.3 in	160 mm

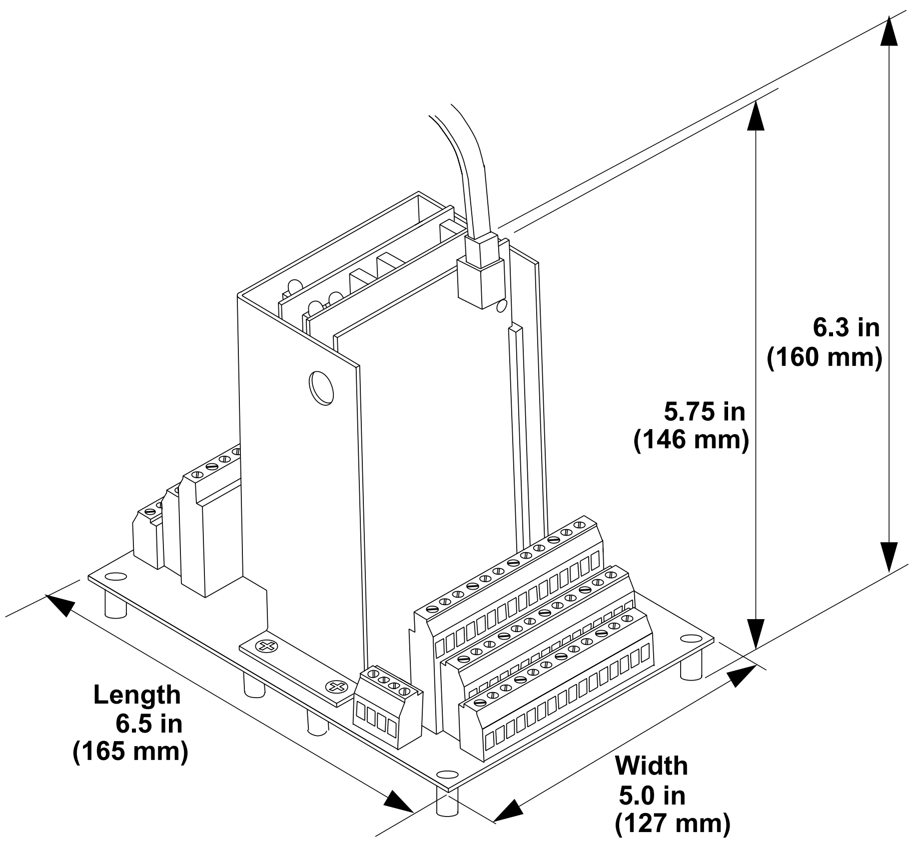


Figure 11.4 MLS300-AIM Module Dimensions

Table 11.9 MLS300 AIM Connections

Power Terminals (TB3)	Captive screw cage clamp
Power Wire Gauge (TB3)	22 to 18 AWG (0.5 to 0.75 mm^2)
Power Terminal Torque (TB3)	4.4 to 5.3 in-lb (0.5 to 0.6 Nm)
AIM Communications Connector	RJ45
Sensor Terminals (TB1 and TB2)	Captive screw cage clamp
Sensor Wire Gauge (TB1 and TB2)	Thermocouples: 20 AWG (0.5 mm^2) Linear: 22 to 20 AWG (0.5 mm^2)
Sensor Terminal Torque (TB1 and TB2)	4.4 to 5.3 in-lb (0.5 to 0.6 Nm)

CIM300 Physical Specifications

Table 11.10 CIM300 Environmental Dimensions

Storage Temperature	-4 to 140°F (-20 to 60°C)
Operating Temperature	32 to 122°F (0 to 50°C)
Humidity	10 to 95% non-condensing

Table 11.11 CIM300 Physical Dimensions

Weight	1 lb	0.45 kg
Length	7.50 in	191 mm
Length to top of AIM cable	8.05 in	205 mm
Width	2.75 in	70 mm
Height	3.75 in	95 mm

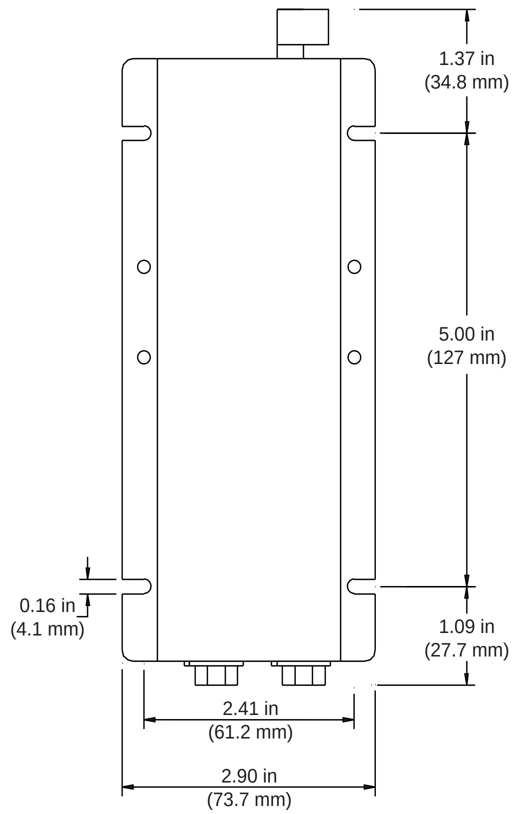


Figure 11.5 CIM300 Module Dimensions

Table 11.12 MLS300 CIM300 Connections

Power Terminals (TB2)	Captive screw cage clamp
Power Wire Gauge (TB2)	22 to 18 AWG (0.5 to 0.75 mm^2)
Power Terminal Torque (TB2)	4.4 to 5.3 in-lb (0.5 to 0.6 Nm)
CIM300 Communications Connector	RJ45
Sensor Terminals (J1)	D-Sub 50 female
Sensor Terminals (J2)	D-Sub 50 male

MLS300-TB50 Physical Specifications

Table 11.13 MLS300-TB50 Physical Dimensions

Weight	0.32 lb	0.15 kg
Length	4.1 in	104 mm
Width	4.0 in	102 mm
Height	1.45 in	37 mm

Table 11.14 MLS300-TB50 Connections

Screw Terminal Torque	4.4 to 5.3 in-lb (0.5 to 0.6 Nm)
SCSI Connector on Board	SCSI-2 female
Output Terminals	Captive screw cage clamp
Output Wire Gauge	Multiconductor cables: 24 AWG (0.2 mm^2) Single-wire: 22 to 18 AWG (0.5 to 0.75 mm^2)
Output Terminal Torque	4.4 to 5.3 in-lb (0.5 to 0.6 Nm)

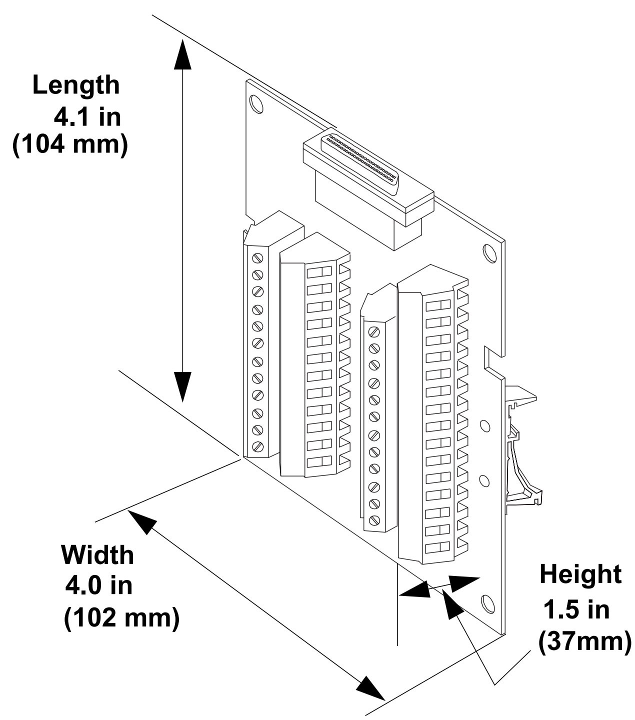


Figure 11.6 MLS300-TB50 Dimensions

Table 11.15 MLS300-TB50 with Straight SCSI

Length	6.4 in	163 mm
Width	4.0 in	102 mm
Height	1.45 in	37 mm

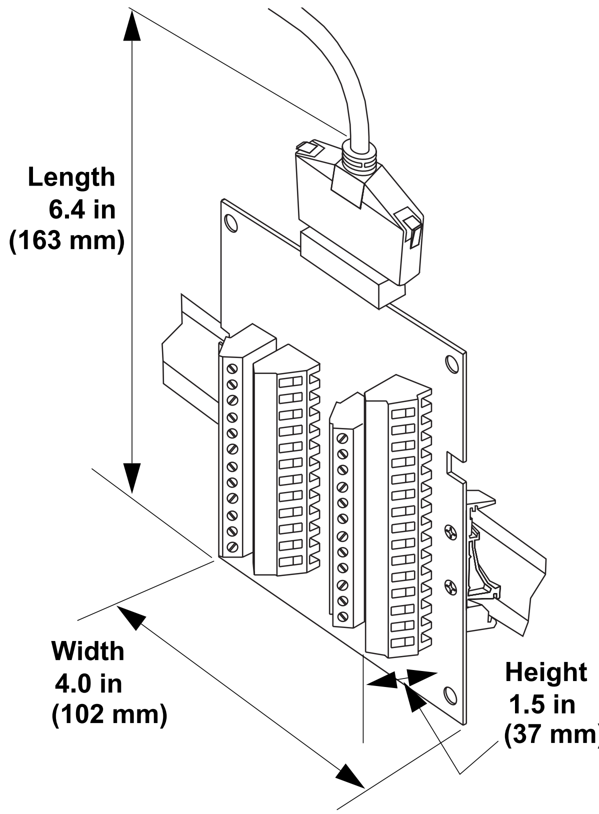


Figure 11.7 MLS300-TB50 Dimensions with Straight SCSI Cable

Table 11.16 MLS300-TB50 with Right-Angle SCSI

Length	5.4 in	137 mm
Width	4.0 in	102 mm
Height	1.5 in	3.7 mm

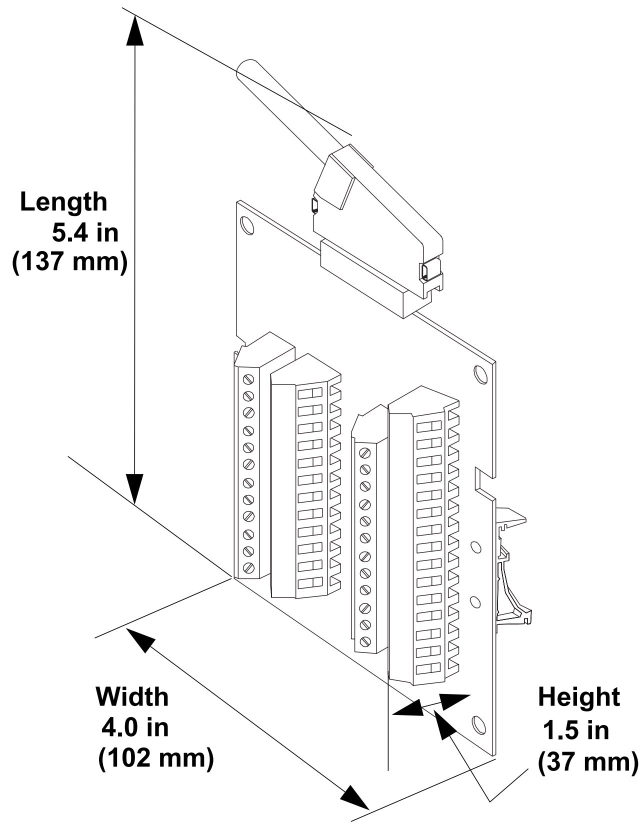


Table 11.17 MLS300-TB50 Dimensions with Right-Angle SCSI Cable

Inputs

The controller accepts analog sensor inputs which are measured and may be used as feedback for control loops. It also accepts digital (TTL) inputs which may be used to trigger certain firmware features.

Table 11.18 Analog Inputs

Parameter	Description
Number of Control Loops	17 (MLS316) 33 (MLS332)
Number of Analog Inputs	MLS316: 16 loops with full range of input types, plus one pulse loop MLS332: 32 loops with full range of input types, plus one pulse loop
Input Switching	Differential solid-state multiplexer
Input Sampling Rate	24 loops per second MLS316: 1.5x/sec (667 ms) at 60 Hz; 1.25x/sec (800 ms) at 50 Hz. MLS332: 0.75x/sec (1.33 sec.) at 60 Hz; 0.625x/sec (1.6 sec.) at 50 Hz.
Analog Over Voltage Protection	70 V peak to peak max.
Maximum Analog Input Voltage	+10 V from A+ or A– to analog common
Common Mode Voltage	500 Vac maximum analog common to MLS-PM or MLS-AIM power supply common
Common Mode Rejection (CMR)	>85 dB at 60 Hz, 110 dB typical
A/D Converter	Integrates voltage to frequency
Input Range	-10 to +60 mV, or 0 to 25 V with scaling resistors
Resolution	0.006%, greater than 14 bits (internal)
Accuracy	0.03% of full scale (60 mV) at 77°F (25°C)
	0.08% of full scale (60 mV) at 32 to 122°F (0 to 50°C)
Calibration	Automatic zero and full scale

Parameter	Description
Analog Ground to Frame Ground Maximum	40 V
DC Common to Frame Ground Maximum potential	40 V
Thermocouple Break Detection	Pulse type for upscale break detection
Milliampere Inputs	0 to 20 mA (3 Ω resistance) or 0 to 10 mA (6 Ω resistance), with scaling resistors
Linear Voltage Input Ranges Available	0 to 12 V, 0 to 10 V, 0 to 5 V, 0 to 1 V, 0 to 500 mV, 0 to 100 mV with scaling resistors
Source Impedance	For 60 mV thermocouple, measurements are within specification with up to 500 Ω source resistance For other types of analog signals, maximum source impedance is 5000 Ω

Table 11.19 Pulse Inputs

Parameter	Description
Number	1
Frequency Range	0 to 2000 Hz
Input Voltage Protection	Diodes to supply and common
Voltage Levels	<1.3 V = Low >3.7 V = High (TTL)
Maximum Switch Resistance to Pull Input Low	2 kΩ
Minimum Switch Off Resistance	30 kΩ

Table 11.20 Thermocouple Ranges and Resolution

Thermo-couple Type	Range in °F	Range in °C	* Accuracy: 77°F (25°C) Ambient		* Accuracy: 32 to 122°F (0 to 50°C) Full Temperature Range	
			°C	°F	°C	°F
J	-350 to 1400	-212 to 760	±0.5	±0.9	±1.1	±2.0
K	-450 to 2500	-268 to 1371	±0.6	±1.2	±1.35	±2.7
T	-450 to 750	-268 to 399	±1.3	±2.4	±2.9	±5.4
S	0 to 3200	-18 to 1760	±2.5	±4.5	±5.6	±10.1
R	0 to 3210	-18 to 1766	±2.5	±4.5	±5.6	±10.1
B	150 to 3200	66 to 1760	±6.6	±12.0	±14.9	±27.0
E	-328 to 1448	-200 to 787	±0.5	±0.9	±1.1	±2.0
* True for 10 to 100% of span.						

Table 11.21 RTD Ranges and Resolution

Name	Range in °F	Range in °C	Resolution	Measurement Temperature in °C	Accuracy: 77°F (25°C) Ambient °C	°F	Accuracy: 32 to 122°F (0 to 50°C) Ambient °C	°F
RTD1	-148.0 to 527.0	-100.0 to 275.0	0.023°C	25	±0.35	±0.63	±0.5	±0.9
				275	±1	±1.8	±1.5	±2.7
RTD2	-184 to 1544	-120 to 840	0.062°C	25	±0.9	±1.62	±2.8	±5.04
				840	±1.1	±1.98	±4.3	±7.74

Table 11.22 Input Resistances for Voltage Inputs

Range	Input Resistance
0 to 12 V	85 kΩ
0 to 10 V	50 kΩ
0 to 5 V	40 kΩ
0 to 1 V	7.4 kΩ
0 to 500 mV	6.2 kΩ
0 to 100 mV	1.2 kΩ

Table 11.23 Digital Inputs

Parameter	Description
Number	8
Configu ation	8 selectable for output override, remote job selection
Input Voltage Protection	Diodes to supply and common. Source must limit current to 10 mA for override conditions.
Voltage Levels	<1.3 V = Low; >3.7 V = High (TTL) 5 Vdc maximum
Maximum Switch Resistance to Pull Input Low	1 kΩ
Minimum Switch Off Resistance	11 kΩ

Outputs

The controller directly accommodates switched DC and open-collector outputs only. These outputs can be used to control a wide variety of loads. They are typically used to control SSRs or other power switching devices which in turn control, for example, heaters. They may also be used to signal another device of an alarm condition in the controller.

Analog outputs may be accomplished by using DAC or SDAC modules in conjunction with one of the control outputs.

An open-collector CPU watchdog output is also provided so that an external device may monitor the CPU state.

Analog Outputs

No direct analog outputs are provided.

The digital outputs may be used in conjunction with DAC or SDAC modules to provide analog signals. See *DAC Specifications on page 235* and *SDAC Specifications on page 237.*

Digital Outputs

Table 11.24 Digital Outputs Control / Alarm

Parameter	Description
Number	35
Operation	Open collector output; ON state sinks to logic common
Function	34 Outputs selectable as closed-loop control or alarm/ control. 1 global alarm output
Number of Control Outputs per PID Loop	2 (maximum)
Control Output Types	Time Proportioning, Distributed Zero Crossing, SDAC, or On/Off—all independently selectable for each output. Heat and cool control outputs can be individually disabled for use as alarm outputs.
Time Proportioning Cycle Time	1 to 255 seconds, programmable for each output
Control Action	Reverse (heat) or direct (cool), independently selectable for each output
Off State Leakage Current	<0.01 mA to dc common
Maximum Current	60 mA for each output. 5V power supply (from the processor module) can supply up to 350 mA total to all outputs.
Maximum Voltage Switched	24 Vdc

Table 11.25 CPU Watchdog Output

Parameter	Description
Number	1
Operation	Open collector output; ON state sinks to logic common
Function	Monitors the processor module microprocessor
Maximum Current	10 mA (5 V power supply in the processor module can supply up to 350 mA total to all outputs.)
Maximum Voltage Switched	5 Vdc

Table 11.26 5 Vdc Output (power to operate Solid-State Relays)

Parameter	Description
Voltage	5 Vdc
Maximum Current	350 mA

Table 11.27 Reference Voltage Output (power to operate bridge circuit sensors)

Parameter	Description
Voltage	5 Vdc
Maximum Current	100 mA

Table 11.28 Processor Serial Interface

Parameter	Description
Type	EIA/TIA-232 3-wire or EIA/TIA-485 4-wire
Isolation	None
Baud Rate	2400, 9600 or 19,200 user-selectable
Error Check	BCC or CRC, user-selectable
Number of Controllers	1 with EIA/TIA-232 communications; up to 32 with EIA/TIA-485 communications, depending on protocol
Protocol	Form of ANSI X3.28-1976 (D1, F1), compatible with Allen Bradley PLC, full duplex, or ModBus RTU

Table 11.29 Processor Power Requirements

Parameter	Description
Voltage	12 to 24 +/- 15% Vdc
Maximum Current	1 A

MLS300 Power Supply

Specifications for the power supply are on the MLS300 page at www.watlow.com.

DAC Specifications

The Watlow Anafaze Digital to Analog Converter (DAC) is an optional module for the MLS300 series controller. DACs convert a distributed zero crossing (DZC) output signal to an analog process control signal. Watlow Anafaze provides the following version of the DAC:

- 4 to 20 mAdc
- 0 to 5 Vdc
- 0 to 10 Vdc

Table 11.36 DAC Environmental Specifications

Storage Temperature	-4 to 140°F (-20 to 60°C)
Operating Temperature	32 to 122°F (0 to 50°C)
Humidity	10 to 95% non-condensing

Table 11.37 Physical Specifications

Weight	0.42 lb	0.19 kg
Length	4.4 in	112 mm
Width	3.6 in	91 mm
Height	1.75 in	44 mm

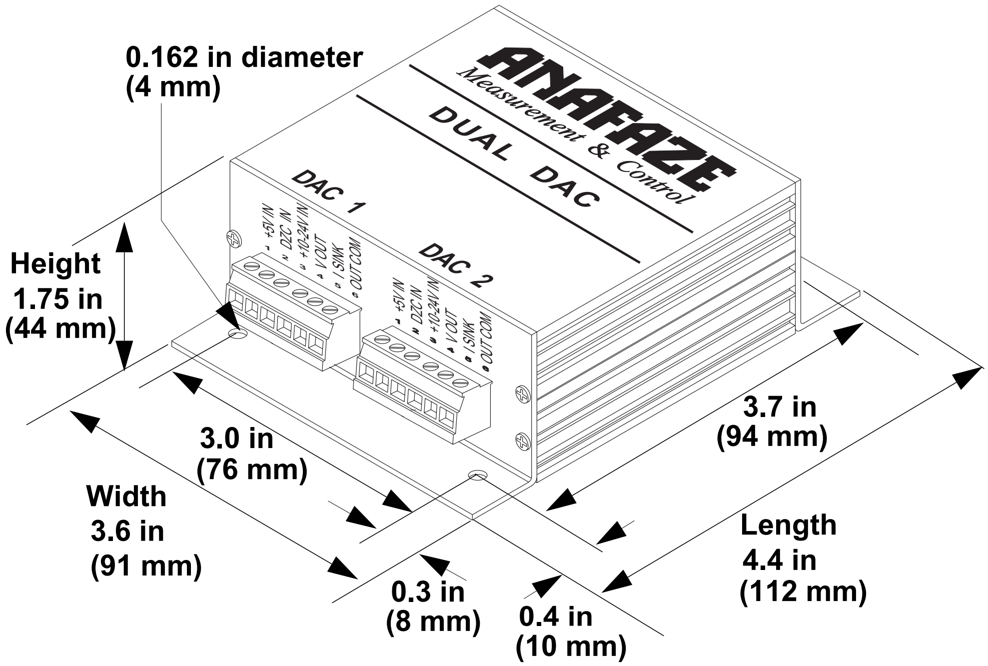


Figure 11.9 DAC Dimensions

Inputs

The DAC accepts an open-collector signal from the MLS300 controller and the power from an external power supply. See *Table 11.38 on page 236.*

Table 11.38 DAC Power Requirements

Parameter	Description
Voltage	12 to 24 Vdc
Current	100 mA @ 15 Vdc

Analog Outputs

Table 11.39 DAC Specifications by Output Range

Version	4 to 20 mA	0 to 5 V	0 to 10 V	Units	
Gain Accuracy	± 6	± 6	±	6	%
Output Offset	± 0.75	± 0.75	± 0.75	% of full scale range	
Ripple	1.6	1.6	1.6	% of full scale range	
Time Constant	2	2	2	seconds	
Maximum Current Output	20	10	10	mA dc	
Load Resistance (12 V)	250 maximum	500 minimum	1000 minimum	Ω	
Load Resistance (24 V)	850 maximum	n/a	n/a	Ω	

SDAC Specifications

Watlow Anafaze offers a Serial DAC for precision open-loop analog outputs. The SDAC is jumper selectable for a 0 to 10 Vdc or 4 to 20 mA output. Multiple SDAC modules can be used with one MLS. The SDAC carries a CE mark.

Table 11.40 SDAC Environmental Specifications

Storage Temperature	-4 to 140°F (-20 to 60°C)
Operating Temperature	32 to 158°F (0 to 70°C)
Humidity	10 to 95% non-condensing
Environment	The SDAC is for indoor use only.

Table 11.41 SDAC Physical Specifications

Weight	0.76 lb	0.34 kg
Length	5.4 in	137 mm
Width	3.6 in	91 mm
Height	1.75 in	44 mm

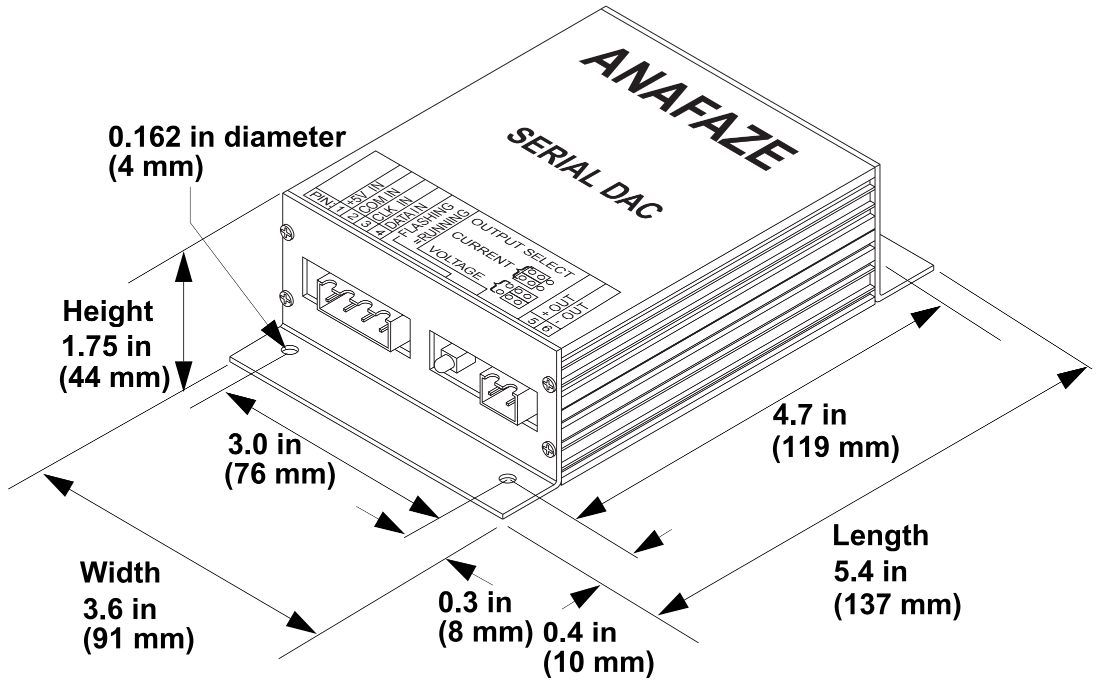


Figure 11.10 SDAC Dimensions

Table 11.42 Agency Approvals / Compliance

CE Directive	Electromagnetic Compatibility (EMC) directive 89/336/EEC
UL© and cUL©	UL© 916 Standard for Energy Management Equipment File E177240

Inputs

The SDAC requires a proprietary serial data signal and the clock signal from the MLS300 via the TB50. Any control output can be configured to provide the data signal. The SDAC also requires a 5 Vdc power input.

Table 11.43 SDAC Inputs

Parameter	Description
Data	4 mA maximum to DC COM Open collector or HC CMOS logic levels
Clock	0.5 mA max to DC COM Open collector or HC CMOS logic levels

Table 11.44 Power Requirements

Parameter	Description
Voltage	4.75 to 5.25 Vdc @ 300 mA max
Current	210 mA typical @ 20 Vdc out

Analog Outputs

Table 11.45 SDAC Analog Output Specifications

Parameter	Description
Absolute Maximum Common Mode Voltage	Measured between output pins and controller common: 1000 V
Resolution	15 bits (plus polarity bit for voltage outputs) (0.305 mV for 10 V output range) (0.00061 mA for 20 mA output range)
Accuracy (calibrated for voltage output)	For voltage output: +/- 0.005 V (0.05% at full scale) For current output: +/- 0.1 mA (0.5% at full scale)
Temperature coefficien	440 ppm/ °C typical
Isolation Breakdown Voltage	1000 V between input power and signals

Parameter	Description
Current	0 to 20 mA (500 Ω load maximum)
Voltage	0 to 10 Vdc with 10 mA source capability
Output Response Time	1 ms typical
Update Rate	Once per controller A/D cycle nominal. Twice per second maximum for 60 Hz clock rate. Output changes are step changes due to the fast time constant. All SDAC loop outputs are updated at the same time.

Glossary

A

AC
See Alternating Current.

AC Line Frequency
The frequency of the AC power line measured in Hertz (Hz), usually 50 or 60 Hz.

Accuracy
Closeness between the value indicated by a measuring instrument and a physical constant or known standards.

Action
The response of an output when the process variable is changed. *See also Direct action, Reverse action.*

Address
A numerical identifier for a controller when used in computer communications.

Alarm
A signal that indicates that the process has exceeded or fallen below a certain range around the set point. For example, an alarm may indicate that a process is too hot or too cold. *See also:*
Deviation Alarm
Failed Sensor Alarm
Global Alarm
High Deviation Alarm
High Process Alarm
Loop Alarm
Low Deviation Alarm
Low Process Alarm

Alarm Delay
The lag time before an alarm is activated.

Alternating Current (AC)
An electric current that reverses at regular intervals, and alternates positive and negative values.

Ambient Temperature
The temperature of the air or other medium that surrounds the components of a thermal system.

American Wire Gauge (AWG)
A standard of the dimensional characteristics of wire used to conduct electrical current or signals. AWG is identical to the Brown and Sharpe (B&S) wire gauge.

Ammeter
An instrument that measures the magnitude of an electric current.

Ampere (Amp)
A unit that defines the rate of flow of electricity (current) in the circuit. Units are one coulomb (6.25 x 1018 electrons) per second.

Analog Output
A continuously variable signal that is used to represent a value, such as the process value or set point value. Typical hardware configurations are 0 to 20 mA, 4 to 20 mA or 0 to 5 Vdc.

Automatic Mode
A feature that allows the controller to set PID control outputs in response to the Process Variable (PV) and the set point.

Autotune
A feature that automatically sets temperature control PID values to match a particular thermal system.

B

Baud Rate
The rate of information transfer in serial communications, measured in bits per second.

Block Check Character (BCC)
A serial communications error checking method. An acceptable method for most applications, BCC is the default method. *See CRC.*

Bumpless Transfer
A smooth transition from Auto (closed loop) to Manual (open loop) operation. The control output does not change during the transfer.

C

Calibration

The comparison of a measuring device (an unknown) against an equal or better standard.

Celsius (Centigrade)

Formerly known as Centigrade. A temperature scale in which water freezes at 0°C and boils at 100°C at standard atmospheric pressure. The formula for conversion to the Fahrenheit scale is:
°F = (1.8 x °C) + 32.

Central Processing Unit (CPU)

The unit of a computing system that includes the circuits controlling the interpretation of instructions and their execution.

Circuit

Any closed path for electrical current. A configuration of electrically or electromagnetically connected components or devices.

Closed Loop

A control system that uses a sensor to measure a process variable and makes decisions based on that feedback.

Cold Junction

Connection point between thermocouple metals and the electronic instrument.

Common Mode Rejection Ratio

The ability of an instrument to reject electrical noise, with relation to ground, from a common voltage. Usually expressed in decibels (dB).

Communications

The use of digital computer messages to link components.
See Serial Communications.
See Baud Rate.

Control Action

The response of the PID control output relative to the error between the process variable and the set point. For reverse action (usually heating), as the process decreases below the set point the output increases. For direct action (usually cooling), as the process increases above the set point, the output increases.

Control Mode

The type of action that a controller uses. For example, On/Off, time proportioning, PID, Automatic or manual, and combinations of these.

CRC

See Cyclic Redundancy Check.

Current

The rate of flow of electricity. The unit of measure is the ampere (A).
1 ampere = 1 coulomb per second.

Cycle Time

The time required for a controller to complete one on-off-on cycle. It is usually expressed in seconds.

Cyclic Redundancy Check (CRC)

An error checking method in communications. It provides a high level of data security but is more difficult to implement than Block Check Character (BCC).
See Block Check Character.

D

Data Logging

A method of recording a process variable over a period of time. Used to review process performance.

Deadband

The range through which a variation of the input produces no noticeable change in the output. In the deadband, specific conditions can be placed on control output actions. Operators select the deadband. It is usually above the heating proportional band and below the cooling proportional band.

Default Parameters

The programmed instructions that are permanently stored in the microprocessor software.

Derivative Control (D)

The last term in the PID algorithm. Action that anticipated the rate of change of the process, and compensates to minimize overshoot and undershoot. Derivative control is an instantaneous change of the control output in the same direction as the proportional error. This is caused by a change in the process variable (PV) that decreases over the time of the derivative (TD). The TD is in units of seconds.

Deutsche Industrial Norms (DIN)
A set of technical, scientific and dimensional standards developed in Germany. Many DIN standards have worldwide recognition.

Deviation Alarm
Warns that a process has exceeded or fallen below a certain range around the set point.

Digital to Analog Converter (DAC)
A device that converts a numerical input signal to a signal that is proportional to the input in some way.

Direct Action
An output control action in which an increase in the process variable, causes an increase in the output. Cooling applications usually use direct action.

Direct Current (DC)
An electric current that flows in one direction.

Distributed Zero Crossing (DZC)
A form of digital output control. Similar to burst fire.

E

Earth Ground
A metal rod, usually copper, that provides an electrical path to the earth, to prevent or reduce the risk of electrical shock.

Electrical Noise
See Noise.

Electromagnetic Interference (EMI)
Electrical and magnetic noise imposed on a system. There are many possible causes, such as switching ac power on inside the sine wave. EMI can interfere with the operation of controls and other devices.

Electrical-Mechanical Relays
See Relay, electromechanical.

Emissivity
The ratio of radiation emitted from a surface compared to radiation emitted from a blackbody at the same temperature.

Engineering Units
Selectable units of measure, such as degrees Celsius and Fahrenheit, pounds per square inch, newtons per meter, gallons per minute, liters per minute, cubic feet per minute or cubic meters per minute.

EPROM
Erasable Programmable, Read-Only Memory inside the controller.

Error
The difference between the correct or desired value and the actual value.

F

Fahrenheit
The temperature scale that sets the freezing point of water at 32°F and its boiling point at 212°F at standard atmospheric pressure. The formula for conversion to Celsius is: °C = 5/9 (°F to 32°F).

Failed Sensor Alarm
Warns that an input sensor no longer produces a valid signal. For example, when there are thermocouple breaks, infrared problems or resistance temperature detector (RTD) open or short failures.

Filter
Filters are used to handle various electrical noise problems.

Digital Filter (DF) — A filter that allows the response of a system when inputs change unrealistically or too fast. Equivalent to a standard resistor-capacitor (RC) filter

Digital Adaptive Filter — A filter that rejects high frequency input signal noise (noise spikes).

Heat/Cool Output Filter — A filter that slows the change in the response of the heat or cool output. The output responds to a step change by going to approximately 2/3 its final value within the numbers of scans that are set.

Frequency
The number of cycles over a specified period of time, usually measured in cycles per second. Also referred to as Hertz (Hz). The reciprocal is called the period.

G

Gain
The amount of amplification used in an electrical circuit. Gain can also refer to the Proportional (P) mode of PID.

Global Alarm
Alarm associated with a global digital output that is cleared directly from a controller or through a user interface.

Global Digital Outputs
A preselected digital output for each specific alarm that alerts the operator to shut down critical processes when an alarm condition occurs.

Ground
An electrical line with the same electrical potential as the surrounding earth. Electrical systems are usually grounded to protect people and equipment from shocks due to malfunctions. Also referred to a "safety ground."

H

Hertz (Hz)
Frequency, measured in cycles per second.

High Deviation Alarm
Warns that the process is above set point, but below the high process variable. It can be used as either an alarm or control function.

High Power
(As defined by ANAFAZE) Any voltage above 24 Vac or Vdc and any current level above 50 mA ac or mA dc.

High Process Alarm
A signal that is tied to a set maximum value that can be used as either an alarm or control function.

High Process Variable
See Process Variable.

High Reading
An input level that corresponds to the high process value. For linear inputs, the high reading is a percentage of the full scale input range. For pulse inputs, the high reading is expressed in cycles per second (Hz).

I

Infrared
A region of the electromagnetic spectrum with wavelengths ranging from one to 1,000 microns. These wavelengths are most suited for radiant heating and infrared (noncontact) temperature sensing.

Input
Process variable information that is supplied to the instrument.

Input Scaling
The ability to scale input readings (readings in percent of full scale) to the engineering units of the process variable.

Input Type
The signal type that is connected to an input, such as thermocouple, RTD, linear or process.

Integral Control (I)
Control action that automatically eliminates offset, or droop, between set point and actual process temperature.
See Reset, Automatic.

J

Job
A set of operating conditions for a process that can be stored and recalled in a controller's memory. Also called a Recipe.

Junction
The point where two dissimilar metal conductors join to forma thermocouple.

L

Lag
The delay between the output of a signal and the response of the instrument to which the signal is sent.

Linear Input
A process input that represents a straight line function.

Linearity
The deviation in response from an expected or theoretical straight line value for instruments and transducers. Also called Linearity Error.

Liquid Crystal Display (LCD)
A type of digital display made of a material that changes reflectance or transmittance when an electrical field is applied to it.

Load
The electrical demand of a process, expressed in power (watts), current (amps), or resistance (ohms). The item or substance that is to be heated or cooled.

Loop Alarm
Any alarm system that includes high and low process, deviation band, deadband, digital outputs, and auxiliary control outputs.

Low Deviation Alarm
Warns that the process is below the set point, but above the low process variable. It can be used as either an alarm or control function.

Low Process Alarm
A signal that is tied to a set minimum value that can be used as either an alarm or control function.

Low Reading
An input level corresponding to the low process value. For linear inputs, the low reading is a percentage of the full scale input range. For pulse inputs, the low reading is expressed in cycles per second (Hz).

M

Manual Mode
A selectable mode that has no automatic control aspects. The operator sets output levels.

Manual Reset
See Reset.

Milliampere (mA)
One thousandth of an ampere.

N

No Key Reset
A method for resetting the controller's memory (for instance, after an EPROM change).

Noise
Unwanted electrical signals that usually produce signal interference in sensors and sensor circuits. *See Electromagnetic Interference.*

Noise Suppression
The use of components to reduce electrical interference that is caused by making or breaking electrical contact, or by inductors.

Non Linear
Through ANAFAZE software, the Non Linear field sets the system to linear control, or to one of two non linear control options. Input 0 for Linear, 1 or 2 for nonlinear.

O

Offset
The difference in temperature between the set point and the actual process temperature. Offset is the error in the process variable that is typical of proportional-only control.

On/Off Control
A method of control that turns the output full on until set point is reached, and then off until the process error exceeds the hysteresis.

Open Loop
A control system with no sensory feedback.

Operator Menus
The menus accessible from the front panel of a controller. These menus allow operators to set or change various control actions or features.

Optical Isolation
Two electronic networks that are connected through an LED (Light Emitting Diode) and a photoelectric receiver. There is no electrical continuity between the two networks.

Output
Control signal action in response to the difference between set point and process variable.

Output Type
The form of PID control output, such as Time Proportioning, Distributed Zero Crossing, SDAC, or Analog. Also the description of the electrical hardware that makes up the output.

Overshoot
The amount by which a process variable exceeds the set point before it stabilizes.

P

Panel Lock
A feature that prevents operation of the front panel by unauthorized people.

PID
Proportional, Integral, Derivative. A control mode with three functions:
Proportional action dampens the system response, Integral corrects for droops, and Derivative prevents overshoot and undershoot.

Polarity
The electrical quality of having two opposite poles, one positive and one negative. Polarity determines the direction in which a current tends to flow.

Process Variable (PV)
The parameter that is controlled or measured. Typical examples are temperature, relative humidity, pressure, flow, fluid level, events, etc. The high process variable is the highest value of the process range, expressed in engineering units. The low process variable is the lowest value of the process range.

Proportional (P)
Output effort proportional to the error from set point. For example, if the proportional band is 20°F and the process is 10°F below the set point, the heat proportioned effort is 50%. The lower the PB value, the higher the gain.

Proportional Band (PB)
A range in which the proportioning function of the control is active. Expressed in units, degrees or percent of span.
See PID.

Proportional Control
A control using only the P (proportional) value of PID control.

Pulse Input
Digital pulse signals from devices, such as optical encoders.

R

Ramp
A programmed increase in the temperature of a set point system.

Range
The area between two limits in which a quantity or value is measured. It is usually described in terms of lower and upper limits.

Recipe
See Job.

Reflection Compensation Mode
A control feature that automatically corrects the reading from a sensor.

Relay
A switching device.

Electromechanical Relay — A power switching device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other. Not recommended for PID control.

Solid-State Relay (SSR) — A switching device with no moving parts that completes or interrupts a circuit electrically.

Reset

Control action that automatically eliminates offset or droop between set point and actual process temperature.
See also Integral.

Automatic Reset — The integral function of a PI or PID temperature controller that adjusts the process temperature to the set point after the system stabilizes. The inverse of integral.

Automatic Power Reset — A feature in latching limit controls that

Resistance

Opposition to the flow of electric current, measured in ohms.

Resistance Temperature Detector (RTD)

A sensor that uses the resistance temperature characteristic to measure temperature. There are two basic types of RTDs: the wire RTD, which is usually made of platinum, and the thermistor which is made of a semiconductor material. The wire RTD is a positive temperature coefficient sensor only, while the thermistor can have either a negative or positive temperature coefficient.

Reverse Action

An output control action in which an increase in the process variable causes a decrease in the output. Heating applications usually use reverse action.

RTD

See Resistance Temperature Detector.

S

Serial Communications

A method of transmitting information between devices by sending all bits serially over a single communication channel.

EIA/RS-232—An Electronics Industries of America (EIA) standard for interface between data terminal equipment and data communications equipment for serial binary data interchange. This is usually for communications over a short distance (50 feet or less) and to a single device.

EIA/RS-485—An Electronics Industries of America (EIA) standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems. This is usually used to communicate with multiple devices over a common cable or where distances over 50 feet are required.

set point (SP)

The desired value programmed into a controller. For example, the temperature at which a system is to be maintained.

Shield

A metallic foil or braided wire layer surrounding conductors that is designed to prevent electrostatic or electromagnetic interference from external sources.

Signal

Any electrical transmittance that conveys information.

Solid-State Relay (SSR)

See Relay, Solid-State.

Span

The difference between the lower and upper limits of a range expressed in the same units as the range.

Spread

In heat/cool applications, the +/- difference between heat and cool. Also known as process deadband.

See Deadband.

Stability

The ability of a device to maintain a constant output with the application of a constant input.

T

Thermocouple Extension Wire

A grade of wire used between the measuring junction and the reference junction of a thermocouple. Extension wire and thermocouple wire have similar properties, but extension wire is less costly.

TD (Timed Derivative)
The derivative function.

Thermistor
A temperature-sensing device made of semiconductor material that exhibits a large change in resistance for a small change in temperature. Thermistors usually have negative temperature coefficients, although they are also available with positive temperature coefficients.

Thermocouple
A temperature sensing device made by joining two dissimilar metals. This junction produces an electrical voltage in proportion to the difference in temperature between the hot junction (sensing junction) and the lead wire connection to the instrument (cold junction).

TI (Timed Integral)
The Integral term.

Transmitter
A device that transmits temperature data from either a thermocouple or RTD by way of a two-wire loop. The loop has an external power supply. The transmitter acts as a variable resistor with respect to its input signal. Transmitters are desirable when long lead or extension wires produce unacceptable signal degradation.

U

Upscale Break Protection
A form of break detection for burned-out thermocouples. Signals the operator that the thermocouple has burned out.

Undershoot
The amount by which a process variable falls below the set point before it stabilizes.

V

Volt (V)
The unit of measure for electrical potential, voltage or electromotive force (EMF).

See Voltage.

Voltage (V)
The difference in electrical potential between two points in a circuit. It's the push or pressure behind current flow through a circuit. One volt (V) is the difference in potential required to move one coulomb of charge between two points in a circuit, consuming one joule of energy. In other words, one volt (V) is equal to one ampere of current (I) flowing through one ohm of resistance (R), or V = IR.

Z

Zero Cross
Action that provides output switching only at or near the zero-voltage crossing points of the ac sine wave.

Menu Structure

SETUP GLOBAL PARAMETERS (p. 94)
LOAD SETUP FROM JOB
SAVE SETUP TO JOB
JOB SELECT DIG INPUTS
JOB SEL DIG INS ACTIVE
OUTPUT OVERRIDE DIG INPUT
OVERRIDE DIG IN ACTIVE
STARTUP ALARM DELAY
RAMP/SOAK TIME BASE
KEYBOARD LOCK STATUS
POWER UP OUTPUT STATUS
PROCESS POWER DIGIN
CONTROLLER ADDRESS
COMMUNICATIONS BAUD RATE
COMMUNICATIONS PROTOCOL
COMMUNICATIONS ERR CHECK
AC LINE FREQ
DIG OUT POLARITY ON ALARM
CLS200 [FIRMWARE INFO.]

SETUP LOOP INPUT (p. 102)
INPUT TYPE
LOOP NAME
INPUT UNITS
INPUT READING OFFSET
REVERSED T/C DETECT
INPUT PULSE SAMPLE TIME
DISP FORMAT
INPUT SCALING HI PV
INPUT SCALING HI RDG
INPUT SCALING LO PV
INPUT SCALING LO RDG
INPUT FILTER

SETUP LOOP CONTROL PARAMS (p. 110)
HEAT CONTROL PB
HEAT CONTROL TI
HEAT CONTROL TD
HEAT CONTROL FILTER
COOL CONTROL PB
COOL CONTROL TI
COOL CONTROL TD
COOL CONTROL FILTER
SPREAD
RESTORE PID DIGIN

SETUP LOOP OUTPUTS (p. 113)
HEAT CONTROL OUTPUT
HEAT OUTPUT TYPE
HEAT OUTPUT CYCLE TIME
SDAC MODE
SDAC LO VALUE
SDAC HI VALUE
HEAT OUTPUT ACTION
HEAT OUTPUT LIMIT
HEAT OUTPUT LIMIT TIME
SENSOR FAIL HT OUTPUT
HEAT T/C BRK OUT AVG
HEAT OUTPUT
COOL CONTROL OUTPUT
COOL OUTPUT TYPE
COOL OUTPUT CYCLE TIME
SDAC PARAMETERS
COOL OUTPUT ACTION
COOL OUTPUT LIMIT
COOL OUTPUT LIMIT TIME
SENSOR FAIL CL OUTPUT
COOL T/C BRK OUT AVG
COOL OUTPUT

SETUP LOOP ALARMS (p. 120)
HI PROC ALARM SETPT
HI PROC ALARM TYPE
HI PROC ALARM OUTPUT
DEV ALARM VALUE
HI DEV ALARM TYPE
HI DEV ALARM OUTPUT
LO DEV ALARM TYPE
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LO PROC ALARM TYPE
LO PROC ALARM OUTPUT
ALARM DEADBAND
ALARM DELAY

MANUAL I/O TEST (p. 124)
DIGITAL INPUTS
TEST DIGITAL OUTPUT
DIGITAL OUTPUT NUMBER XX
KEYPAD TEST
TEST DISPLAY

Additional Enhanced Features Option Menus

SETUP LOOP PV RETRANSMIT (p. 135)
HEAT OUTPUT RETRANS PV
HEAT RETRANS MIN INP
HEAT RETRANS MIN OUT%
HEAT RETRANS MAX INP
HEAT RETRANS MAX OUT%
COOL OUTPUT RETRANS PV
COOL RETRANS MIN INP
COOL RETRANS MIN OUT%
COOL RETRANS MAX INP
COOL RETRANS MAX OUT%

SETUP LOOP CASCADE (p. 141)
CASCADE PRIM. LOOP
CASCADE BASE SP
CASCADE MIN SP
CASCADE MAX SP
CASCADE HT SPAN
CASCADE CL SPAN

SETUP LOOP RATIO CONTROL (p. 148)
RATIO CONTROL MSTR LOOP
RATIO CONTROL MIN SP
RATIO CONTROL MAX SP
RATIO CONTROL CTRL RATIO
RATIO CONTROL SP DIFF

Additional Ramp/Soak Option Menus

SETUP LOOP PV RETRANSMIT (p. 135)
HEAT OUTPUT RETRANS PV
HEAT RETRANS MIN INP
HEAT RETRANS MIN OUT%
HEAT RETRANS MAX INP
HEAT RETRANS MAX OUT%
COOL OUTPUT RETRANS PV
COOL RETRANS MIN INP
COOL RETRANS MIN OUT%
COOL RETRANS MAX INP
COOL RETRANS MAX OUT%

SETUP RAMP/SOAK PROFILE (p. 161)
EDIT RAMP & SOAK PROFILE
COPY SETUP FROM PROFILE
OUT-OF-TOLRNCE ALARM TIME
READY SEGMENT SETPOINT
READY SEGMENT EDIT EVENTS
READY EVENT OUTPUT
EXTERNAL RESET INPUT NUMBER
EDIT SEGMENT NUMBER
SEGMENT ## SEG TIME
SEGMENT ## SEG SETPT
SEGMENT ## EDIT SEG EVENTS
SEG ## EVENT # OUTPUT
SEG ## EV# DO## ACTIVE STATE
SEGMENT ## EDIT SEG TRGGRS
SEG ## TRIG # INPUT NR
SEG ## TR# DI## ACTIVE STATE
SEG ## TR# DI## TRIG
SEGMENT ## SEG TOLERANCE
SEGMENT ## LAST SEGMENT
REPEAT CYCLES

Declaration of Conformity

MLS300 Series

WATLOW ANAFAZE
314 Westridge Drive
Watsonville, California 95076 USA

Declares that the following product: ***English***

Designation:	MLS300 Series
Model Number(s):	3 (16,32,C1 or C2) - (0,1,2,3,4, or C) (0 or 1) (0 or 2) (0,1,2, or 3) (0,1,2,3,7 or 8) (0,1 or 2) (0,1 or 2) (2 letters or numbers)
Classification:	Installation Category II, Pollution Degree II
Rated Voltage:	15 to 24 VDC
Rated Current:	1A maximum

Meets the essential requirements of the following European Union Directive(s) using the relevant section(s) of the normalized standards and related documents shown:

89/336/EEC Electromagnetic Compatibility Directive

EN 61326:	**1997**	**Electrical equipment for measurement, control and laboratory use - EMC requirements (Class A)**
EN 61000-3-2:	1995	Limits for harmonic current
EN 61000-3-3:	1995	Limitations of voltage fluctuations and flicker
EN 61000-4-2:	1995	Electrostatic discharge
EN 61000-4-3:	1997	Radiated immunity
EN 61000-4-4:	1995	Electrical fas t transients
EN 61000-4-5:	1995	Surge immunity
EN 61000-4-6:	1994	Conducted immunity
EN 61000-4-11:	1994	Voltage dips, short interruptions and voltage variations immunity

Déclare que le produit suivant : ***Français***

Désignation :	Série MLS300
Numéro(s) de modèle(s):	3 (16,32,C1 ou C2) - (0,1,2,3,4, ou C) (0 ou 1) (0 ou 2) (0,1,2 ou 3) (0,1,2,3,7 ou 8) (0,1, ou 2) (0,1, ou 2) (2 lettres ou chiffres)
Classification :	Installation catégorie II, degré de pollution II
Tension nominale :	15 à 24V c.c.
Courant nominal :	1A maximum

Conforme aux exigences de la (ou des) directive(s) suivante(s) de l'Union Européenne figurant aux sections correspondantes des normes et documents associés ci-dessous :

89/336/EEC Directive de compatibilité électromagnétique

EN 61326:	**1995**	**Appareillage électrique pour la mesure, la commande et l'usage de laboratoire –– Prescriptions relatives à la Compatilité Electro Magnétique (Classe A)**
EN 61000-3-2 :	1995	Limites d'émission de courant harmonique
EN 61000-3-3 :	1995	Limites de fluctuation de tension
EN 61000-4-2 :	1995	Décharge électrostatique
EN 61000-4-3:	1997	Insensibilité à l'énergie rayonnée
EN 61000-4-4 :	1995	Courants électriques transitoires rapides
EN 61000-4-5 :	1995	Insensibilité aux surtensions
EN 61000-4-6:	1996	Insensibilité à l'énergie par conduction
EN 61000-4-11 :	1994	Insensibilité aux chutes subites, aux courtes interruptions et aux variations de tension

Erklärt, daß das folgende Produkt: ***Deutsch***

Beschreibung:	Seri e MLS300
Modellnummer(n):	3 (16,32,C1 oder C2) - (0,1,2,3 ,4 oder C) (0 oder 1) (0 oder 2) (0,1,2 oder 3) (0,1,2,3,7 oder 8) (0,1 oder 2) (0,1 oder 2) (2 Buchstaben oder Ziffern)
Klassifikation:	Installationskategorie II, Emissionsgrad II
Nennspannung:	15 bis 24 Vdc
Nominaler Stromverbrauch:	max. 1A

Erfüllt die wichtigsten Normen der folgenden Anweisung(en) der Europäischen Union unter Verwendung des wichtigsten Abschnitts bzw. der wichtigsten Abschnitte der normalisierten Spezifikationen und der untenstehenden einschlägigen Dokumente:

89/336/EEC Elektromagnetische Übereinstimmungsanweisung

EN 61326:	**1997**	**Elektrogeräte zur Messung, Regelung und zum Laboreinsatz EMC - Richtlinien (Klasse A)**
EN 61000-3-2:	1995	Grenzen der Oberwellenstromemissionen
EN 61000-3-3:	1995	Grenzen der Spannungsschwankungen
EN 61000-4-2:	1995	Elektrostatische Entladung
EN 61000-4-3:	1997	Strahlungsimmunität
EN 61000-4-4:	1995	Elektrische schnelle Stöße
EN 61000-4-5:	1995	Spannungsstoßimmunität
EN 61000-4-6:	1994	Störimmunität
EN 61000-4-11:	1994	Immunität gegen Spannungsgefälle, kurze Unterbrechungen und Spannungsabweichungen

Declara que el producto siguiente: ***Español***

Designación:	Serie MLS300
Números de modelo:	3 (16,32,C1 ó C2) - (0,1,2,3,4 ó C) (0 ó 1) (0 ó 2) (0,1,2 ó 3) (0,1,2,3,7 ó 8) (0,1 ó 2) (0,1 ó 2) (2 letras ó numeros)
Clasificación:	Categoría de instalación II, grado de contaminación ambiental II
Tensión nominal:	15 a 24Vcc
Consumo nominal de energía:	1A máximo

Cumple con los requisitos esenciales de las siguientes Directivas de la Unión Europea, usando las secciones pertinentes de las reglas normalizadas y los documentos relacionados que se muestran:

89/336/EEC - Directiva de Compatibilidad Electromagnética

EN 61326:	**1997**	**Equipo elét rico para medición control y uso en laboratorios - Requisitos de compatibilidad electromagnética (Clase A)**
EN 61000-3-2	1995	Límites para emisiones de corriente armónica
EN 61000-3-3	1995	Limitaciones de fluctuaciones del voltaje
EN 61000-4-2:	1995	Descarga electrostática
EN 61000-4-3:	1997	Inmunidad radiada
EN 61000-4-4:	1995	Perturbaciones transitorias eléctricas rápidas
EN 61000-4-5:	1995	Sobretensión
EN 61000-4-6:	1994	Inmunidad conducida
EN 61000-4-11:	1994	Caídas de tensión, interrupciones breves y variaciones de tensión

Sean Wilkinson	Watsonville, California. USA
Name of Authorized Representative	Place of Issue
Manager	June 19, 2003
Title of Authorized Representative	Date of Issue

Signature of Authorized Representative