CLS200
User's Guide

WATLOW®

Powered by Possibility

Safety Warnings, Cautions, and Notes

WARNING! The controller may fail in a 0% or 100% power output state. To prevent death, personal injury, equipment damage or property damage, install external safety shutdown devices. If death or injury may occur, you must install approved safety shutdown devices that operate independently from the process control equipment.

WARNING! Risk of electric shock. Shut off power to your entire process before you begin installation of the controller.

WARNING! To reduce the risk of fire or electric shock, install the CLS200 in a controlled environment, relatively free of contaminants.

WARNING! To reduce the risk of electrical shock, fire, and equipment damage, follow all local and national electrical codes. Correct wire sizes, fuses and thermal breakers are essential for safe operation of this equipment.

WARNING! Use a power supply with a Class 2 rating only. UL® approval requires a Class 2 power supply.

WARNING! During autotuning, the controller will set the output to 100% until the process variable rises near the setpoint. Set the setpoint within the safe operating limits of your system.

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

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.

CAUTION! Never run input leads in bundles with high power wires or near other sources of EMI. This could inductively couple voltage onto the input leads and damage the controller or could induce noise and cause poor measurement and control.

Physically separate high-voltage circuits from low-voltage circuits and from CLS200 hardware. If possible, install high-voltage ac power circuits in a separate panel.

CAUTION! Without proper grounding, the CLS200 may not operate properly or may be damaged.

CAUTION! To prevent damage from incorrect connections, do not turn on the ac power before testing the connections.

CAUTION! The EPROM and other components are sensitive to damage from electrostatic discharge (ESD). To prevent ESD damage, use an ESD wrist strap or another antistatic device.

NOTE! For indoor use only.

Avertissements, Attentions et Remarques

AVERTISSEMENT! Le régulateur peut s'avérer défaillant avec un régime de puissance de sortie à 0 % ou à 100 %. Pour éviter tout risque de décès, blessure personnelle, endommagements de l'équipement ou dégâts matériels, veuillez installer des équipements d'arrêt d'urgence externes. Si un décès ou un accident venait à se produire, vous devez installer des équipements d'arrêt d'urgence approuvés qui fonctionnent indépendamment du matériel de contrôle du processus.

AVERTISSEMENT! Risques de choc électrique. Coupez le courant de votre processus tout entier avant de commencer à installer le régulateur.

AVERTISSEMENT! Afin de minimiser les risques d'incendie ou de choc électrique, installez le CLS200 dans un environnement sous contrôle et relativement épargné par les contaminants.

AVERTISSEMENT! Afin de minimiser les risques de choc électrique, d'incendie, et de dégâts matériels, suivez tous les codes de l'électricité locaux et nationaux. Des diamètres de fils, des fusibles et des disjoncteurs magnéto-thermiques adaptés sont indispensables pour un fonctionnement sécurisé de cet équipement.

AVERTISSEMENT! Utilisez uniquement une alimentation électrique avec une note de rang 2. Une approbation UL® impose une alimentation électrique de rang 2.

AVERTISSEMENT! Pendant le réglage automatique, le régulateur définira la sortie sur 100 % jusqu'à ce que la variable du processus s'élève près de la valeur seuil. Définissez la valeur seuil dans les limites de fonctionnement sécurisées de votre système.

AVERTISSEMENT! Ne comptez pas uniquement sur la fonction de priorité de sortie pour arrêter le processus. Installez les dispositifs de sécurité externes ou de protection contre l'excès de température pour les arrêts d'urgence.

AVERTISSEMENT! Ne comptez pas uniquement sur l'alarme d'échec du capteur pour ajuster la sortie dans l'éventualité d'une défaillance du capteur. Si la boucle est en contrôle manuel lorsqu'une alarme d'échec du capteur se déclenche, la sortie n'est pas ajustée. Installez des dispositifs externes indépendants qui éteindront le système si une défaillance se produit.

ATTENTION! Ne faites jamais fonctionner des conducteurs d'entrée en faisceau avec des câbles à haute puissance ou près d'autres sources d'EMI. Cela pourrait lier par couplage inductif la tension sur les conducteurs d'entrée et endommager le régulateur, ou créer un bruit et être à l'origine de mauvaises mesures et de régulations erronées.

Séparez physiquement les circuits haute-tension des circuits basse-tension et du matériel CLS200. Si possible, installez des circuits électriques ca haute-tension dans un panneau séparé.

ATTENTION! Sans mise à la terre appropriée, il se peut que le CLS200 ne fonctionne pas correctement ou soit endommagé.

ATTENTION! Pour éviter tout dommage causé par des connexions incorrectes, n'allumez pas l'alimentation électrique en ca avant d'avoir testé les connexions.

ATTENTION! L'EPROM et les autres composants sont sensibles aux dégâts provoqués par les décharges électrostatiques (ESD). Pour éviter de tels dommages, utilisez un bracelet antistatique ou tout autre dispositif antistatique.

REMARQUE : Destiné à un usage intérieur uniquement.

Technical Assistance

If you encounter a problem with your Watlow® controller, review your configuration information to verify that your selections are consistent with your application: inputs, outputs, alarms, limits, etc. If the problem persists, you can get technical assistance from your local Watlow representative (see back cover), by e-mailing your questions to wintechsupport@watlow.com or by dialing +1 (507) 494-5656 between 7 a.m. and 5 p.m. Central Time USA & Canada. Ask for for an Applications Engineer. Please have the complete model number available when calling.

Return Material Authorization (RMA)

1. Call Watlow Customer Service, (507) 454-5300, for a Return Material Authorization (RMA) number before returning any failed product to Watlow. If you do not know why the product failed, contact an Application Engineer. All RMA's require:
    - Ship-to address
    - Bill-to address
    - Contact name
    - Phone number
    - Method of return shipment
    - Your P.O. number
    - Detailed description of the problem
    - Any special instructions
    - Name and phone number of person returning the product
2. Prior approval and an RMA number from the customer service department is required when returning any product. Make sure the RMA number is on the outside of the carton and on all paperwork returned. Ship on a freight prepaid basis.
3. After we receive your return, we will examine it to verify the reason for the product failure. Unless otherwise agreed to in writing, Watlow's standard warranty provisions, which can be located at www.watlow.com/terms, will apply to any failed product.
4. In the event that the product is not subject to an applicable warranty, we will quote repair costs to you and request a purchase order from you prior to proceeding with the repair work.
5. Watlow reserves the right to charge for no trouble found (NTF) returns.

Contact Watlow

1241 Bundy Boulevard
Winona, Minnesota 55987 USA
Phone: +1 (507) 454-5300
Fax: +1 (507) 452-4507
http://www.watlow.com

Warranty

This product is warranted by Watlow for a period of 36 months in accordance with the terms and conditions set forth on Watlow's website, which may be accessed at www.watlow.com/terms.

Document

Document Number: 10-30466 Revision –
August 2019

Table of Contents

Chapter 1: System Overview—12

- Manual Contents 12
- Getting Started 13
  - Safety Symbols 13
  - Initial Inspection 13
- Product Features 13
- CLS200 Parts List 15
  - CLS200 16
  - TB50 17
  - CLS200 Cabling 18
  - External Safety Devices 18
  - Power-Fail Protection 18

Chapter 2: Installation—19

- Typical Installation 19
- Mounting Controller Components 20
  - Recommended Tools 20
  - Mounting the Controller 21
  - Mounting the TB50 23
  - Mounting the Power Supply 25
- System Wiring 25
  - Wiring Recommendations 26
  - Noise Suppression 26
  - Ground Loops 28
- Power Connections 29
  - Wiring the Power Supply 29
  - Connecting TB50 to CLS200 31
- Testing Your System 31
  - TB50 or TB18 Test 31
  - Digital Output Test 31
  - Digital Input Test 31
- Sensor Wiring 32
  - Input Wiring Recommendations 33
  - Thermocouple Connections 33
  - RTD Input Connections 34
  - Reference Voltage Terminals 34
  - Voltage Input Connections 34
  - Current Input Connections 35
  - Pulse Input Connections 35
- Wiring Control and Digital I/O 36
  - Output Wiring Recommendations 36
  - Cable Tie Wraps 37
  - Digital Outputs 37
  - Digital Inputs 40
  - TB18 Connections 41
  - TB50 Connections 42
- Analog Outputs 44
  - Wiring the Dual DAC 44
  - Wiring the Serial DAC 44
- Serial Communications 44
  - EIA/TIA-232 Interface 44
  - EIA/TIA-485 Interface 46
  - EIA/TIA-485 Converters and Laptop Computers 47

Chapter 3: Using CLS200—48

- Front Panel 49
  - Front Panel Keys 49
- Displays 51
  - Bar Graph Display 51
  - Single Loop Display 52
  - Alarm Displays 53
  - System Alarms 55
- Job Display 55
- Changing the Setpoint 56
- Selecting the Control Status 56
  - Manual and Automatic Control 57
  - Autotuning a Loop 57
- Using Alarms 59
  - Alarm Delay 59
  - Failed Sensor Alarms 59
  - Process Alarms 61
  - Global Alarm 63
- Ramp/Soak 63

Chapter 4: Setup—64

- How to Access the Setup Menus 64
  - How to Change a Parameter 64
- Standard Menus 66
- Setup Global Parameters Menu 67
  - Load Setup From Job 67
  - Save Setup to Job 68
  - Job Select Digital Inputs 68
  - Job Select Digital Inputs Active 69
  - Output Override Digital Input 70
  - Override Digital Input Active 70
  - Startup Alarm Delay 70
  - Keyboard Lock Status 71

Power Up Output Status 71
Process Power Digital Input 71
Controller Address 72
Communications Baud Rate 72
Communications Protocol 72
Communications Error Checking 72
AC Line Frequency 73
Digital Output Polarity on Alarm 73
EPROM Information 73
Setup Loop Input Menu 74
Input Type 75
Loop Name 76
Input Units 76
Input Reading Offset 76
Reversed T/C Detection 77
Input Pulse Sample Time 77
Linear Scaling Parameters 77
Input Filter 80
Setup Loop Control Parameters Menu 81
Heat or Cool Control PB 82
Heat or Cool Control TI 82
Heat or Cool Control TD 82
Heat or Cool Output Filter 83
Spread 83
Restore PID Digital Input 83
Setup Loop Outputs Menu 84
Enable or Disable Heat or Cool Outputs 85
Heat or Cool Output Type 85
Heat or Cool Cycle Time 86
SDAC Mode 86
SDAC Low Value 86
SDAC High Value 86
Heat or Cool Output Action 87
Heat or Cool Output Limit 87
Heat or Cool Output Limit Time 87
Sensor Fail Heat or Cool Output 88
Heat or Cool Thermocouple Break Output Average 88
Heat or Cool Linearity 88
Setup Loop Alarms Menu 89
High Process Alarm Setpoint 90
High Process Alarm Type 90
High Process Alarm Output Number 90
Deviation Alarm Value 91
High Deviation Alarm Type 91
High Deviation Alarm Output Number 91
Low Deviation Alarm Type 91
Low Deviation Alarm Output Number 92
Low Process Alarm Setpoint 92
Low Process Alarm Type 92
Low Process Alarm Output Number 92
Alarm Deadband 92
Alarm Delay 93
Manual I/O Test 93
Digital Inputs 94
Test Digital Output 94
Digital Output Number 94
Keypad Test 95
Display Test 95

Chapter 5: Enhanced Features—96
Enhanced Features Menus 97
Process Variable Retransmit 98
Process Variable Retransmit Menu 98
Process Variable Retransmit Example: Data Logging 100
Cascade Control 102
Setup Loop Cascade Menu 103
Cascade Control Example: Water Tank 105
Ratio Control 108
Setup Loop Ratio Control Menu 108
Ratio Control Example: Diluting KOH 110
Remote Analog Setpoint 112
Remote Analog Setpoint Example: Setting a Setpoint with a PLC 112
Differential Control 113
Differential Control Example: Thermoforming 113

Chapter 6: Ramp/Soak—115
Features 116
Ramp/Soak Menus 117
Setup Global Parameters Menu 118
Ramp/Soak Time Base 118
Setup Ramp/Soak Profile Menu 118
Edit Ramp/Soak Profile 118
Copy Setup From Profile 118
Tolerance Alarm Time 119
Ready Segment Setpoint 119
Ready Segment Edit Events 119
External Reset Input Number 120
Edit Segment Number 120
Segment Time 120
Segment Setpoint 121
Edit Segment Events 121
Edit Segment Triggers 122
Segment Tolerance 123
Last Segment 124
Repeat Cycles 124
Setpoints and Tolerances for Various Input Types 124
Using Ramp/Soak 125
Ramp/Soak Displays 125
Assigning a Profile to a Loop 127
Running a Profile 128
Holding a Profile or Continuing from Hold 128
Responding to a Tolerance Alarm 129
Resetting a Profile 130
In Case of a Power Failure 130

Chapter 7: Turning and Control—131

Control Algorithms 131
- On/Off Control 131
- Proportional Control 132
- Proportional and Integral Control 133
- Proportional, Integral and Derivative Control 133
- Heat and Cool Outputs 134

Control Outputs 134
- Output Control Signals 134
- Output Filter 135
- Reverse and Direct Action 135

Setting Up and Tuning PID Loops 136
- Proportional Band (PB) Settings 136
- Integral Settings 136
- Derivative Settings 137

General PID Constants by Application 138
- Proportional Band Only (P) 138
- Proportional with Integral (PI) 138
- PI with Derivative (PID) 138

Chapter 8: Troubleshooting and Reconfiguring—139

When There is a Problem 139

Troubleshooting Controllers 140
- Process and Deviation Alarms 140
- Failed Sensor Alarms 141
- System Alarms 142
- Other Behaviors 142

Corrective and Diagnostic Procedures 143
- Low Power 143
- Battery Dead 143
- Ambient Warning 144
- H/W Ambient Failure 144
- H/W Gain or Offset Failure 145
- Keys Do Not Respond 145
- Checking Analog Inputs 145
- Earth Grounding 146
- Checking Control Outputs 147
- Testing Control Output Devices 147
- Testing the TB18 and TB50 147
- Testing Control and Digital Outputs 147
- Testing Digital Inputs 148

Additional Troubleshooting for Computer Supervised Systems 148
- Computer Problems 148
- Communications 149
- Ground Loops 149
- Software Problems 149

NO-Key Reset 150

Replacing the EPROM 150

Removing or Replacing the Battery 152

Changing Communications 153

Scaling Resistors 154
- Four-Loop and Eight-Loop Input Circuit 154
- Current Inputs to Four-Loop and Eight-Loop Controllers 155
- Voltage Inputs to Four-Loop and Eight-Loop Controllers 155
- RTDs and Thermistor Inputs to Four-Loop and Eight-Loop Controllers 156
- Sixteen-Loop Input Circuit 157
- Current Inputs to Sixteen-Loop Controllers 157
- Voltage Inputs to Sixteen-Loop Controllers 158
- Scaling and Calibration 158

Chapter 9: Linear Scaling Examples—159

Example 1: A 4-to-20mA Sensor 159
- Situation 159
- Setup 159

Example 2: A 0-to-5VDC Sensor 160
- Situation 160
- Setup 160

Example 3: A Pulse Encoder 161
- Situation 161
- Setup 161

Chapter 10: Specifications—162

CLS200 System Specifications 162
- CLS200 Processor Physical Specifications 162
- TB50 Physical Specifications 164
- Inputs 166
- Outputs 168

Glossary—171

Index—180

Menu Structure—192

Declaration of Conformity—193

How to Reach Us—194

List of Figures

Chapter 1: System Overview—12

Figure 1.1 — CLS200 Rear Views 16
Figure 1.2 — CLS200 Front Panel 17
Figure 1.3 — TB50 17

Chapter 2: Installation—19

Figure 2.1 —CLS200 System Components 20
Figure 2.2 —Clearance with TB18 Option 21
Figure 2.3 —Clearance with Standard SCSI Cable 21
Figure 2.3a —Clearance with Right-Angle SCSI Cable 22
Figure 2.4 —Mounting Bracket Clearance 22
Figure 2.5 —Panel Thickness and Cutout Size 22
Figure 2.6 —Mounting the TB50 23
Figure 2.7 —TB50 Mounted on a DIN Rail (Front) 24
Figure 2.8 —TB50 Mounted on DIN Rail (Side) 24
Figure 2.9 —Mounting a TB50 with Standoffs 25
Figure 2.10 —CLS200 Series Controller with TB18 29
Figure 2.11 —CLS200 Series Controller with TB50 29
Figure 2.12 —Power Connections 30
Figure 2.13 —Thermocouple Connections 33
Figure 2.14 —RTD Connections 34
Figure 2.15 —Linear Voltage Signal Connections 35
Figure 2.16 —Linear Current Signal Connections 35
Figure 2.17 —Encoder with 5VDC TTL Signa 36
Figure 2.18 —Encoder Input with Voltage Divider 36
Figure 2.19 —Digital Output Wiring 38
Figure 2.20 —S ample Heat, Cool and Alarm Output Connections 39
Figure 2.21 —Output Connections Using External Power Supply 39
Figure 2.22 —TB50 Watchdog Timer Output 39
Figure 2.23 —TB18 Watchdog Timer Output 40
Figure 2.24 — Wiring Digital Inputs 41
Figure 2.25 —Connecting One CLS200 to a Computer Using EIA/TIA-232 45
Figure 2.26 —EIA/TIA-485 Wiring 46
Figure 2.27 —Recommended System Connections 47

Chapter 3: Using CLS200—48

Figure 3.1 —Operator Displays 48
Figure 3.2 —CLS200 Front Panel 49
Figure 3.3 —Bar Graph Display 51
Figure 3.4 —Single Loop Display 52
Figure 3.5 —Single Loop Display, Heat and Cool Outputs Enabled 53
Figure 3.6 —Single Loop Display with a Process Alarm 53

Figure 3.7 — Failed Sensor Alarm in the Single Loop Display 54
Figure 3.8 — Alarm Symbols in the Bar Graph Display 54
Figure 3.9 — Activation and Deactivation of Process Alarms 62

Chapter 4: Setup—64

Figure 4.1 — CLS200 Menu Tree 66
Figure 4.2 — Two Points Determine Process Variable Conversion 78
Figure 4.3 — Process Variable Limited by Input Reading Range 78
Figure 4.4 — Linear and Nonlinear Outputs 89
Figure 4.5 — Digital Inputs Screen 94

Chapter 5: Enhanced Features—96

Figure 5.1 — Enhanced Features Option Menus 97
Figure 5.2 — Linear Scaling of Process Variable for Retransmit 100
Figure 5.3 — Application Using Process Variable Retransmit 101
Figure 5.4 — Relationship Between the Primary Loop's Output and the Secondary Loop's Setpoint 103
Figure 5.5 — Application Using Cascade Control 105
Figure 5.6 — Secondary Loop Setpoint Related to Primary Loop Output 107
Figure 5.7 — Relationship Between the Master Loop's Process Variable and the Ratio Loop's Setpoint 108
Figure 5.8 — Application Using Ratio Control 110

Chapter 6: Ramp/Soak—115

Figure 6.1 — Sample Ramp/Soak Profile 115
Figure 6.2 — Setup Ramp/Soak Profiles Menu 117
Figure 6.3 — Positive and Negative Tolerances 123
Figure 6.4 — Ramp/Soak Screens 125

Chapter 7: Turning and Control—131

Figure 7.1 — On/Off Control 132
Figure 7.2 — Proportional Control 132
Figure 7.3 — Proportional and Integral Control 133
Figure 7.4 — Proportional, Integral and Derivative Control 133
Figure 7.5 — Time Proportioning and Distributed Zero Crossing Waveforms 134

Chapter 8: Troubleshooting and Reconfiguring—139

Figure 8.1 — Remove Board Assembly from Case 151
Figure 8.2 — Disconnect Keypad Ribbon Cable from Processor Board 151
Figure 8.3 — *Unlatch Boards from Carrier 151*
Figure 8.4 — Remove the Standoffs 151
Figure 8.5 — EPROM Location 152
Figure 8.6 — Remove EPROM 152
Figure 8.7 — Battery-Backed RAM Module on the Processor Board 153
Figure 8.8 — Jumper Configurations 153
Figure 8.9 — Differential Input Circuit in Four-Loop and Eight-Loop Controllers 154
Figure 8.10 — Single-Ended Input Circuit in Sixteen-Loop Controllers 157

Chapter 10: Specifications—162

Figure 10.1 — CLS200 Processor Module Dimensions 163
Figure 10.2 — CLS200 Clearances with Straight SCSI Cable 163
Figure 10.3 — CLS200 Clearances with Right-Angle SCSI Cable 164
Figure 10.4 — TB50 Dimensions 165
Figure 10.5 — TB50 Dimensions with Standard SCSI Cable 165
Figure 10.6 — TB50 Dimensions with Right-Angle SCSI Cable 166

List of Tables

Chapter 1: System Overview—12

Table 1.1 — Ordering Options 15

Chapter 2: Installation—19

Table 2.1 — Cable Recommendations 26
Table 2.2 — Power Connections 29
Table 2.3 — Analog Input Connections on TB1 for Four-Loop and Eight-Loop Models 32
Table 2.4 — Analog Input Connections on TB1 for Sixteen-Loop Models 32
Table 2.5 — Digital Output States and Values Stored in the Controller 37
Table 2.6 — Digital Inputs States and Values Stored in the Controller 40
Table 2.7 — TB18 Connections 41
Table 2.8 — TB50 Connections for Four-Loop and Eight-Loop Controllers 42
Table 2.9 — TB50 Connections for Sixteen-Loop Controllers 43
Table 2.10 — EIA/TIA-232 Connections 45
Table 2.11 — RTS/CTS Pins in DB-9 and DB-25 Connectors 45

Chapter 3: Using CLS200—48

Table 3.1 — Bar Graph Display Symbols 51
Table 3.2 — Control Status Symbols on the Bar Graph and Single Loop Displays 52
Table 3.3 — Alarm Type and Symbols 54

Chapter 4: Setup—64

Table 4.1 — Global Parameters 67
Table 4.2 — Job Select Inputs 69
Table 4.3 — Job Selected for Various Input States 69
Table 4.4 — Firmware Option Codes 74
Table 4.5 — Setup Loop Input 74
Table 4.6 — CLS200 Input Types and Ranges 75
Table 4.7 — Input Character Sets 76
Table 4.8 — Input Reading Offset 77
Table 4.9 — Display Formats 79
Table 4.10 — Setup Loop Control Parameters 81
Table 4.11 — Setup Loop Outputs 84
Table 4.12 — Heat / Cool Output Types 85
Table 4.13 — Setup Loop Alarms 90
Table 4.14 — Manual I/O Test 93

Chapter 5: Enhanced Features—96

Table 5.1 — Application Example: Setting Up Process Variable Retransmit 101
Table 5.2 — Application Example: Setting Up Cascade Control 106
Table 5.3 — Application Example: Setting Up Ratio Control 111

Table 5.4 — Application Example: Setting Up Remote Setpoint 112
Table 5.5 — Application Example: Setting Up Differential Control 114

Chapter 6: Ramp/Soak—115

Table 6.1 — Ramp/Soak Specifications 116
Table 6.2 — Trigger Latch Logic 123
Table 6.3 — Display Formats 124
Table 6.4 — Ramp/Soak Single Loop Display 125
Table 6.5 — Ramp/Soak Control Status Symbols 126
Table 6.6 — Ramp/Soak Profile Modes 129

Chapter 7: Turning and Control—131

Table 7.1 — Proportional Band Settings 136
Table 7.2 — Integral Term and Reset Settings 137
Table 7.3 — Derivative Term Versus Rate 137
Table 7.4 — General PID Constants 138

Chapter 8: Troubleshooting and Reconfiguring—139

Table 8.1 — Controller Alarm Codes for Process and Deviation Alarms 140
Table 8.2 — Operator Response to Alarms 141
Table 8.3 — Failed Sensor Alarm Codes 141
Table 8.4 — Hardware Error Messages 142
Table 8.5 — Other Symptoms 142
Table 8.6 — Resistor Values for Current Inputs to Four-Loop and Eight-Loop Controllers 155
Table 8.7 — Resistor Locations for Current Inputs to Four-Loop and Eight-Loop Controllers 155
Table 8.8 — Resistor Values for Voltage Inputs to Four-Loop and Eight-Loop Controllers 155
Table 8.9 — Resistor Locations for Voltage Inputs to Four-Loop and Eight-Loop Controllers 156
Table 8.10 — Resistor Values for RTD and Thermistor Inputs to Four-Loop and Eight-Loop Controllers 156
Table 8.11 — Resistor Locations for RTD and Thermistor Inputs to Four-Loop and Eight-Loop Controllers 156
Table 8.12 — Resistor Values for Current Inputs to Sixteen-Loop Controllers 157
Table 8.13 — Resistor Locations for Current Inputs to Sixteen-Loop Controllers 157
Table 8.14 — Resistor Values for Voltage Inputs to Sixteen-Loop Controllers 158
Table 8.15 — Resistor Locations for Voltage Inputs to Sixteen-Loop Controllers 158

Chapter 9: Linear Scaling Examples—159

Table 9.1 — Input Readings 159
Table 9.2 — Scaling Values 159
Table 9.3 — Input Readings and Calculations 160
Table 9.4 — Scaling Values 160
Table 9.5 — Scaling Values 161

Chapter 10: Specifications—162

Table 10.1 — Agency Approvals / Compliance 162
Table 10.2 — Environmental Specifications 162
Table 10.3 — Physical Dimensions 162
Table 10.4 — Processor with Standard SCSI Cable 163
Table 10.5 — Processor with Right Angle SCSI Cable 163
Table 10.6 — Processor Connections 164
Table 10.7 — TB50 Physical Dimensions 164
Table 10.8 — TB50 Connections 165
Table 10.9 — TB50 with Straight SCSI Cable 165
Table 10.10 — TB50 with Right Angle SCSI Cable 166
Table 10.11 — Analog Inputs 166

Table 10.12 — Pulse Inputs 167
Table 10.13 — Thermocouple Range and Resolution 167
Table 10.14 — RTD Range and Resolution 168
Table 10.15 — Input Resistance for Voltage Inputs 168
Table 10.16 — Digital Inputs 168
Table 10.17 — Digital Outputs Control / Alarm 169
Table 10.18 — CPU Watchdog Output 169
Table 10.19 — 5VDC Output (Power to Operate Solid-State Relays) 169
Table 10.20 — Reference Voltage Output (Power to Operate Bridge Circuit Sensors) 170
Table 10.21 — Serial Communication 170
Table 10.22 — Power Requirements 170

Chapter 1: System Overview

Manual Contents

This manual describes how to install, set up, and operate CLS200 controllers. Each chapter covers a different aspect of your control system and may apply to different users:

- **Chapter 1: System Overview** provides a component list and summary of features for the CLS200 series controllers.
- **Chapter 2: Installation** provides detailed instructions on installing the CLS200 series controller and its peripherals.
- **Chapter 3: Using CLS200** provides an overview of operator displays used for system monitoring and job selection.
- **Chapter 4: Setup** provides detailed descriptions of all menus and parameters for controller setup.
- **Chapter 5: Enhanced Features** describes process variable retransmit, ratio, differential and cascade control features available with the enhanced features option.
- **Chapter 6: Ramp/Soak** explains how to set up and use the features of the ramp/soak option.
- **Chapter 7: Turning and Control** describes available control algorithms and provides suggestions for applications.
- **Chapter 8: Troubleshooting and Reconfiguring** includes troubleshooting, upgrading and reconfiguring procedures for technical personnel.
- **Chapter 9: Linear Scaling Examples** provides an example configuring a pressure sensor, a flow sensor, and an encoder using linear scaling.
- **Chapter 10: 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.

Safety Symbols

These symbols are used throughout this manual:

NOTE! Marks a short message to alert you to an important detail.

CAUTION! Information that is important for protecting your equipment and performance. Be especially careful to read and follow all cautions that apply to your application.

WARNING! Safety alert appears with information that is important for protecting you, others and equipment from damage. Pay very close attention to all warnings that apply to your application.

Initial Inspection

Accessories may or may not be shipped in the same container as the CLS200, depending upon their size. Check the shipping invoice carefully against the contents received in all boxes.

Product Features

The CLS200 series controllers provide 4, 8 or 16 fully independent control loops. When used as a stand-alone controller, you may operate the CLS200 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 CLS200 can be locally or remotely controlled via an EIA/TIA-232 or EIA/TIA-485 serial communications interface.

The CLS200 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.
- **Accepts Resistive Temperature Detectors (RTDs):** Use 3-wire, 100Ω, platinum, 0.00385-curve sensors with two choices for range and precision of measurements. (To use this input, order a four-loop or eight-loop controller with scaling resistors.)
- **Automatic Scaling for Linear Analog Inputs:** The CLS200 series automatically scales linear inputs used with industrial process sensors. Enter two points, and all input values are automatically scaled in your units. Scaling resistors must be installed.
- **Dual Outputs:** The CLS200 series includes both heat and cool control outputs for each loop. 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 (digital-to-analog converter), 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 CLS200 series CPU watchdog timer output notifies you of system failure. 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. Watlow® offers SpecView, a Windows® compatible Human Machine Interface (HMI) software package that includes data logging and graphing features in addition to process monitoring.
- **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 eight 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 setpoints and alarms.
- **Nonlinear Output Curves:** Select either of two non-linear output curves for each control output.
- **Autotuning:** Use the autotune feature to set up your system quickly and easily.
- **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.

CLS200 Parts List

You may have received one or more of the following components. See *Table 1.1 – Ordering Options* for configuration information.

- CLS200 series controller
- Controller mounting kit
- TB50 with 50-pin SCSI cable
- EIA/TIA-232 or EIA/TIA-485 communications cable
- Special input resistors (installed in CLS200)

Table 1.1 — Ordering Options

CHARACTERISTIC	OPTIONS	DESCRIPTION
Number of Loops	4 Loops	The number of analog inputs and control loops that can be controlled based on the feedback from the analog inputs. There is an additional control loop that uses feedback from the pulse input.
	8 Loops	
	16 Loops	
Firmware	Standard	Includes closed-loop, PID control, auto-tune, alarms, job memory and failed sensor detection
	Ramp and Soak	Provides the features of the standard version plus the additional Ramp and Soak features
	Enhanced Features	Provides the features of the standard version plus the additional Enhanced Features
Digital I/O Termination	Screw Terminals (TB18)	TB18 Terminal Block
	Mass Termination (SCSI)	SCSI Connector
Digital I/O Termination Board Accessory	None	No external terminal board included
	TB50 Terminal Board	TB50-SCSI (50 Pin terminal board)
Digital I/O Termination Cable Accessory	None	Accessory cable to connect digital I/O signals between the SCSI connector on the controller and the TB50 board
	3-foot SCSI cable	
	6-foot SCSI cable	
	3-foot SCSI cable with right angle connector	
Serial Communication Jumper Settings	EIA/TIA-232	Application uses 232 communication or no communication
	EIA/TIA-485, not terminated	Application uses 485 communication, this controller is not last in the network
	EIA/TIA-485, terminated	Application uses 485 communication, this controller is last in the network
Serial Communication Cable	None	No communication cable
	10 foot communication cable (DB-9 female/bare wires)	Cable for 232 communication
Mounting Hardware	Plastic collar and screw clips	Standard mounting hardware
	Low profile metal L-brackets and screws	Mounting hardware for legacy applications with tight fit
Customer Specific	None	Not applicable to standard product

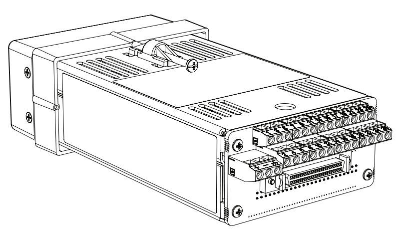
CHARACTERISTIC	OPTIONS	DESCRIPTION
Analog Input 1	Options for all units: • Standard (Thermocouples and -10 to 60mV) • Linear Current: 0-20mA DC / 4-20mA DC • Linear Voltage: 0-5VDC • Linear Voltage: 0-10VDC Additional options for 4-loop and 8-loop units: • 100 Ohm RTD Tenths Degree • 100 Ohm RTD Whole Degree	Standard units accept thermocouples on all inputs. Controllers can be equipped with resistors to scale signals for various types of sensors. These resistors must be factory installed. Sixteen loop controllers cannot accept RTD sensors.
Analog Input 2		
Analog Input 3		
Analog Input 4		
Analog Input 5		
Analog Input 6		
Analog Input 7		
Analog Input 8		
Analog Input 9		
Analog Input 10		
Analog Input 11		
Analog Input 12		
Analog Input 13		
Analog Input 14		
Analog Input 15		
Analog Input 16		

Technical Description

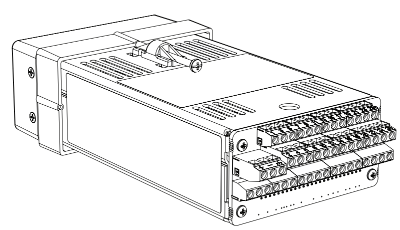
This section contains a technical description of each component of your CLS200 series controller.

CLS200

The CLS200 is housed in an 1/8-DIN panel mount package. It contains the CPU, RAM with a built-in battery, EPROM, serial communications, digital I/O, analog inputs, the screen and touch keypad.



SCSI Digital I/O Option



TB18 Digital I/O Option

Figure 1.1 *— CLS200 Rear Views*

The CLS200 has the following features:

- Keypad and 2-line, 16-character display.
- Screw terminals for the power and analog inputs and communications.
- Input power is 12 to 24VDC at 1 Amp.
- A 50-pin SCSI cable connects the digital inputs and outputs to the 50-terminal block (TB50). Four-loop and eight-loop models are available with an 18-terminal block (TB18) in place of the SCSI connector, as shown in *Figure 1.2*.

The firmware resides in an EPROM. See *Replacing the EPROM on page 150* for information on removing and replacing the EPROM.

The operating parameters are stored in battery-backed RAM. If there is 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 display and touch keypad provide an intelligent way to operate the controller. The display has 16 alphanumeric or graphic characters per line. The 8-key keypad allows you to change the operating parameters, controller functions, and displays.

The information-packed displays show process variables, setpoints, 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.

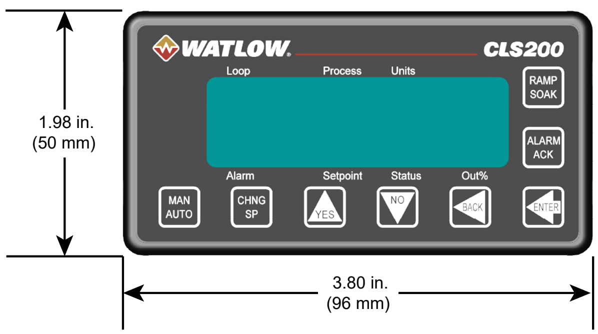


Figure 1.2 *— CLS200 Front Panel*

TB50

The TB50 is an optional screw-terminal interface for control wiring which allows you to connect relays, encoders and discrete I/O devices to the CLS200. The screw terminal blocks accept wires as large as 18 AWG (0.75 mm^2). A 50-pin SCSI cable connects the TB50 to the CLS200.

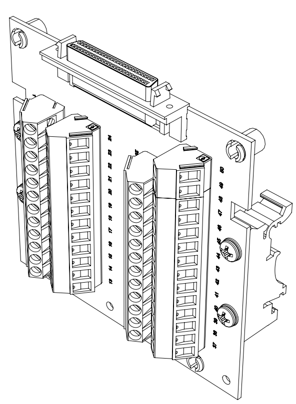


Figure 1.3 *— TB50*

CLS200 Cabling

Watlow offers optional cables to support installing your CLS200. A 50-pin SCSI cable connects the TB50 to the CLS200.

The optional cable used to connect the CLS200 to a computer using EIA/TIA-232 communications has a DB9 connector for the computer and bare wires for connecting to the CLS200.

Safety

Watlow 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.

External Safety Devices

The CLS200 controller may fail full-on (100% output power) or full-off (0% output power), or may remain full-on if an undetected sensor failure occurs. For more information about failed sensor alarms, see *Failed Sensor Alarms* on page 59.

Design your system to be safe even if the controller sends a 0% or 100% output power signal at any time. Install independent, external safety devices that will shut down the system if a failure occurs.

Typically, a shutdown device consists of an agency approved high/low process limit controller that operates a shutdown device such as a mechanical contactor. The limit controller monitors for a hazardous condition such as an undertemperature or over-temperature fault. If a hazardous condition is detected, the limit controller sends a signal to open the contactor.

The safety shutdown device (limit controller and contactor) must be independent from the process control equipment.

WARNING! The controller may fail in a 0% or 100% power output state. To prevent death, personal injury, equipment damage or property damage, install external safety shutdown devices. If death or injury may occur, you must install approved safety shutdown devices that operate independently from the process control equipment.

With proper approval and installation, thermal fuses may be used in some processes.

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 71*.)

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 if you have any questions about system safety or system operation.

Chapter 2: Installation

This chapter describes how to install the CLS200 series controller and its peripherals. Installation of the controller involves the following procedures:

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

WARNING! Risk of electric shock. Shut off power to your entire process before you begin installation of the controller.

WARNING! The controller may fail in a 0% or 100% power output state. To prevent death, personal injury, equipment damage or property damage, install external safety shutdown devices. If failure may cause death or injury, you must install approved safety shutdown devices that operate independently from the process control equipment.

Typical Installation

Figure 2.1 shows typical installations of the controller with the TB50 and the TB18 terminal blocks. The type of terminal block you use greatly impacts the layout and wiring of your installation site. (See *Figures 2.2* to *2.11*.)

We recommend that you read this entire chapter first before beginning the installation procedure. This will help you to carefully plan and assess the installation.

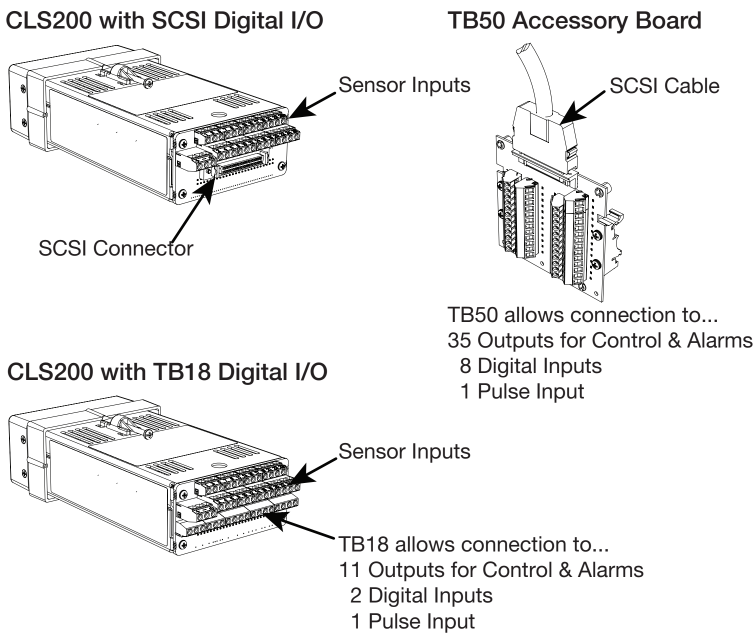


Figure 2.1 *— CLS200 System Components*

Mounting Controller Components

Install the controller in a location free from excessive heat (below 50ºC [122°F]), dust, and unauthorized handling. Electromagnetic and radio frequency interference can induce noise on sensor wiring. Select locations for the CLS200 and TB50 such that wiring can be routed clear of sources of interference such as high voltage wires, power switching devices and motors.

NOTE! For indoor use only.

WARNING! To reduce the risk of fire or electric shock, install the CLS200 in a controlled environment, relatively free of contaminants.

Recommended Tools

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.
- 1/8-DIN rectangular punch for most panel materials and thicknesses.
- Nibbler and metal file, for aluminum and lightweight panel doors.

You will also need these tools:

- Phillips head screwdriver
- 1/8 in. (3 mm) flathead screwdriver for wiring
- Multimeter

Mounting the Controller

Mount the controller 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.

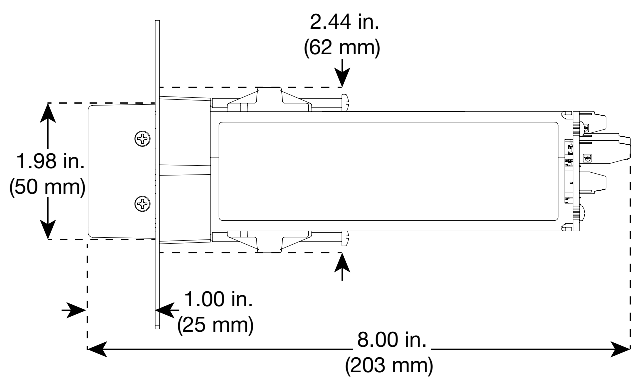


Figure 2.2*—Clearance with TB18 Option*

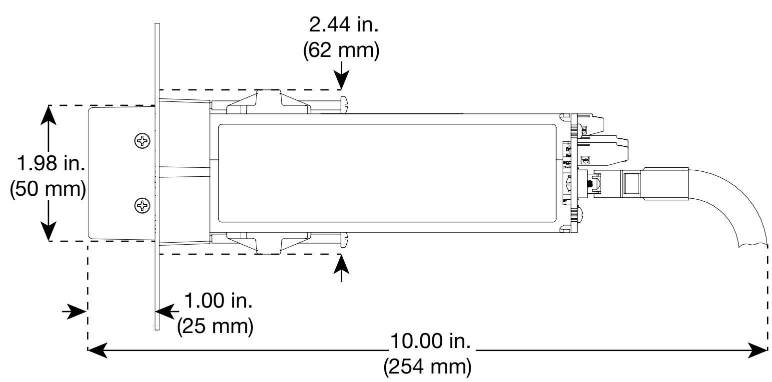


Figure 2.3*—Clearance with Standard SCSI Cable*

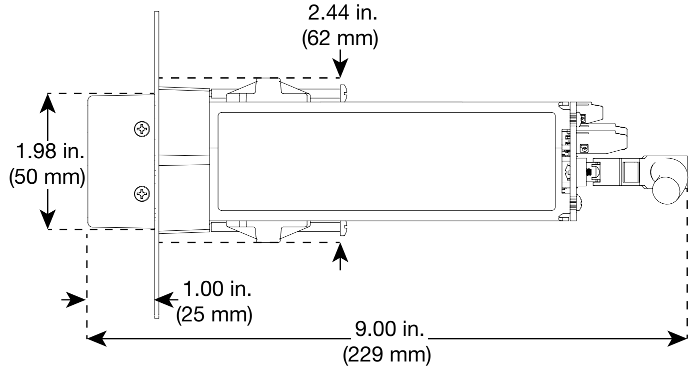


***Figure 2.3a** — Clearance with Right-Angle SCSI Cable*

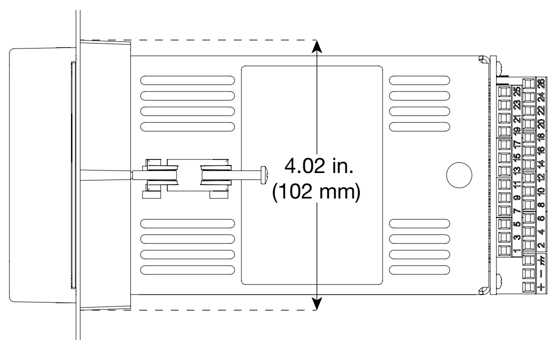


***Figure 2.4** — Mounting Bracket Clearance*

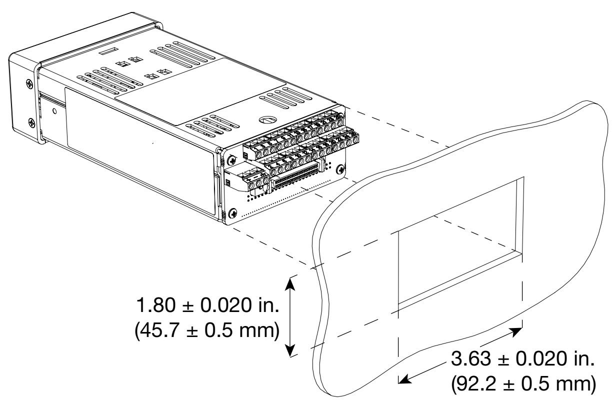


***Figure 2.5** — Panel Thickness and Cutout Size*

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 (below 50°C [122°F]), dust, and unauthorized handling. (Make sure there is adequate clearance for the mounting hardware, terminal blocks, and cables. The controller extends 7.00 in. (178 mm) behind the panel. Allow adequate room for wiring and cables beyond the connectors.)
2. Temporarily cover 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 above. (Use caution; the dimensions given here have 0.02 in. (0.5 mm) tolerances.
4. Remove the brackets and collar from the controller, if they are already in place.
5. Slide the controller into the panel cutout.
6. Slide the mounting collar over the back of the controller, making sure the mounting screw indentations face toward the back of the controller.
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 controller). Push each bracket backward then to the side to secure it to the controller's case.
8. Make sure the controller is seated properly. Tighten the installation screws firmly against the collar to secure the unit. Ensure that the end of the mounting screws fit into the indentations on the mounting collar.

Mounting the TB50

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

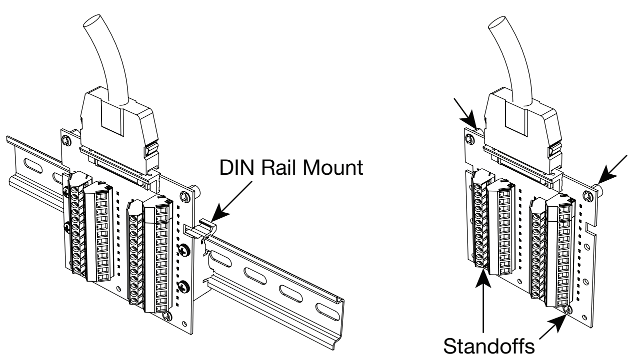


Figure 2.6 *— Mounting the TB50*

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. (See *Figure 2.7*.)

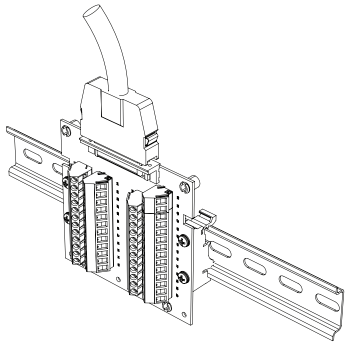


Figure 2.7 *— TB50 Mounted on a DIN Rail (Front)*

To remove the TB50 from the rail, use a flathead screwdriver to unsnap the bracket from the rail. (See *Figure 2.8*.)

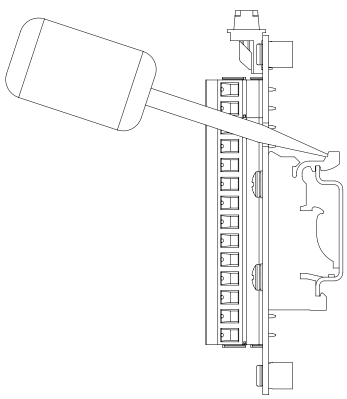


Figure 2.8 *— TB50 Mounted on DIN Rail (Side)*

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 four mounting holes for #6 (3.5 mm) screws or bolts.
5. Mount the TB50 with four screws.

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

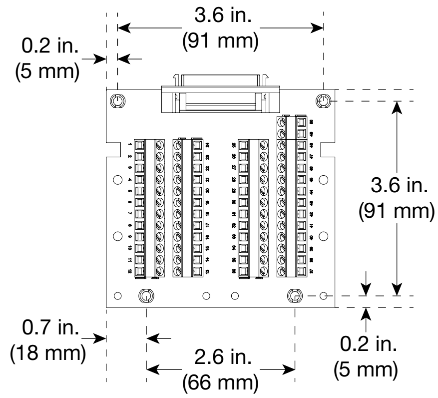


***Figure 2.9** — Mounting a TB50 with Standoffs*

Mounting the Power Supply

Refer to the power supply manufacturer's instructions for mounting information. Choose a Class 2 power supply that supplies an isolated regulated 12 to 24VDC at 1A.

Mounting Environment

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

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! To reduce the risk of electrical shock, fire, and equipment damage, follow all local and national electrical codes. Correct wire sizes, fuses and thermal breakers are essential for safe operation of this equipment.

CAUTION! Do not wire bundles of low-voltage signal and control circuits next to bundles of high voltage ac wiring. High voltage may be inductively coupled onto the low-voltage circuits, which may damage the controller or induce noise and cause poor control.

Physically separate high-voltage circuits from low-voltage circuits and from CLS200 hardware. If possible, install high-voltage ac power circuits in a separate panel.

Wiring Recommendations

Follow these guidelines for 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 (0.5 mm^2) 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 CLS200 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.

Table 2.1 — Cable Recommendations

FUNCTION	MFR. P/N	NO. OF WIRES	AWG	MM^2	MAXIMUM LENGTH
Analog Inputs	Belden 9154	2	20	0.5	
	Belden 8451	2	22	0.5	
RTD Inputs	Belden 8772	3	20	0.5	
	Belden 9770	3	22	0.5	
Thermocouple Inputs	T/C Ext. Wire	2	20	0.5	
Control Outputs and Digital I/O	Belden 9539	9	24	0.2	
	Belden 9542	20	24	0.2	
	Ribbon Cable	50	22 to 14	0.5 to 2.5	
Analog Outputs	Belden 9154	2	20	0.5	
	Belden 8451	2	22	0.5	
Computer Communication: EIA/TIA-232, 422 or 485, or 20mA	Belden 9729	4	24	0.2	4,000 ft. (1,219 m)
	Belden 9730	6	24	0.2	
	Belden 9842	4	24	0.2	4,000 ft. (1,219 m)
	Belden 9843	6	24	0.2	
	Belden 9184	4	22	0.5	6,000 ft. (1,829 m)

Noise Suppression

The CLS200'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 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 CLS200 case.

Symptoms of RFI/EMI

If your controller displays the following symptoms, suspect EMI:

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

Noise 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 for repair.

Avoiding RFI/EMI

To avoid or eliminate most RFI/EMI noise problems:

- Connect the CLS200 case to earth ground. The CLS200 system includes noise suppression circuitry. This circuitry requires proper grounding.
- Separate the 120 or 240VAC power leads from the low-level input and output leads connected to the CLS200 series controller. Do not run the digital I/O or control output leads in bundles with ac wires.
- Where possible, use solid-state relays (SSRs) instead of electromechanical relays. If you must use electromechanical relays, try to avoid mounting them in the same panel as the CLS200 series equipment.
- If you must use electromechanical relays and you must place them in a panel with CLS200 series equipment, use a 0.01 microfarad capacitor rated at 1000VAC (or higher) in series with a 47Ω, 0.5 watt resistor across the normally-open 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 130VAC for 120VAC control circuits across the load, which limits the peak ac voltage to about 180VAC. You can also place a transorb (back-to-back zener diodes) across the digital output, which limits the digital output voltage.

Additional Recommendations for a Noise Immune System

It is strongly recommended 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 this is not possible, then make sure the digital input is the only connection to earth ground other than the chassis ground.
- If you are using EIA/TIA-232 from a non-isolated host, either (1) do not connect any other power common point to earth ground, or (2) use an optical isolator in the communications line.

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:

- Power supply dc common
- TB1, terminals 5, 6, 11, 12 (analog common)
- TB1, terminal 17 (reference voltage common)
- TB1, terminals 23, 24 (communications common)
- TB2, terminal 2 (dc power common)

Special Precautions for the Sixteen-Loop Models

Sixteen-loop models have single-ended inputs. All the negative sensor leads are tied to the analog common. That means there is no sensor-to-sensor isolation. Proper grounding is critical for this unit. Take these additional precautions with a sixteen-loop controller:

- Use all ungrounded or all well-grounded thermocouples, not a mix.
- If using a mixture of thermocouples or low-voltage inputs (<500mV) and current inputs, connect the negative leads of the current transmitters to terminal 17 (Ref Com) on TB1.
- If using voltage transmitters, use only sourcing models or configuration. Sinking configurations will not work.
- Isolate the controller's communication port (if used) by using an optically isolated 232-to-485 converter.

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 to the CLS200 and connecting the TB50.

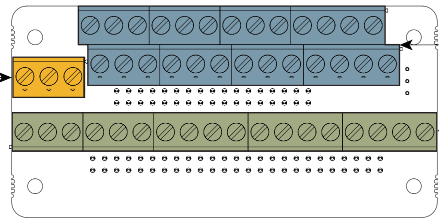


Figure 2.10 *— CLS200 Series Controller with TB18*

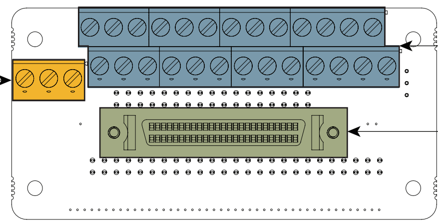


Figure 2.11 *— CLS200 Series Controller with TB50*

Wiring the Power Supply

WARNING! Use a power supply with a Class 2 rating only. UL® approval requires a Class 2 power supply.

Connect power to the controller before any other connections, This allows you to ensure that the controller is working before any time is taken installing inputs and outputs.

Table 2.2 — Power Connections

FUNCTION	POWER SUPPLY	CLS200 TB2
DC Power (Controller)	+12 to 24VDC	+
DC Common	12 to 24VDC Common	–
Earth Ground	Ground	⏚

1. Connect the dc common terminal on the power supply to the dc common (-) terminal on CLS200 TB2.
2. Connect the positive terminal on the power supply to the dc positive (+) terminal on CLS200 TB2.
3. If using an isolated dc output or another power supply to power the loads, connect the dc common of the supply powering the loads to the dc common of the supply powering the controller.

4. Use the ground connector on TB2 for chassis ground. This terminal is connected to the CLS200 chassis and must be connected to earth ground.
5. Connect 120/240VAC power to the power supply.

NOTE! Connect the dc common of the power supply used for loads to the dc common of the supply powering the controller. If the supplies are not referenced to one another, the controller's outputs will not be able to switch the loads.

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

CAUTION! Without proper grounding, the CLS200 may not operate properly or may be damaged.

CAUTION! To prevent damage from incorrect connections, do not turn on the ac power before testing the connections as explained in *Testing Your System on page 31.*

NOTE! Do not connect the controller's dc common (COM) to earth ground. Doing so will defeat the noise protection circuitry, making measurements less stable.

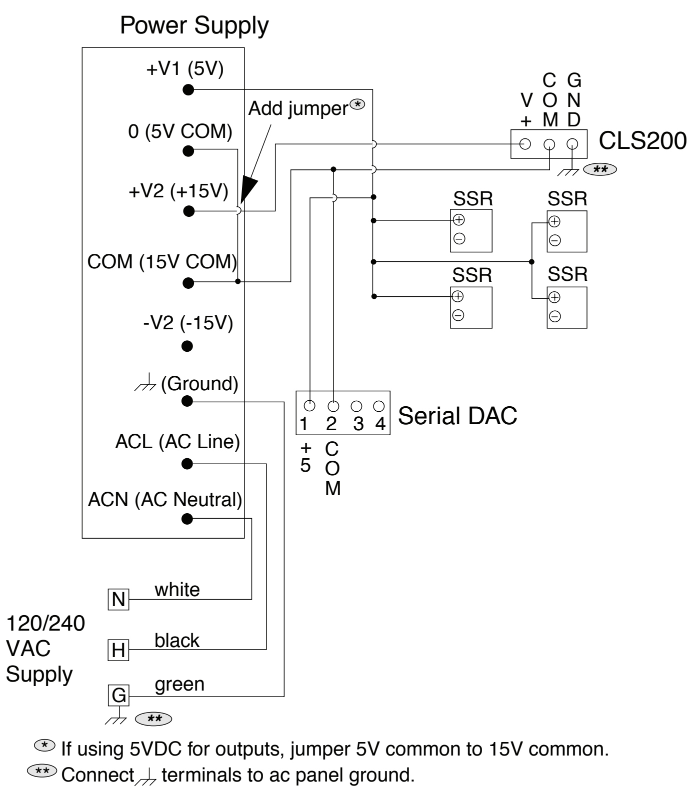


***Figure 2.12** — Power Connections*

Connecting TB50 to CLS200

1. Connect the SCSI cable to the controller.
2. Connect the SCSI cable to the TB50.

Testing Your System

This section explains how to test the controller after installation and prior to making field wiring connections.

TB50 or TB18 Test

Use this procedure to verify that the TB50 or TB18 is properly connected and supplied with power:

1. Turn on power to the CLS200. The display should read `CALCULATING CHECKSUM` then show the bar graph display. (See *Figure 3.3*.) If you do not see these displays, disconnect power and check wiring and power supply output.
2. Measure the +5VDC supply at the TB50 or TB18:
   a. Connect the voltmeter's common lead to TB50 or TB18 terminal 3 or TB18 terminal 2.
   b. Connect the voltmeter's positive lead to TB50 or TB18 screw terminal 1. The voltage should be +4.75 to +5.25VDC.

Digital Output Test

Use this procedure to test the controller's outputs before loads are connected. If using it at another time for troubleshooting, disconnect loads from outputs before testing.

1. Connect a 500Ω to 100kΩ resistor between TB50 or TB18 screw terminal 1 and a digital output terminal. (See *Table 2.7 TB18 Connections; Table 2.8 TB50 Connections for CLS204 and CLS208;* or *Table 2.9 TB50 Connections for CLS216*.)
2. Connect the voltmeter's positive lead to screw terminal 1.
3. Connect the common lead to the digital output terminal.
4. Use the digital output test in the `MANUAL I/O TEST` menu to turn the digital output on and off. (See *Test Digital Output on page 94* and *Digital Output Number on page 94*.) When the output is ON, the output voltage should be less than 1V. When the output is OFF, the output voltage should be between 4.75 and 5.25V.

NOTE! By default, heat outputs are enabled. Only disabled outputs may be turned on using the manual I/O test. To test heat outputs, set the corresponding loop to manual mode 100% output. See *Selecting the Control Status on page 56.*

Digital Input Test

Use the following procedure to test digital inputs before connecting to field devices:

1. Disconnect any system wiring from the input to be tested.
2. Go to the `DIGITAL INPUTS` test in the `MANUAL I/O TEST` menu. (See *Digital Inputs on page 94*.) This test shows whether the digital inputs are `H` (high, or open) or `L` (low, or closed).

3. Attach a wire to the terminal of the digital input you want to test. See *Table 2.7* to *Table 2.9* for connections.
    a. When the wire is connected only to the digital input terminal, the digital input test should show that the input is H (high, or open).
    b. When you connect the other end of the wire to the controller common (TB50 terminal 3 or TB18 terminal 2), the digital input test should show that the input is L (low, or closed).

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 (done by Watlow before the controller is delivered).

All inputs are connected to the terminals on TB1 on the back of the controller. The tables below list the connector locations.

CAUTION! Never run input leads in bundles with high power wires or near other sources of EMI. This could inductively couple voltage onto the input leads and damage the controller, or could induce noise and cause poor measurement and control.

Table 2.3 — Analog Input Connections on TB1 for Four-Loop and Eight-Loop Models

INPUT	+ TERMINAL	– TERMINAL
Input 1	1	2
Input 2	3	4
Input 3	7	8
Input 4	9	10
Input 5	13	14
Input 6	15	16
Input 7	19	20
Input 8	21	22

Table 2.4 — Analog Input Connections on TB1 for Sixteen-Loop Models

INPUT	+ TERMINAL	COMMON	REFERENCE COMMON*
Input 1	1	5	17
Input 2	3	5	17
Input 3	7	5	17
Input 4	9	5	17
Input 5	13	11	17
Input 6	15	11	17
Input 7	19	11	17
Input 8	21	11	17

INPUT	+ TERMINAL	COMMON	REFERENCE COMMON*
Input 9	2	6	17
Input 10	4	6	17
Input 11	8	6	17
Input 12	10	6	17
Input 13	14	12	17
Input 14	16	12	17
Input 15	20	12	17
Input 16	22	12	17

* For sixteen-loop controllers when mixing current inputs and low-voltage inputs (thermocouples or voltage inputs less than 1V), connect the current signal to the positive input and reference common (terminal TB1-17). If no low-voltage sensors are used, connect current inputs to the positive input and common terminals listed in the table above.

Input Wiring Recommendations

Use multicolored stranded shielded cable for analog inputs. Watlow recommends that you use 20 AWG wire (0.5 mm^2). If the sensor manufacturer requires it, you can also use 24 or 22 AWG wiring (0.2 mm^2). Most inputs use a shielded twisted pair; some require a 3-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, B and E thermocouples.
- Linear inputs with ranges between -10 and 60mV.

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

Thermocouple Connections

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

Use 18 or 20 AWG (0.5 or 0.75 mm^2) for all the thermocouple inputs. Most thermocouple wire is solid, unshielded wire. When using shielded wire, ground one end only.

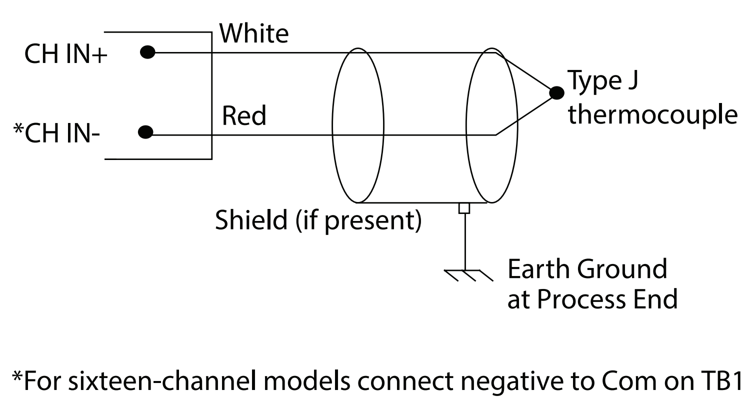


Figure 2.13 *— Thermocouple Connections*

NOTE! When mixing current inputs with low-voltage inputs (thermocouples or voltage inputs less than 1V) to a sixteen-loop controller, connect the current inputs to the IN+ and Ref Com terminals. If no low-voltage sensors are used, connect current inputs to the IN+ and Com terminals on TB1. For all inputs to a four or eight-loop controller, connect the sensors to the IN+ and IN- terminals.

CAUTION! Ground loops and common mode noise can damage the controller or disrupt measurements. To minimize ground loops and common mode noise:

- With a sixteen-loop controller, use only ungrounded thermocouples with each thermocouple sheath electrically connected to earth ground. The negative sensor terminals on sixteen-loop controllers are tied to analog common.
- With a four-loop or eight-loop controller, do not mix grounded and ungrounded thermocouples. If any thermocouple connected to the controller is of grounded construction, all thermocouples should be of grounded construction and each should be connected to ground at the process end.
- Connect the earth ground terminal on TB2 to a good earth ground, but do not connect the analog common to earth ground. The CLS200 uses a floating analog common for sensor measurements. The noise protection circuits on the sensor inputs function correctly only when the controller is correctly installed. See *Ground Loops on page 28*.

RTD Input Connections

This input type requires scaling resistors. Watlow recommends that you use a 100 W, 3-wire platinum RTD to prevent reading errors due to cable resistance. If you use a 2-wire RTD, jumper the negative input to common. If you must use a 4-wire RTD, leave the fourth wire unconnected.

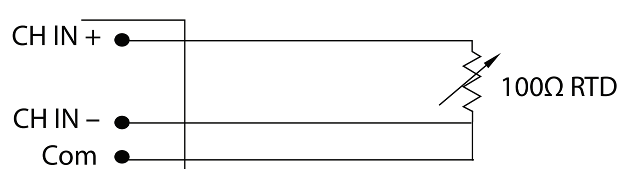


Figure 2.14 *— RTD Connections*

Reference Voltage Terminals

The +5V Ref and Ref Com terminals are provided in order to power external bridge circuits for special sensors. Do not connect any other types of devices to these terminals.

Voltage Input Connections

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

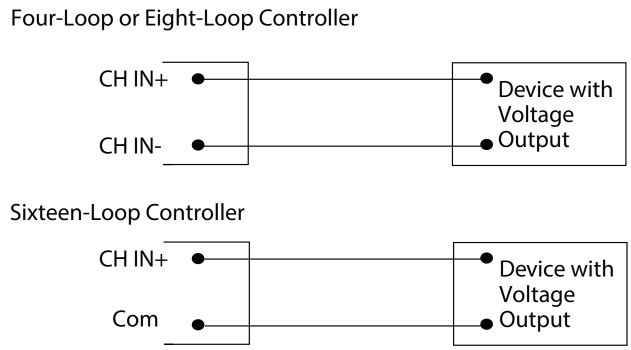


Figure 2.15 *— Linear Voltage Signal Connections*

Current Input Connections

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

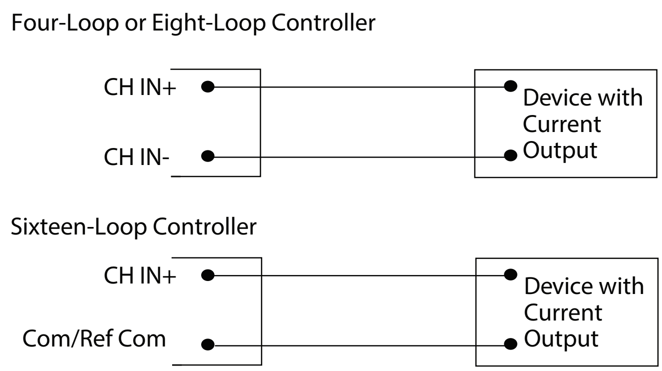


Figure 2.16 *— Linear Current Signal Connections*

> **NOTE!** When mixing current inputs with low-voltage inputs (thermocouples or voltage inputs less than 1V) to a sixteen-loop controller, connect the current inputs to the IN+ and Ref Com terminals. If no low-voltage sensors are used, connect current inputs to the IN+ and Com terminals on TB1.

Pulse Input Connections

The CLS200 can accept a pulse input of up to 2000Hz 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 74 and Example 3: A Pulse Encoder on page 161*. This scaled value is the process variable for loop 5 on a four-loop model, loop 9 on an eight-loop model or loop 17 on a sixteen-loop model.

The CLS200 can accommodate encoder signals up to 24VDC using a voltage divider or can power encoders with the 5VDC from the TB50 or TB18. The following figures illustrate connecting encoders. A pull-up resistor in the CLS200 allows open collector inputs to be used.

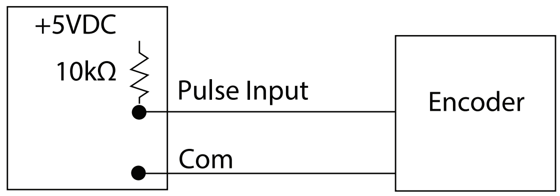


Figure 2.17 *— Encoder with 5VDC TTL Signa*

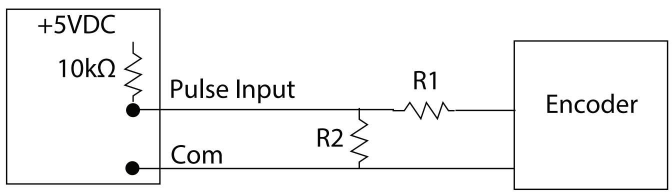


Figure 2.18 *— Encoder Input with Voltage Divider*

For encoders with signals greater than 5VDC, use a voltage divider to drop the voltage to 5 volts at the input. Use appropriate values for R1 and R2 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 CLS200 series controller.

NOTE! Control outputs are connected to the CLS200'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 CLS200 provides dual PID control outputs for each loop. These outputs can be enabled or disabled, and are connected via TB50 or TB18.

Output Wiring Recommendations

When wiring output devices, use multicolored, stranded, shielded cable for analog outputs and digital outputs connected to panel-mounted solid state relays.

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

Cable Tie Wraps

Once 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 CLS200 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 or Disable Heat or Cool Outputs on page 85*. 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 39*.

Table 2.5 – Digital Output States and Values Stored in the Controller

STATE	VALUE	DESCRIPTION
Off	High	Open circuit
On	Low	Sinking current to common

The digital outputs sink current from the load to the controller common. The load may powered by the 5VDC supplied by the controller at 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 CLS200 power supply available from Watlow includes a 5VDC supply. When using it to supply output loads, connect the 5VDC common to the 15VDC 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 in (See *Figure 2.21*), then use a solid-state relay.

All digital outputs are sink outputs referenced to the CLS200 series 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 60mA at 24VDC. They cannot "source" current to a load.

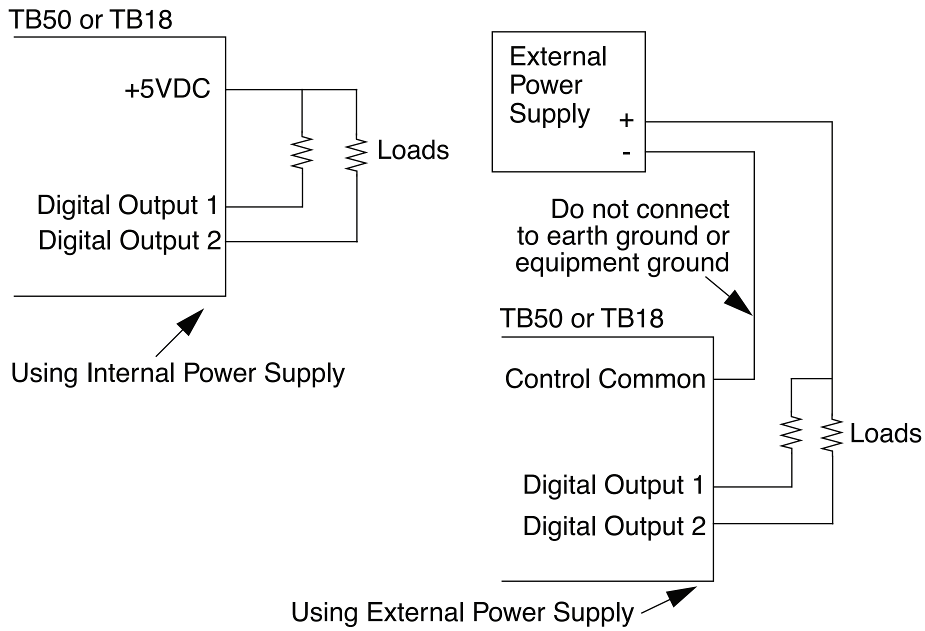


Figure 2.19 *— Digital Output Wiring*

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, time proportioning, distributed zero crossing, or Serial DAC control.
- You can individually program each control output for direct or reverse action.
- Alarm outputs other than the global alarm are nonlatching.
- Alarms can be suppressed during process start up and for preprogrammed durations. See *Alarm Delay on page 93*.
- Alarm outputs can be configured as a group as normally on (low) or normally off (high). See *Digital Output Polarity on Alarm on page 73*.

Control and Alarm Output Connections

Typically control and alarm outputs use external optically isolated solid state relays (SSRs). SSRs accept a 3 to 32VDC input for control, and some can switch up to 100 Amps at 480VAC. For larger currents, use silicon control rectifier (SCR) power controllers up to 1000 Amps at 120 to 600VAC. You can also use SCRs and a Serial DAC for phase-angle fired control.

The 34 control and alarm outputs are open collector outputs referenced to the CLS200's common. Each output sinks up to 60mA DC to the controller common when on.

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 2.20 shows sample heat, cool and alarm output connections.

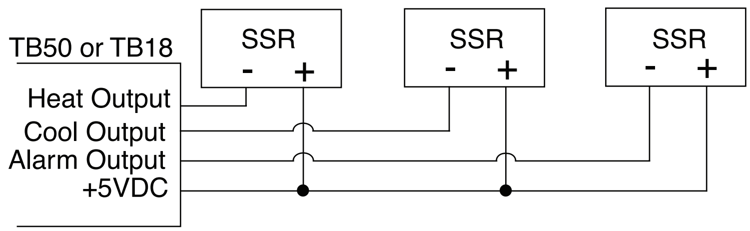


Figure 2.20 *—Sample Heat, Cool and Alarm Output Connections*

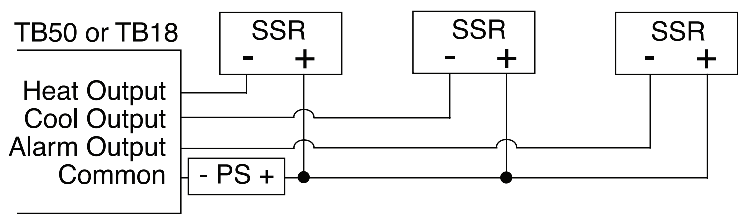


Figure 2.21 *—Output Connections Using External Power Supply*

CPU Watchdog Timer

The CPU watchdog timer constantly monitors the microprocessor. It is a sink output located on TB50 terminal 6 or TB18 terminal 3. 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 5VDC, 10mA DC) 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 2.22 and *Figure 2.23* show the recommended circuit for the watchdog timer output for the TB50 and the TB18.

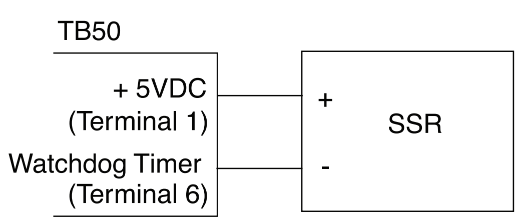


Figure 2.22 *—TB50 Watchdog Timer Output*

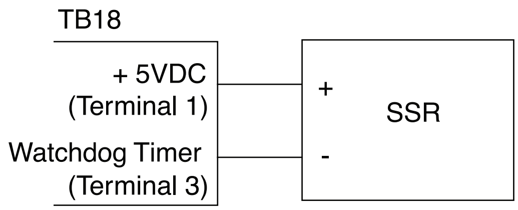


***Figure 2.23** — TB18 Watchdog Timer Output*

Digital Inputs

All digital inputs are transistor-transistor logic (TTL) level inputs referenced to control common and the internal +5V power supply of the CLS200.

When an input is connected to the controller common, the input is considered on. Otherwise, the input is considered off. Most features that use the digital inputs can be user-configured to activate when an input is either on or off.

In the off state, internal 10k resistors pull the digital inputs high to 5VDC with respect to the controller common.

Table 2.6 — Digital Inputs States and Values Stored in the Controller

STATE	VALUE	DESCRIPTION
Off	High	Open circuit
On	Low	DIgital input connected to controller common

External Switching Devices

To ensure that 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 swiching device must provide an impedance of at least 11kΩ to ensure that the voltage will rise to greater than 3.7VDC. When on, the switch must provide not more than 1kΩ impedance to ensure the voltage drops below 1.3VDC.

To install a switch as a digital input, connect one lead to the common terminal on the TB50 (terminals 3 and 4) or TB18 (terminal 2). Connect the other lead to the desired digital input terminal on the TB50 (terminals 43 to 50) or TB18 (terminals 16 to 18).

Functions Activated by Digital Inputs

Use digital inputs to activate the following functions:

- Load a job that is stored in controller memory. See *Job Select Digital Inputs on page 68*.
- Change all loops to manual mode at specified output levels. See *Output Override Digital Input on page 70*.
- Enable thermocouple short detection. See *Process Power Digital Input on page 71*.
- Restore control automatically after a failed sensor has been repaired. See *Restore PID Digital Input on page 83*.

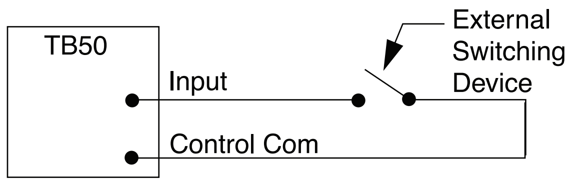


Figure 2.24 — Wiring Digital Inputs

TB18 Connections

Table 2.7 — TB18 Connections

TERMINAL	FUNCTION	CONTROL OUTPUT[1]	
		FOUR-LOOP CONTROLLER	EIGHT-LOOP CONTROLLER
1	+5VDC		
2	CTRL COM		
3	Watchdog timer		
4	Global alarm		
5	Output 1	Loop 1 heat	Loop 1 heat
6	Output 2	Loop 2 heat	Loop 2 heat
7	Output 3	Loop 3 heat	Loop 3 heat
8	Output 4	Loop 4 heat	Loop 4 heat
9	Output 5	Pulse loop heat	Loop 5 heat
10	Output 6	Loop 1 cool	Loop 6 heat
11	Output 7	Loop 2 cool	Loop 7 heat
12	Output 8	Loop 3 cool	Loop 8 heat
13	Output 9	Loop 4 cool	Pulse loop heat
14	Output 10	Pulse loop cool	Loop 1 cool
15	Output 34[2]	Serial DAC clock	Serial DAC clock
16	Input 1		
17	Input 2		
18	Input 3/Pulse input		

[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 for alarms or ramp/soak events.

[2] For Watlow Serial DAC, the CLS200 series controller uses digital output 34 for a clock line. You cannot use output 34 for anything else when you have a control output configured for the SDAC.

TB50 Connections

Table 2.8 – TB50 Connections for Four-Loop and Eight-Loop Controllers

TERMINAL	FUNCTION	CONTROL OUTPUT[1]		TERMINAL	FUNCTION	CONTROL OUTPUT[1]	
		8-LOOP	4-LOOP			8-LOOP	4-LOOP
1	+5VDC			2	+5VDC		
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		
13	Output 3	Loop 3 heat	Loop 3 heat	14	Output 32		
15	Output 4	Loop 4 heat	Loop 4 heat	16	Output 31		
17	Output 5	Loop 5 heat	Pulse loop heat	18	Output 30		
19	Output 6	Loop 6 heat	Loop 1 cool	20	Output 29		
21	Output 7	Loop 7 heat	Loop 2 cool	22	Output 28		
23	Output 8	Loop 8 heat	Loop 3 cool	24	Output 27		
25	Output 9	Pulse loop heat	Loop 4 cool	26	Output 26		
27	Output 10	Loop 1 cool	Pulse loop cool	28	Output 25		
29	Output 11	Loop 2 cool		30	Output 24		
31	Output 12	Loop 3 cool		32	Output 23		
33	Output 13	Loop 4 cool		34	Output 22		
35	Output 14	Loop 5 cool		36	Output 21		
37	Output 15	Loop 6 cool		38	Output 20		
39	Output 16	Loop 7 cool		40	Output 19		
41	Output 17	Loop 8 cool		42	Output 18	Pulse loop cool	
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 for alarms or ramp/soak events.

[2] For Watlow Serial DAC, the controller uses digital output 34 (terminal 10) for a clock line. You cannot use output 34 for anything else when you have a control output configured for the SDAC.

Table 2.9 – TB50 Connections for Sixteen-Loop Controllers

TERMINAL	FUNCTION	CONTROL OUTPUT[1]	TERMINAL	FUNCTION	CONTROL OUTPUT[1]
1	+5VDC		2	+5VDC	
3	CTRL COM		4	CTRL COM	
5	Not Used		6	Watchdog Timer	
7	Pulse Input		8	Global Alarm	
9	Output 1	Loop 1 heat	10	Output 34[2]	Pulse loop cool
11	Output 2	Loop 2 heat	12	Output 33	Loop 16 cool
13	Output 3	Loop 3 heat	14	Output 32	Loop 15 cool
15	Output 4	Loop 4 heat	16	Output 31	Loop 14 cool
17	Output 5	Loop 5 heat	18	Output 30	Loop 13 cool
19	Output 6	Loop 6 heat	20	Output 29	Loop 12 cool
21	Output 7	Loop 7 heat	22	Output 28	Loop 11 cool
23	Output 8	Loop 8 heat	24	Output 27	Loop 10 cool
25	Output 9	Loop 9 heat	26	Output 26	Loop 9 cool
27	Output 10	Loop 10 heat	28	Output 25	Loop 8 cool
29	Output 11	Loop 11 heat	30	Output 24	Loop 7 cool
31	Output 12	Loop 12 heat	32	Output 23	Loop 6 cool
33	Output 13	loop 13 heat	34	Output 22	Loop 5 cool
35	Output 14	Loop 14 heat	36	Output 21	Loop 4 cool
37	Output 15	Loop 15 heat	38	Output 20	Loop 3 cool
39	Output 16	Loop 16 heat	40	Output 19	Loop 2 cool
41	Output 17	Pulse loop heat	42	Output 18	Loop 1 cool
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 for alarms or ramp/soak events.

[2] For Watlow Serial DAC, the controller uses digital output 34 (terminal 10) for a clock line. You cannot use output 34 for anything else when you have a control output configured or the SDAC.

Analog Outputs

Analog outputs can be provided by using a Dual DAC or Serial DAC 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 the Dual DAC and Serial DAC modules.

Wiring the Dual DAC

A Dual DAC module includes two identical circuits. Each can convert a distributed zero-cross (DZC) signal from the controller to a voltage or current signal. Watlow strongly recommends using a power supply separate from the controller supply to power the Dual 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 Dual DAC.

Several Dual DAC modules may be powered by one power supply. Consult the Dual DAC's manual for power requirements. Also note that the Dual DAC does not carry the same industry approvals as the Serial DAC.

Wiring the Serial DAC

The Serial DAC provides a robust analog output signal. The module converts the proprietary Serial DAC signal from the controller's open collector output in conjunction with the clock signal to an analog current or voltage. The Serial DAC is user-configurable for voltage or current output.

The Serial DAC optically isolates the controller's control output from the load. When a single Serial DAC is used, it may be powered by the 5VDC found on the TB50, or by an external supply referenced to the controller's power supply. When using multiple Serial DACs, the controller cannot provide sufficient current; use the 5VDC output from the CLS200 power supply.

Serial Communications

The CLS200 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 153*.

EIA/TIA-232 Interface

EIA/TIA-232 provides communication to the serial port of a compatible computer. It is used for single controller installations where the cable length does not exceed 50 feet (15.2 m).

The EIA/TIA-232 interface is a standard three-wire interface. See the table below for connection information.

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.

Table 2.10 shows EIA/TIA-232 connections for 25-pin and 9-pin connectors.

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 CLS200 controllers.

Table 2.10 — EIA/TIA-232 Connections

WIRE COLOR	CLS200 TB1	DB 9 CONNECTOR	DB 25 CONNECTOR
White	TX Pin 26	RX Pin 2	RX Pin 3
Red	RX Pin 25	TX Pin 3	TX Pin 2
Black	GND Pin 23	GND Pin 5	GND Pin 7
Green	GND Pin 24	N/U Pin 9	N/U Pin 22
Shield	N/C	GND Pin 5	GND Pin 7

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 CLS200 is not configured to receive or transmit these signals. To use such software with the CLS200, jumper the RTS to the CTS and the DTR to the DSR in the DB connector. Table 2.11 lists the standard pin assignments for DB-9 and DB-25 connectors.

Table 2.11 — 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 for EIA/TIA-232 communications include these jumpers.

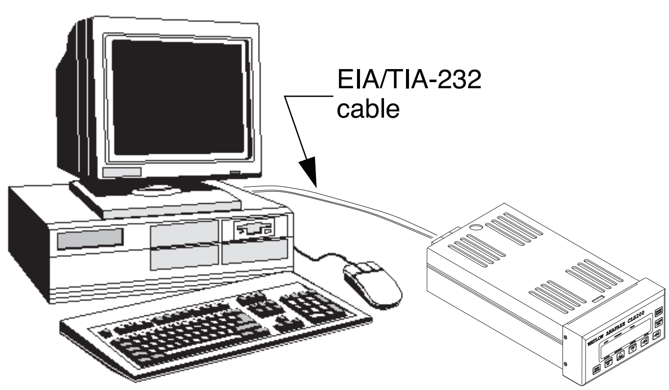


Figure 2.25 *— Connecting One CLS200 to a Computer Using EIA/TIA-232*

EIA/TIA-485 Interface

To communicate with more than one CLS200 series controller on a controller network, or to use communication cable lengths greater than 50 feet (15.2 m) 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 2.26 and *Figure 2.27* show the recommended system wiring. To avoid ground loops, use an optically isolated EIA/TIA-232 to EIA/TIA-485 converter between the computer and the EIA/TIA-485 network.

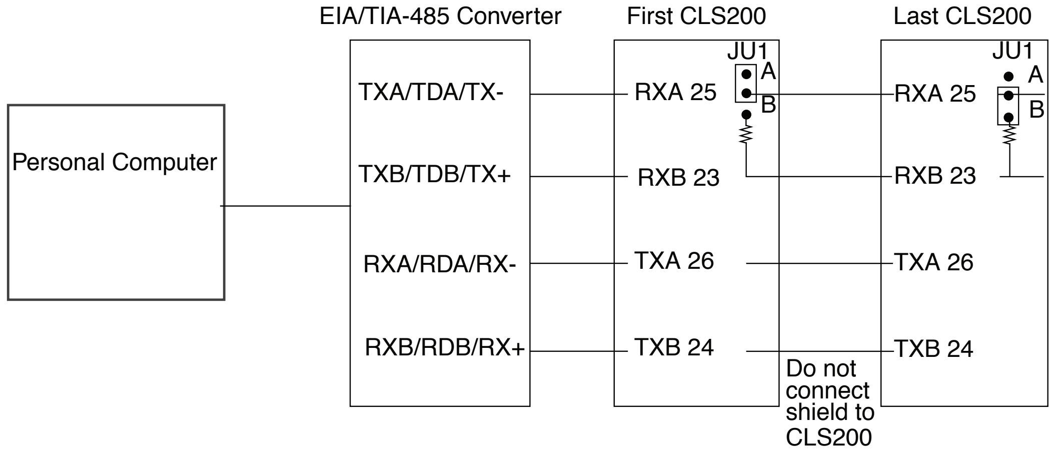


***Figure 2.26** — EIA/TIA-485 Wiring*

Cable Recommendations

Watlow recommends Belden 9843 cable or its equivalent. This cable includes three 24 AWG (0.2 mm^2) shielded, twisted pairs. It should carry signals of up to 19.2k baud with no more than acceptable losses for up to 4,000 feet (1,220 m).

EIA/TIA-485 Network Connections

Watlow recommends that you use a single daisy chain configuration rather than spurs. Run a twisted-pair cable from the host or the converter to the first CLS200, and from that point run a second cable to the next CLS200, and so on. (See *Figure 2.27*.)

If necessary for servicing, instead of connecting each controller directly into the next, install a terminal strip or connector as close as possible to each CLS200, run a communications cable from one terminal strip to the next and connect the controllers to the bus with short lengths of cable.

To avoid unacceptable interference, use less than 10 feet (3 m) of cable from the terminal or connector to the CLS200 serial port.

Some systems may experience problems with sensor signal reading if the commons of multiple controllers are connected. See *Signal Common on page 47*.

Refer to *Termination on page 47* for more on terminating resistors.

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

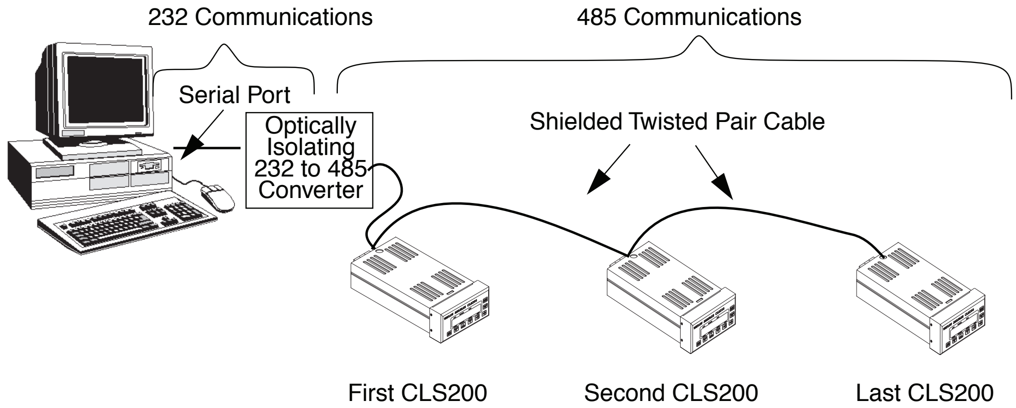


Figure 2.27 *— Recommended System Connections*

Signal Common

For usual installations, do not connect the dc commons of the controllers together or to the converter or host device. Use an optically isolating EIA/TIA-232-to-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 200Ω.

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 JU1 inside the CLS200 in position B to connect a 200Ω resistor across the receive lines. Refer to *Changing Communications on page 153*.

EIA/TIA-485 Converters and Laptop Computers

In order for an EIA/TIA-232-to-485 converter to optically isolate the computer from the 485 network, the 232 and 485 sides must be powered independently. Many 232-to-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.

Chapter 3: Using CLS200

This chapter explains how to use the keypad and display to operate the controller. *Figure 3.1* shows the operator menus and displays accessible from the front panel. To change global parameters, loop inputs, control parameters, outputs, and alarms using the setup menus, see *Chapter 4: Setup*.

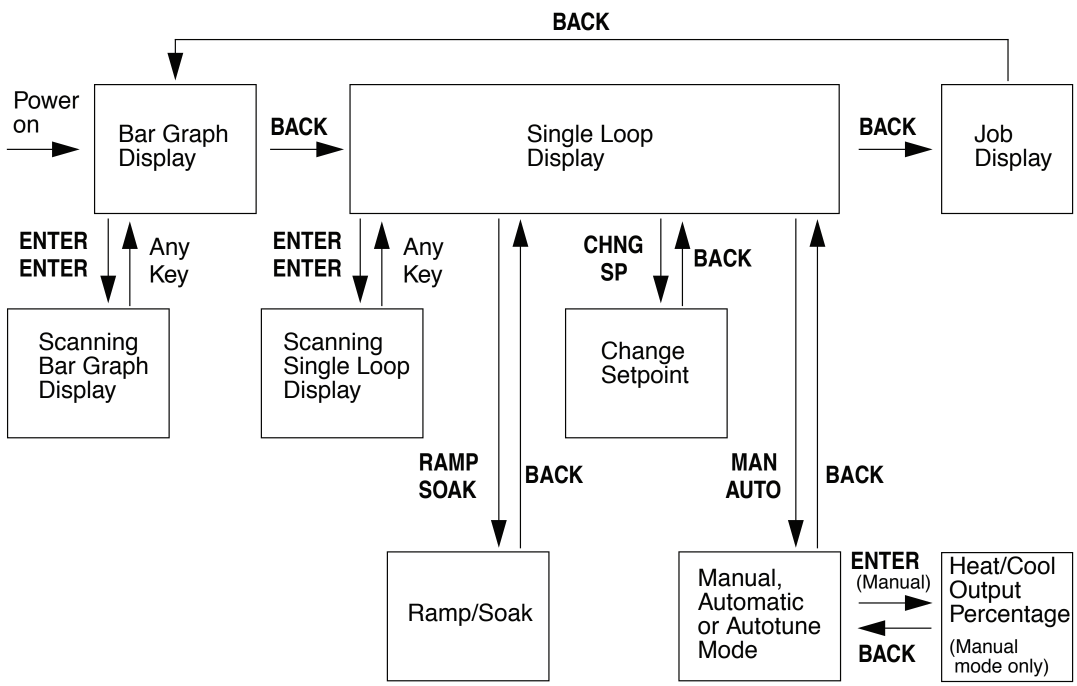


Figure 3.1 *— Operator Displays*

Front Panel

The CLS200 front panel provides a convenient interface with the controller. You can use the front panel keys to program and operate the CLS200.

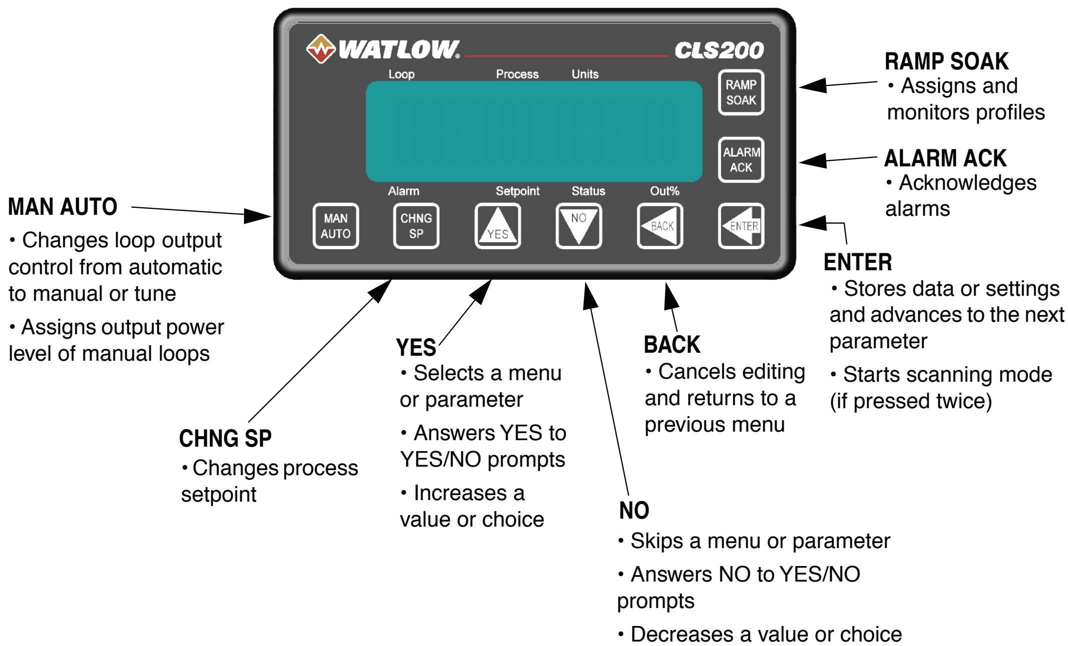


Figure 3.2 *— CLS200 Front Panel*

Front Panel Keys

YES (up)

Press **YES** to:

- Select a menu or parameter
- Answer **YES** to the flashing **?** prompts
- Increase a value or choice when editing
- Stop scanning mode

NO (down)

Press **NO** to:

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

NOTE! Pressing the NO key on power up performs a NO-key reset. This procedure clears the RAM and sets the controller’s parameters to their default values. See *NO-Key Reset on page 150*.

BACK

Press **BACK** to:

- Cancel editing
- Return to a previous menu
- Switch between bar graph, single loop and job displays
- Stop scanning mode

ENTER

Press **ENTER** to:

- Store data or a parameter choice after editing and go to the next parameter
- Start scanning mode (if pressed twice)

CHNG SP

Press **CHNG SP** to change the loop setpoint

MAN AUTO

Press **MAN/AUTO** to:

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

RAMP SOAK

If your controller has the ramp/soak option, press **RAMP/SOAK** 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 option. If it does not, pressing the **RAMP/SOAK** key displays the message `OPTION UNAVAILABLE`.

ALARM ACK

Press **ALARM ACK** to:

- Acknowledge an alarm condition
- Reset the global alarm output

Displays

This section discusses the controller's main displays: bar graph, single loop and job.

Bar Graph Display

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

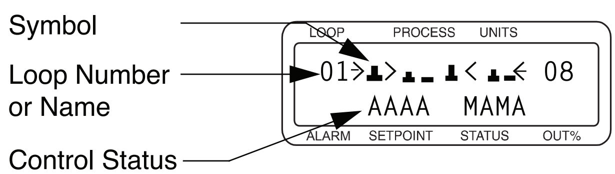


Figure 3.3 *— Bar Graph Display*

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	DESCRIPTION
<	Loop is in low process or low deviation alarm.
>	Loop is in high process or high deviation alarm.
┻	Loop is above setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you do not enable these alarms, these symbols are scaled to the setpoint ±5% of the sensor's range.
▬	Loop is at setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you do not enable these alarms, these symbols are scaled to the setpoint ±5% of the sensor's range.
┳	Loop is below setpoint. If you enable the high or low deviation alarm, this symbol is scaled to it. If you do not enable these alarms, these symbols are scaled to the setpoint ±5% of the sensor's range.
(blank)	Loop's input type is set to `SKIP`.
F	Open thermocouple (T/C), shorted T/C, reversed T/C, open RTD or shorted RTD.

Table 3.2 explains the control status symbols on the bottom line of bar graph display. Additional symbols may appear with the ramp/soak option. (See *Bar Graph Display on page 126.)*

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

BAR GRAPH DISPLAY SYMBOL	SINGLE LOOP DISPLAY SYMBOL	DESCRIPTION
M	MAN	One or both outputs are enabled. Loop is in manual control.
A	AUTO	Only one output (heat or cool) is enabled. Loop is in automatic control.
T	TUNE	The loop is in autotune 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 of loops. 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

The single loop display shows detailed information for one loop at a time.

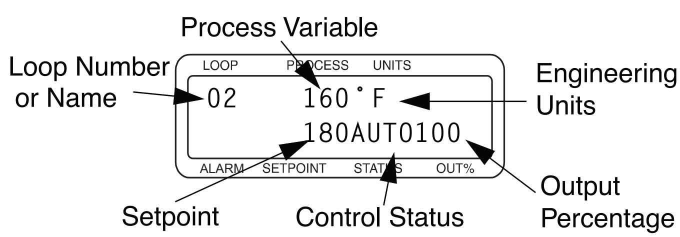


***Figure 3.4** — Single Loop Display*

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

If both control outputs for a loop are enabled and the loop is in automatic control, then the single loop display shows HEAT or COOL as the control status:

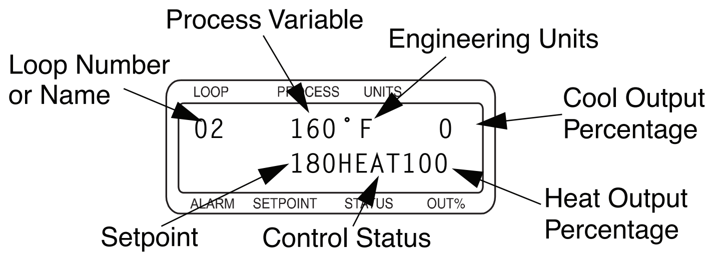


***Figure 3.5** — Single Loop Display, Heat and Cool Outputs Enabled*

Navigating the Single Loop Display

In the single loop display:

- Press **YES** to go to the next loop.
- Press **NO** to go to the previous loop.
- Press **BACK** 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.

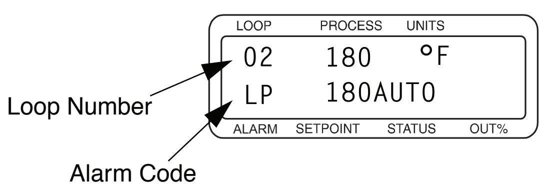


***Figure 3.6** — Single Loop Display with a Process Alarm*

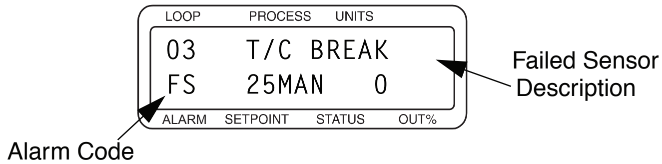


Figure 3.7 *— Failed Sensor Alarm in the Single Loop Display*

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

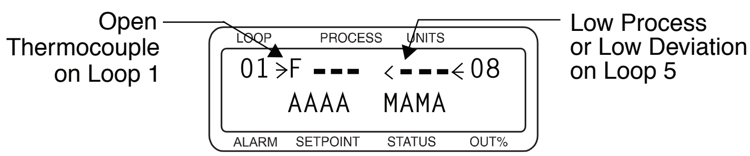


Figure 3.8 *— Alarm Symbols in the Bar Graph Display*

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	DESCRIPTION
FS	F	T/C BREAK	**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 high alarm set point.
HD	>	No message	**High Deviation Alarm:** Process variable has risen above the setpoint plus the deviation alarm value.
LP	<	No message	**Low Process Alarm:** Process variable has dropped below the low alarm set point.
LD	<	No message	**Low Deviation Alarm:** Process variable has dropped below the setpoint minus the deviation alarm value.
AM	*	No message	**Ambient Warning:** Controller's ambient temperature has exceeded operating limits by 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 CLS200 can display the following system alarms:

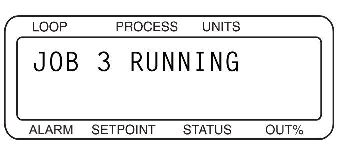
- `BATTERY DEAD`
  See *Battery Dead on page 143*.
- `LOW POWER`
  See *Low Power on page 143*.
- `AW`
  See *Ambient Warning on page 144*.
- `H/W FAILURE: AMBIENT`
  See *H/W Ambient Failure on page 144*.
- `H/W FAILURE: GAIN`
  See *H/W Gain or Offset Failure on page 145*.
- `H/W FAILURE: OFFSET`
  See *H/W Gain or Offset Failure on page 145*.

Job Display

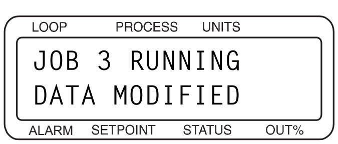
The job display appears only if:

- You have enabled JOB SELECT DIG INPUTS. (See *Job Select Digital Inputs on page 68.*)
  – or –
- You have selected a job from the job load menu.

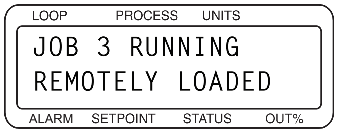
After loading a job using the LOAD SETUP FROM JOB menu, the job display shows you the following screen:



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

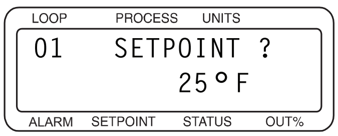


If the job was loaded using digital inputs, the display shows:



Changing the Setpoint

Select the single loop display for the loop you want to change. Press **CHNG SP**. This display appears:



- Press **YES** to change the setpoint.
- Press the up or down keys (**YES** or **NO**) to increase or decrease the setpoint 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 setpoint.

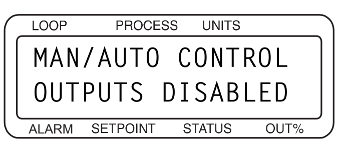
Selecting the Control Status

If you set the control status to `AUTO`, the controller automatically controls the process according to the configuration information you give it.

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

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

NOTE! If the loop outputs are disabled, you cannot toggle between manual and automatic control. If you try it, the screen shows an error message telling you that the outputs are disabled, as shown below. Use the `SETUP LOOPS OUTPUT` menu to enable the outputs. See *Setup Loop Outputs Menu on page 84*.

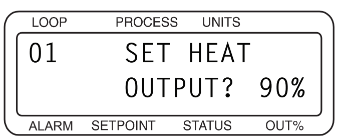


Manual and Automatic Control

1. Switch to the single loop display for the loop.
2. Press `MAN/AUTO`.
3. Press **YES** to change the mode
   – or –
   if the mode is `MAN`, press **NO** to set the output power. Go to the next subsection, *Manual Output Levels*.
   – or –
   press **NO** if in `AUTO` to cancel and remain in `AUTO` mode.
4. Select a mode by pressing the up or down key (**YES** or **NO**) 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 the output power. Go to *Manual Output Levels* below.

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 menu to set the manual heat and cool output levels. You should see a display like this:



1. Press **YES** to change the output power level. (If the heat output is enabled, you will be able to change the heat output power level. If only the cool output is 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. Press up or down (**YES** or **NO**) to select a new output power level.
3. Press **ENTER** to store your changes
   – or –
   press **BACK** to discard your changes and return to single loop display.
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 how to autotune the CLS200.

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 (setpoint) must be known.

The technician or engineer performing the autotune should know how to use the controller front panel or MMI software interface to do the following:

1. Select a loop to operate and monitor.
2. Set a loop's setpoint.
3. Change a loop's control status (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 setpoint 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 integral term (TI). The controller then looks for the slope of the rising temperature to become constant in order to determine the proportional band (PB). The derivative term (TD) is derived mathematically from the TI.

When the controller has finished autotuning, the loop's control status switches to AUTO. If the process reaches 75% of the setpoint or the autotuning time exceeds 30 minutes, the controller switches to AUTO and applies the PID constants it has calculated up to that point.

The 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

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

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

WARNING! During autotuning, the controller will set the output to 100% until the process variable rises near the setpoint. Set the setpoint within the safe operating limits of your system.

4. Use the three-key sequence (**ENTER**, **ALARM ACK**, **CHNG SP**) to access the setup menus. In the SETUP LOOP INPUT menu, locate the INPUT FILTER parameter. 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 **YES** key to toggle to the **TUNE** mode.
8. Press the **ENTER** key to begin tuning the loop. **TUNE** flashes throughout the tuning process. When tuning is completed the control status indicator changes to **AUTO**.
9. Adjust the setpoint to the desired temperature.
10. Restore the INPUT FILTER parameter to its original value.

Using Alarms

The CLS200 has three main types of alarms:

- Failed sensor alarms
- Process alarms
- System alarms

Alarm Delay

You can set the controller to delay normal alarm detection and alarm reporting. There are two kinds of alarm delay:

- Start-up alarm delay delays process alarms (including deviation alarms but not failed sensor alarms) for all loops for a time period you set at the STARTUP ALARM DELAY parameter in the SETUP GLOBAL PARAMETERS menu.
- Loop alarm delay delays failed sensor alarms and process alarms (including deviation alarms) for one loop until the alarm condition is continuously present for longer than the loop alarm delay time you set.

Failed sensor alarms are affected by the loop alarm delay even during the start-up alarm delay time period.

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 set with 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 60*.)
- The controller displays an alarm code and alarm message on the display. See *Alarm Displays on page 53*.
- 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 set with 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.

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 thermocouple 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 CLS200 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

Setting Up Alarms

To set up an alarm:

- Set the alarm setpoint
- Set the alarm type
- Choose an output, if desired
- Set the alarm deadband
- Set an alarm delay, if desired

The setpoints, deviation alarm values, and deadband all use the same decimal format as the loop's process variable.

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 53*.)
- Activates the global alarm output. (See *Global Alarm on page 63*.)
- 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 setpoint. 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 setpoints at the `HI PROC ALARM SETPT` and `LO PROC ALARM SETPT` parameters in the `SETUP LOOP ALARMS` menu.

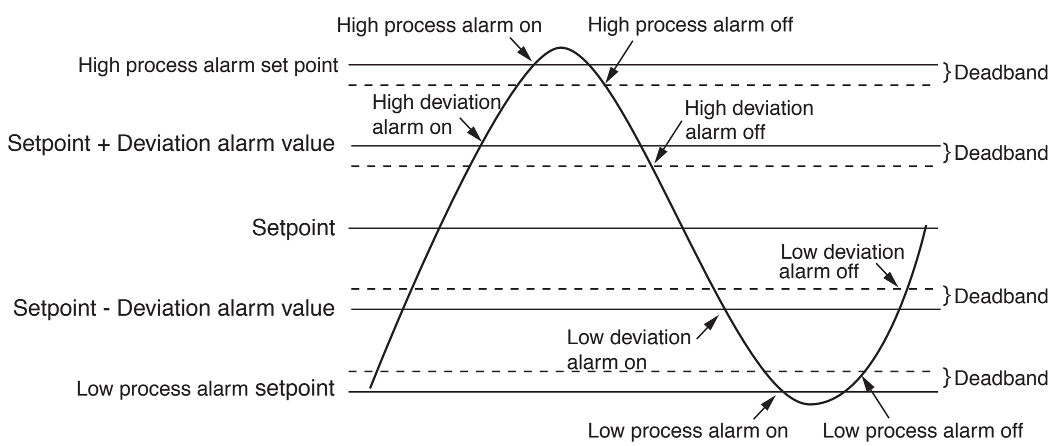


Figure 3.9 *—Activation and Deactivation of Process Alarms*

Deviation Alarms

A deviation alarm occurs if the process deviates from setpoint 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 setpoint 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 setpoint 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 setpoint changes.

Global Alarm

The CLS200 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 type 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, see *Chapter 6: Ramp/Soak on page 115*.

Chapter 4: Setup

The setup menus let you change detailed configuration information. This section describes how to set up the controller using the built-in keypad and display. 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 CLS200 series controller before, or if you do not know what values to enter, please read *Chapter 7: Tuning and Control*, which contains PID tuning constants and useful starting values.

How to Access the Setup Menus

Use the ***three-key sequence*** to enter 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 the single loop display if you do not 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 is `SETUP GLOBAL PARAMETERS`. Refer to *Figure 4.1* for a listing of all top level menus and their related parameters.

1. Select the single loop display for the loop to set up.
2. Enter the three-key sequence. The first menu is displayed: `SETUP GLOBAL PARAMETERS`.

3. To select the appropriate menu:
    a. Press **NO** to move from one menu to the next. The menus wrap around; pressing **NO** continuously advances through the top level menus.
    b. Press **YES** to enter the displayed menu.
4. To select the parameter to be edited:
    a. Press **NO** to advance from one parameter to the next. Parameters do not wrap around.
    b. Press **YES** to edit the displayed parameter.
5. To edit the parameter setting:
    a. Press up or down (**YES** or **NO**) to scroll to the value or choice you want to select.
    b. Press **ENTER** to accept the change
       - or -
       press **BACK** to cancel the change without saving.
6. Select another parameter and repeat from step 4, or press **BACK** to return to the top level menu.
7. Select another menu 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.

Standard Menus

Figure 4.1 shows the top level menus accessible from the single loop display. If the enhanced features option or ramp/soak feature is installed, refer to *Chapter 5: Enhanced Features on page 96* or *Chapter 6: Ramp/Soak on page 115* for additional menus.

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?	DIGITAL OUTPUT NUMBER XX
JOB SEL DIG INS ACTIVE?	INPUT READING OFFSET?	HEAT CONTROL FILTER?	SDAC PARAMETERS (SDAC)	DEV ALARM VALUE?	KEYPAD TEST
OUTPUT OVERRIDE DIG INPUT?	REVERSED T/C DETECT?	COOL CONTROL PB?	HEAT OUTPUT ACTION?	HI DEV ALARM TYPE?	DISPLAY TEST
OVERRIDE DIG IN ACTIVE?	INPUT PULSE SAMPLE TIME? (Pulse input)	COOL CONTROL TI?	HEAT OUTPUT LIMIT?	HI DEV ALARM OUTPUT?	
STARTUP ALARM DELAY?	DISP FORMAT? (Linear and pulse)	COOL CONTROL TD?	HEAT OUTPUT LIMIT TIME?	LO DEV ALARM TYPE?	
RAMP/SOAK TIME BASE? (Ramp/soak)	INPUT SCALING HI PV? (Linear and pulse)	COOL CONTROL FILTER?	SENSOR FAIL HT OUTPUT?	LO DEV ALARM OUTPUT?	
KEYBOARD LOCK STATUS?	INPUT SCALING HI RDG? (Linear and pulse)	SPREAD?	HEAT T/C BRK OUT AVG?	LO PROC ALARM SETPT?	
POWER UP OUTPUT STATUS?	INPUT SCALING LO PV? (Linear and pulse)	RESTORE PID DIGIN?	HEAT OUTPUT?	LO PROC ALARM TYPE?	
PROCESS POWER DIGIN?	INPUT SCALING LO RDG? (Linear and pulse)		COOL CONTROL OUTPUT?	LO PROC ALARM OUTPUT?	
CONTROLLER ADDRESS?	INPUT FILTER?		COOL OUTPUT TYPE?	ALARM DEADBAND?	
COMMUNICATIONS BAUD RATE?			COOL OUTPUT CYCLE TIME? (TP)	ALARM DELAY?	
COMMUNICATIONS PROTOCOL?			SDAC PARAMETERS (SDAC)		
COMMUNICATIONS ERR CHECK?			COOL OUTPUT ACTION?		
AC LINE FREQ?			COOL OUTPUT LIMIT?		
DIG OUT POLARITY ON ALARM?			COOL OUTPUT LIMIT TIME?		
CLS 200 [FIRMWARE INFO]			SENSOR FAIL CL OUTPUT?		
			COOL T/C BRK OUT AVG?		
			COOL OUTPUT?		

Figure 4.1 *— CLS200 Menu Tree*

Setup Global Parameters Menu

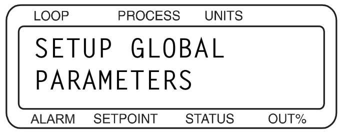


Table 4.1 shows the parameters available in this menu.

Table 4.1 — Global Parameters

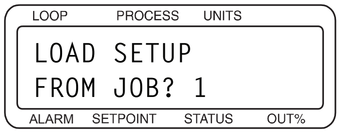
PARAMETER	DEFAULT VALUE
LOAD SETUP FROM JOB?	1
SAVE SETUP TO JOB?	1
JOB SELECT DIG INPUTS?	NONE
JOB SEL DIG INS ACTIVE?	LOW
OUTPUT OVERRIDE DIG INPUT?	NONE
OVERRIDE DIG IN ACTIVE?	LOW
STARTUP ALARM DELAY?	0 MINS
RAMP/SOAK TIME BASE?*	HOURS/MIN
KEYBOARD LOCK STATUS?	OFF
POWER UP OUTPUT STATUS?	OFF
PROCESS POWER DIGIN?	NONE
CONTROLLER ADDRESS?	1
COMMUNICATIONS BAUD RATE?	19200
COMMUNICATIONS PROTOCOL?	MOD
COMMUNICATIONS ERR CHECK?	BCC
AC LINE FREQ?	60 HERTZ
DIG OUT POLARITYON ALARM?	LOW
CLS200 [model no., firmware rev.]	

* The RAMP/SOAK TIME BASE parameter appears only if the ramp/soak feature is installed.

Load Setup From Job

NOTE! 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.

Load any one of eight jobs saved in battery-backed RAM.

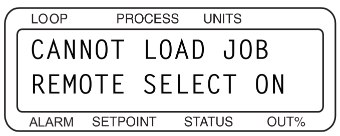


Selectable values: 1 to 8

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

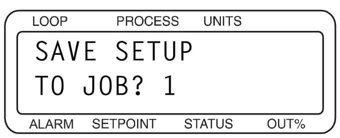
- PID constants, filter settings, setpoints and spread values.
- Loop control status (automatic or manual) and output values (if the loop is in manual control)
- Alarm function (off, alarm control) setpoints, high/low process setpoints, high/low deviation setpoints and deadband settings, and loop alarm delay.

If you have enabled the remote job select function (see J*ob Select Digital Inputs* below), you will not be able to load a job. If you try, you will see this message:



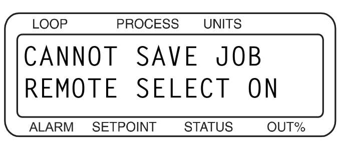
Save Setup to Job

Save the job information for every loop to one of eight jobs in the battery-backed RAM.



Selectable values: 1 to 8

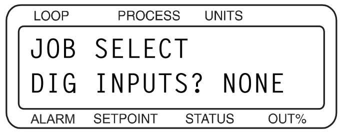
If you have enabled the remote job select function (see *Job Select Digital Inputs* below), you will not be able to save a job. If you try, you will see this message:



Job Select Digital Inputs

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 parameter controls the number of jobs you can select remotely.

If you select `NONE`, digital inputs do not affect job selection. Jobs may be loaded and saved using the `LOAD SETUP FROM JOB` and `SAVE SETUP TO JOB` parameters.



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

Table 4.2 — Job Select Inputs

SETTING	ENABLES
1	Jobs 1-2
2	Jobs 1-4
3	Jobs 1-8
NONE	Disables remote selection

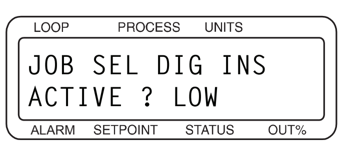
Table 4.3 shows which input states select which jobs. When nothing is connected, the inputs are all false and job 1 is selected.

Table 4.3 — Job Selected for Various Input States

DIGITAL INPUT 3	DIGITAL INPUT 2	DIGITAL INPUT 2	JOB NO.
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 Inputs Active

Specify which state is considered "true" for the digital inputs used for job selection. 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 it is pulled low.

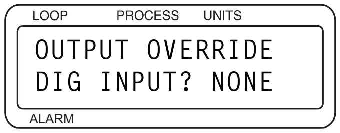


Selectable values: HIGH or LOW.

Changing this setting has the effect of reversing the order of the jobs in *Table 4.3*.

Output Override Digital Input

To enable the output override feature, select a digital input. When the specified input is activated, the controller sets all loops to manual mode at the output levels specified at the SENSOR FAIL HT OUTPUT and SENSOR FAIL CL OUTPUT parameters in the SETUP LOOP OUTPUTS menu.



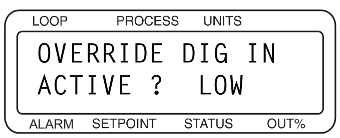
Selectable values: NONE or input number 1 to 8.

Use the next parameter, OVERRIDE DIG IN ACTIVE, to set the signal state that activates the output override feature.

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

Override Digital Input Active

Specify whether a low or high signal activates the output override feature (see OUTPUT OVERRIDE DIG INPUT above).

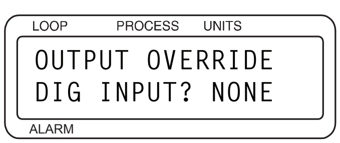


Selectable values: HIGH or LOW.

You can set the input to be active when low or active when high. When the input selected for OUTPUT OVERRIDE DIG INPUT changes to the specified state, all the loop's outputs are set to their sensor fail levels.

Startup Alarm Delay

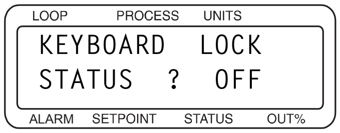
Set a startup delay for process and deviation alarms for all loops. The controller does not report these alarm conditions for the specified number of minutes after the controller powers up. This feature does not delay failed sensor alarms.



Selectable values: 0 to 60 minutes.

Keyboard Lock Status

Set this parameter to ON to disable the **CHNG SP**, **MAN/AUTO**, and **RAMP/SOAK** keys on the keypad. If the keys are disabled, pressing them has no effect. If you want to use these functions, turn off the keyboard lock.



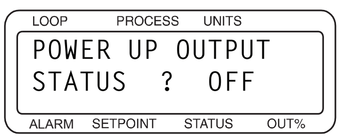
Selectable values: ON or OFF.

Power Up Output Status

> **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.

Set the initial power-up state of the control outputs. If you choose OFF, all loops are initially set to manual mode at 0% output. If you choose MEMORY, the loops are restored to the control status and output value prior to powering down.

See *In Case of a Power Failure on page 130* for information about how this feature affects ramp/soak profiles.

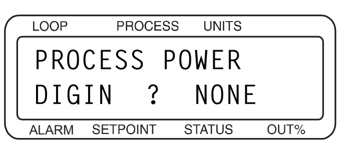


Selectable values: OFF or MEMORY.

Process Power Digital Input

To enable the thermocouple short detection feature, select a digital input (1 to 8). Connect the specified input to a device that pulls the input low when the process power is on. A short is indicated when the process power is on and the temperature does not rise as expected.

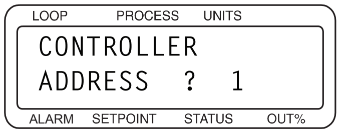
If the controller determines that there is a thermocouple short, it sets the loop to manual mode at the power level set for the SENSOR FAIL HT OUTPUT or SENSOR FAIL CL OUTPUT parameter in the SETUP LOOP OUTPUTS menu.



Selectable values: 1 to 8, or NONE.

Controller Address

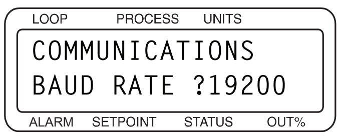
Set the communications address for the controller. On an EIA/TIA-485 communication network, each controller must have a unique address. Begin with address 1 for the first controller and assign each subsequent controller the next higher address.



Selectable values: 1 to 247.

Communications Baud Rate

Set the communications baud rate.

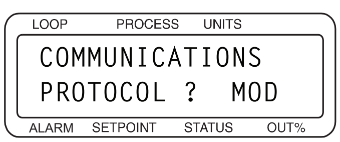


Selectable values: 9600, 2400 or 19200.

NOTE! Set the baud rate to the same speed in both the controller and the HMI software or panel.

Communications Protocol

Set the communications protocol. Choose the correct protocol for the software or device with which the controller will communicate. You must switch power to the controller off, then back on, to make a change to this parameter take effect.

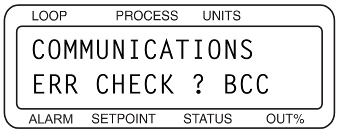


Selectable values: MOD (Modbus® RTU), ANA (Anafaze), AB (Allen Bradley).

Communications Error Checking

If you selected the ANA or AB communications protocol, set the data check algorithm for CLS200 communications.

CRC (Cyclic Redundancy Check) is a more secure error checking algorithm than BCC, but it requires more calculation time and slows communications. BCC (Block Check Character) ensures a high degree of communications integrity. We recommend BCC unless your application requires CRC.

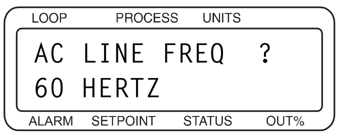


Selectable values: BCC or CRC.

AC Line Frequency

Specify the ac line frequency. 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.

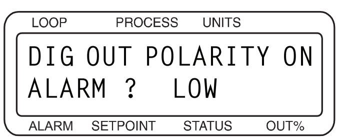
You must switch power to the controller off, then back on, to make a change to this parameter take effect.



Selectable values: 50 HERTZ or 60 HERTZ.

Digital Output Polarity on Alarm

Set the polarity of all digital outputs used for alarms. If LOW is selected, if an alarm occurs the outputs sink to analog common. If HIGH is selected, the outputs sink to common when no alarm is active and go high when an alarm occurs.



Selectable values: HIGH or LOW.

This parameter does not affect the Global Alarm output or the Watchdog Alarm output.

EPROM Information

The display shows the controller type, firmware options, the firmware version and the EPROM checksum. Table 4.4 lists the available firmware options.

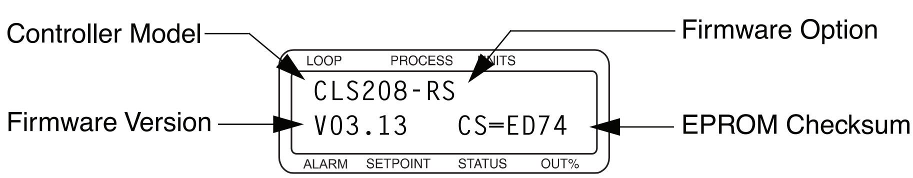
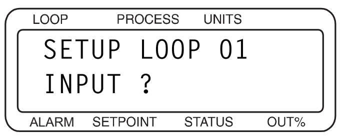


Table 4.4 — Firmware Option Codes

FIRMWARE OPTION	DECRIPTION
(none)	Standard Firmware
-EF	Enhanced Features Option
-RS	Ramp/Soak Option

NOTE! If the EPROM information does not match this description, the EPROM probably contains a custom program. Custom programs may not work as described in this manual. If that is the case, contact your dealer for more information about the firmware.

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

Table 4.5 — Setup Loop Input

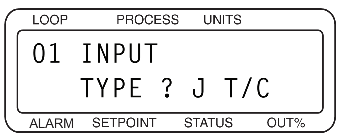
PARAMETER	DEFAULT VALUE
INPUT TYPE?	J
LOOP NAME?	01
INPUT UNITS?	˚F
INPUT READING OFFSET?	0˚ F
REVERSED T/C DETECT?[3]	OFF
INPUT PULSE SAMPLE TIME?[1]	1
DISP FORMAT?[2]	-999 to 3000
INPUT SCALING HI PV?[2]	1000
INPUT SCALING HI RDG?[2]	100.0% FS
INPUT SCALING LO PV?[2]	0
INPUT SCALING LO RDG?[2]	0.0% FS
INPUT FILTER?	3 SCANS

[1] This parameter is available only for the pulse loop (loop 5 on four-channel controller, loop 9 on an eight-channel controller and loop 17 on a sixteen-channel controller).
[2] These parameters are available only if LINEAR is selected for INPUT TYPE.
[3] These parameter is available only if INPUT TYPE is set to one of the thermocouple or RTD options.

Input Type

Specify the type of input sensor used on this loop:

- Thermocouple type J, K, T, S, R, B or E.
- RTD 1 or RTD 2.
- Linear input.
- Skip (an input type available for unused loops). Alarms are not detected, and the scanning display does not show loops that are set to SKIP.
- Pulse input (available only for loop 5 on a four-channel controller, loop 9 on an eight-channel controller or loop 17 on a sixteen-channel controller).



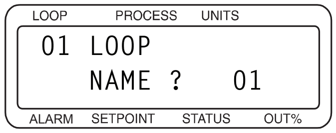
Selectable values: See *Table 4.6*.

Table 4.6 — CLS200 Input Types and Ranges

INPUT TYPE	INPUT RANGE
J T/C	-350 to 1,400° F (-212 to 760° C)
K T/C	-450 to 2,500° F (-268 to 1,371° C)
T T/C	-450 to 750° F (-268 to 399° C)
S T/C	0 to 3,200° F (-18 to 1,760° C)
R T/C	0 to 3,210° F (-18 to 1,766° C)
B T/C	150 to 3,200° F (+66 to 1,760° C)
E T/C	150 to 3,200° F (+66 to 1,760° C)
RTD1	-148.0 to 572.0° F (-100.0 to 275.0° C)
RTD2	-184 to 1,544° F (-120 to 840° C)
PULSE	0 to 2kHz
SKIP	Loop not used.
LINEAR	See *Linear Scaling Parameters on page 77*.

Loop Name

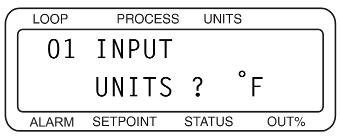
Assign a two-character name to the loop. This name is shown on the single loop display in place of the loop number.



Selectable values: 0 to 9, A to Z, %, /, ° (degree symbol).

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.

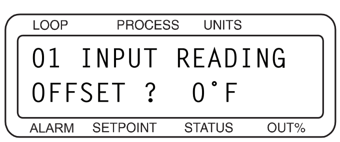
Table 4.7 — Input Character Sets

INPUT	CHARACTER SETS FOR UNITS
Thermocouple or RTD	° F or ° C
LINEAR or PULSE	0 to 9, A to Z,%, /, °, space

Input Reading Offset

If the input type is a thermocouple or RTD, specify the offset to correct for signal inaccuracy at a given point. For example, at temperatures below 400°F, a type J thermocouple may be inaccurate or "offset" by several degrees. Use an independent thermocouple or your own calibration equipment to find the offset for your equipment.

A positive value increases the reading and a negative value decreases it.



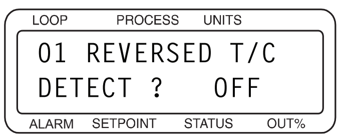
Selectable values: See *Table 4.8*.

Table 4.8 — Input Reading Offset

TYPE OF SENSOR	OFFSET RANGE	
	°F	°C
RTD2 J K T	-300 to +300	-300 to +300
RTD1	-300.0 to +300.0	-300.0 to +300.0
B S	-300 to +76	-300 to +300
R	-300 to +66	-300 to +300

Reversed T/C Detection

Set this parameter to ON to enable polarity checking for thermocouples. If a reversed thermocouple is detected, the controller sets the loop to manual control at the SENSOR FAIL HT OUTPUT or SENSOR FAIL CL OUTPUT power level and displays the alarm.

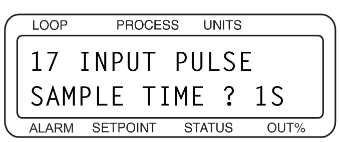


Selectable values: ON or OFF.

Input Pulse Sample Time

You can connect a digital pulse signal of up to 2kHz to the pulse input. Use this parameter to set the time over which pulses are counted. The controller counts pulses for the amount of time you set here before calculating the frequncy. The controller scales this frequency and uses the resulting value as the process variable for the pulse loop. Generally, the longer the pulse sample time, the more stable the process variable, but the slower the response of the pulse loop.

This parameter is available only for loop 5 on a four-loop model, loop 9 on an eight-loop model or loop 17 on a sixteen-loop model



Selectable values: 1 to 20 seconds.

Linear Scaling Parameters

The following parameters are only available if the input type is LINEAR or PULSE. These parameters let you scale the raw input 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 60mV 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 (PV) to the input signal. The engineering units of the process variable can be any units—the graph in *Figure 4.2* shows PSI as an example.

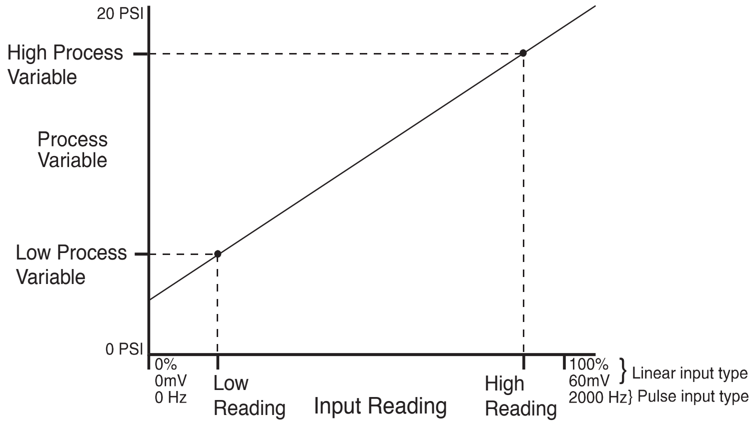


Figure 4.2 *— Two Points Determine Process Variable Conversion*

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 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 setpoint, alarms limits, deadband, spread and proportional band.

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 0Hz and 2000Hz readings. The process variable range defines the limits for the setpoint and alarms. See *Figure 4.3*.

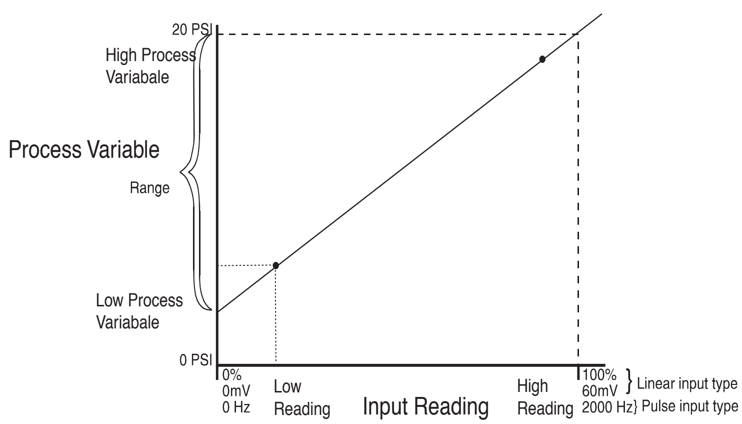
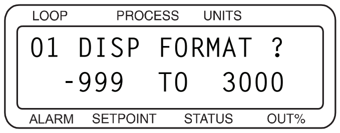


Figure 4.3 *— Process Variable Limited by Input Reading Range*

Display Format

Select a display format for a linear or pulse input. Choose a format appropriate for the input range and sensor accuracy.



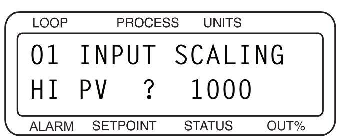
Selectable values: The controller has several available display formats, as shown in *Table 4.9*. The table also shows the maximum and minimum process variable for each display format.

Table 4.9 — Display Formats

DISPLAY FORMAT	MAXIMUM PROCESS VARIABLE	MINIMUM PROCESS VARIABLE
-9999 TO +30000	30,000	-9,999
-999 TO +3000	3,000	-999
-999.9 TO +3000.0	3,000.0	-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	-0.9999

High Process Variable

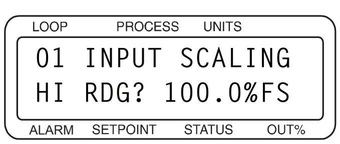
Set a high process variable for input scaling purposes. The high process variable and the high reading (HI RDG) together define one of the points on the linear scaling function's conversion line. Set HI PV to the value you want displayed when the signal is at the level set for the HI RDG.



Selectable values: Any value between the low process variable (LO PV) and the maximum process variable for the selected display format. See *Table 4.9*.

High Reading

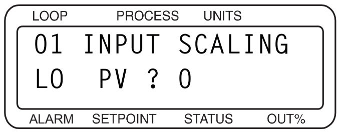
Enter the input signal level that corresponds to the high process variable (HI PV) you entered in the previous parameter.



Selectable values: For linear inputs, any value between -99.9% and 999.9% of full scale, where 100% corresponds to 60mV and 0% corresponds to 0mV. For pulse inputs, any value between 0 and 2000HZ. The high reading must be greater than the low reading (LO RDG).

Low Process Variable

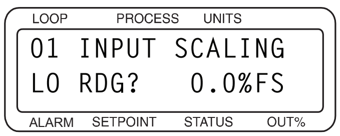
Set a low process variable for input scaling purposes. The low process variable and the low reading (LO RDG) together define one of the points on the linear scaling function's conversion line. Set LO PV to the value you want displayed when the signal is at the level set for the low reading (LO RDG).



Selectable values: Any value between the minimum process variable and the high process variable for the selected display format. See *Table 4.9* on the previous page.

Low Reading

Enter the input signal level that corresponds to the low process variable (LO PV) you entered in the previous parameter.

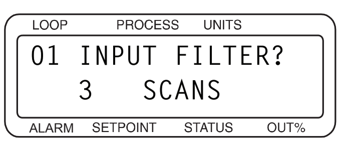


Selectable values: For linear inputs, any value between -99.9% and 999.9% percent of full scale, where 100% corresponds to 60mV and 0% corresponds to 0mV. For pulse inputs, any value between 0 and 2000 HZ. The low reading must be less than the high reading (HI RDG).

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° 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 values: 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 parameters appear only if the corresponding output is enabled.

See *Setup Loop Outputs Menu on page 84* for help enabling and disabling heat and cool outputs.

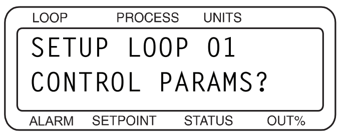


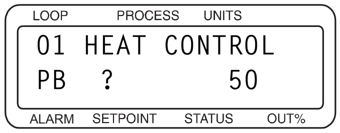
Table 4.10 shows the parameters available in the SETUP LOOP CONTROL PARAMS menu.

Table 4.10—Setup Loop Control Parameters

PARAMETER	DEFAULT VALUE
HEAT CONTROL PB?	Depends upon the INPUT TYPE setting; 50 for J-type thermocouple.
HEAT CONTROL TI?	Depends upon the INPUT TYPE setting; 180 SEC/R for J-type thermocouple.
HEAT CONTROL TD?	0
HEAT CONTROL FILTER?	3
COOL CONTROL PB?	50
COOL CONTROL TI?	Depends upon the INPUT TYPE setting; 60 SEC/R for J-type thermocouple.
COOL CONTROL TD?	Depends upon the INPUT TYPE setting; 0 SECONDS for J-type thermocouple.
COOL CONTROL FILTER?	3
SPREAD?	5
RESTORE PID DIGIN?	NONE

Heat or Cool Control PB

Set the proportional band (also known as gain). A larger value yields less proportional action for a given deviation from setpoint.



Selectable values: Dependent upon sensor type.

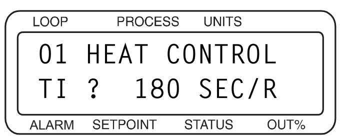
The controller internally represents the proportional band (PB) as a gain value. When you edit the proportional band, you will see the values change in predefined steps; small steps for narrow proportional band values and large steps for wide proportional band values.

The controller calculates the default proportional band 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

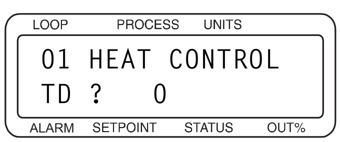
Set the integral term (also known as reset). A larger value yields less integral action.



Selectable values: 0 (off) to 6000 seconds.

Heat or Cool Control TD

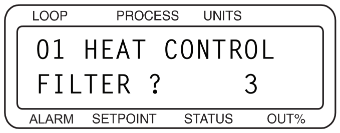
Set the derivative constant. A larger value yields greater derivative action.



Selectable values: 0 to 255 seconds.

Heat or Cool Output Filter

Dampen the response of the heat or cool output. 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 value results in a slower, or more dampened, response to changes in the process variable.



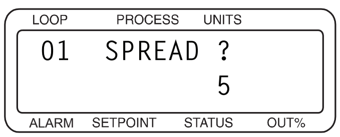
Selectable values: 0 to 255.0 disables the output filter.

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 the setpoint before the controller can switch from heating to cooling. A loop will not switch from heat to cool or vice versa unless the process variable deviates from setpoint by more than the spread.

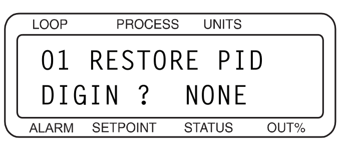
When the loop is using PID control and the spread is set to 0, the PID calculation alone determines when the heat or cool output should be on.



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

Restore PID Digital Input

To enable the sensor failure recovery feature, select a digital input at this parameter. If the specified input is held low when a thermocouple fails, the loop returns to automatic control after the thermocouple is repaired.



Selectable range: NONE (disable the sensor failure recovery feature), 1 to 8.

Setup Loop Outputs Menu

Use the SETUP LOOP OUTPUTS menu to:

- Enable or disable outputs
- Set output type
- Set cycle time for time proportioning outputs
- Enter Serial DAC parameters (for Serial DAC outputs)
- Select control action
- Set output level limit and limit time
- Select sensor fail output (output override)
- Select a nonlinear output curve

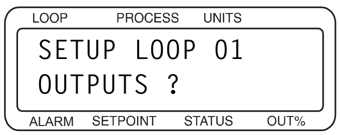


Table 4.11 shows the parameters available in the SETUP LOOP OUTPUTS menu. Both heat and cool outputs have the same parameters; only one of each parameter is shown.

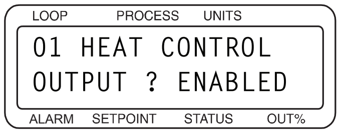
Table 4.11 — Setup Loop Outputs

PARAMETER	DEFAULT VALUE
HEAT CONTROL OUTPUT?	ENABLED
HEAT OUTPUT TYPE?	TP
HEAT OUTPUT CYCLE TIME?	10s
SDAC MODE?*	VOLTAGE
SDAC LO VALUE?*	0.00 VDC
SDAC HI VALUE?*	10.00 VDC
HEAT OUTPUT ACTION?	REVERSE
HEAT OUTPUT LIMIT?	100%
HEAT OUTPUT LIMIT TIME?	CONT
SENSOR FAIL HT OUTPUT?	0%
HEAT T/C BRK OUT AVG?	OFF
HEAT OUTPUT?	LINEAR
COOL CONTROL OUTPUT?	DISABLED

* The SDAC parameters are available only if you select SDAC as the output type. Use these parameters to configure the Serial DAC signal output.

Enable or Disable Heat or Cool Outputs

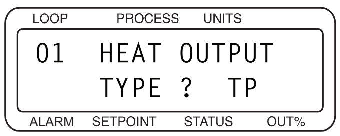
Enable or disable the heat or cool output for the loop. If you want the loop to have a control output, you must enable at least one output. You can also disable a heat or cool control output and use the output for something else, such as an alarm.



Selectable values: `ENABLED` or `DISABLED`.

Heat or Cool Output Type

Select the output type.



Selectable values: `TP`, `DZC`, `SDAC`, `ON/OFF`, `3P DZC`. See *Table 4.12* for a description of the output types.

NOTE! The controller assigns digital output 34 as a clock line for the Serial DAC. You will not be able to assign another function to output 34 if any loop's output is set to SDAC.

Table 4.12 — Heat / Cool Output Types

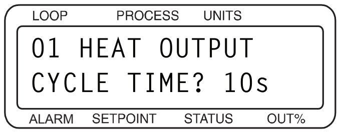
OPTION	OUTPUT TYPE	DEFAULT VALUE
`TP`	Time Proportioning	Percent output converted to a percent duty cycle over the user-selected, fixed time base.
`DZC`	Distributed Zero Crossing	Output on/off state calculated for every ac line cycle. Use with solid state relay or Dual DAC.
`SDAC`	Serial DAC	Use with Serial DAC.
`ON/OFF`	On/Off	Output either full on or full off.
`3P DZC`	3-Phase Distributed Zero Crossing	Use with 3-phase heaters when wired in delta configuration. (For grounded Y configuration, use `DZC` instead.)

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.

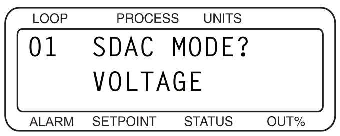
This parameter appears only if the heat or cool output type for the loop is set to time proportioning (TP).



Selectable values: 1 to 255 seconds.

SDAC Mode

Select the Serial DAC output signal.

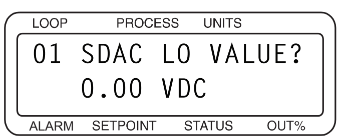


Selectable values: CURRENT or VOLTAGE.

SDAC Low Value

Set the low output signal level for the Serial DAC. The Serial DAC converts 0% output from the controller to the value set here.

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 - 10.00 V range, set the SDAC LO VALUE to 0.00 VDC and set the SDAC HI VALUE to 10.00 VDC.

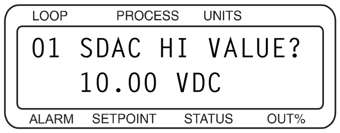


Selectable values: 0.00 to 9.00 VDC or 0.0 to 19.90 MA. This value must be less than the SDAC HI VALUE.

SDAC High Value

Set the high output signal level for the Serial DAC. The Serial DAC converts 100% output from the controller to the value set here.

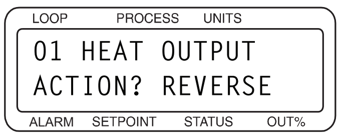
Set the high and low values to match the range of the output device. For instance, if the output device has a 4 to 20mA range, set the SDAC HI VALUE to 20.00 MA and the SDAC LO VALUE to 4.00 MA.



Selectable values: 0.10 to 10.00 VDC or 0.10 to 20.00 MA. This value must be greater than the SDAC LO VALUE.

Heat or Cool Output Action

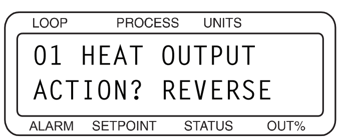
Select the control action for the output. Normally, heat outputs are set to reverse action and cool outputs are set to direct action. When output action is set to REVERSE, the output goes up when the process variable goes down. When set to DIRECT, the output goes up when the process variable goes up.



Selectable values: REVERSE or DIRECT.

Heat or Cool Output Limit

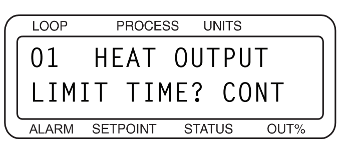
This parameter limits the maximum PID control output for a loop's heat or cool output. This limit may be continuous, or it or it may be in effect for a specified number of seconds (see the next parameter). If you choose a timed limit, the output limit time restarts when the controller powers up and whenever 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 values: 0 to 100%.

Heat or Cool Output Limit Time

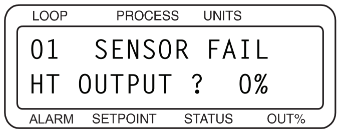
Set a time limit for the output limit set at the previous parameter.



Selectable values: 1 to 999 seconds, or to CONT (continuous).

Sensor Fail Heat or Cool Output

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



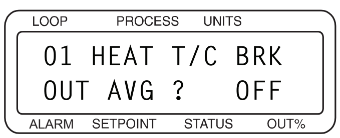
Selectable values: 0 to 100%.

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

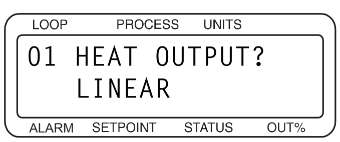
If you set this parameter to ON and a thermocouple break occurs, a loop set to automatic control status will go to manual mode at a percentage equal to the average output prior to the break.



Selectable range: ON or OFF.

Heat or Cool Linearity

Select an output curve. For a nonlinear process, select CURVE 1 or CURVE 2.



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

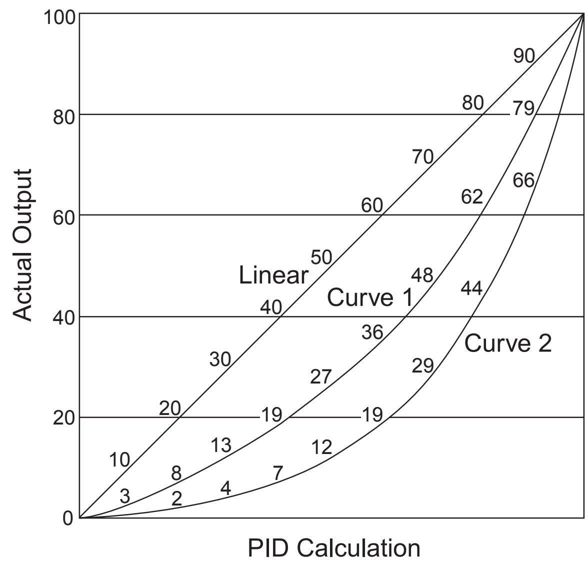


Figure 4.4 *— Linear and Nonlinear Outputs*

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

Setup Loop Alarms Menu

Use the `SETUP LOOP ALARMS` menu to set:

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

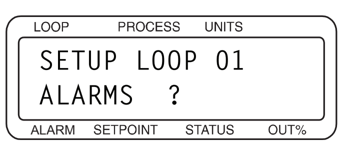


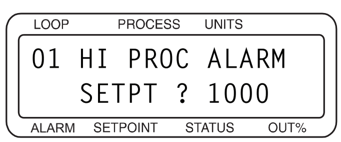
Table 4.13 shows the parameters available in the `SETUP LOOP ALARMS` menu.

Table 4.13 — Setup Loop Alarms

PARAMETER	DEFAULT VALUE
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

High Process Alarm Setpoint

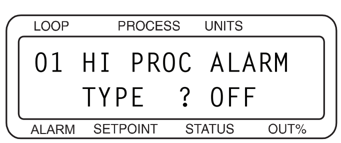
Set the value at which the high process alarm activates.



Selectable values: Any point within the scaled sensor range.

High Process Alarm Type

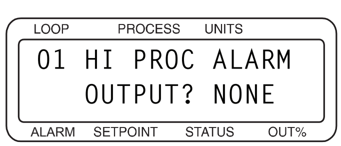
Select an alarm type for the high process alarm.



Selectable values: OFF, ALARM, or CONTROL.

High Process Alarm Output Number

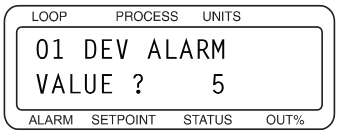
Choose a digital output to activate when the high process alarm occurs, if desired.



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

Deviation Alarm Value

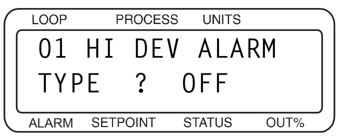
Set the deviation from setpoint at which the high and low deviation alarms occur.



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

High Deviation Alarm Type

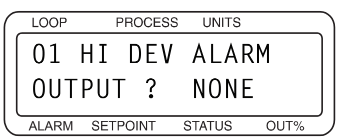
Select an alarm type for the high deviation alarm.



Selectable values: `ALARM`, `CONTROL` or `OFF`.

High Deviation Alarm Output Number

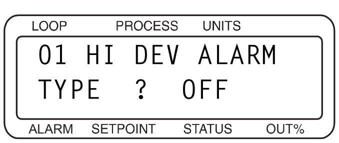
Choose a digital output to activate when the high deviation alarm occurs, if desired.



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

Low Deviation Alarm Type

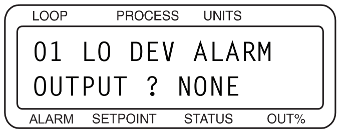
Select an alarm type for the low deviation alarm.



Selectable values: `ALARM`, `CONTROL` or `OFF`.

Low Deviation Alarm Output Number

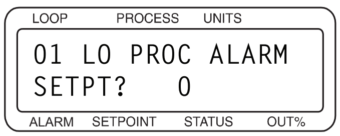
Choose a digital output to activate when the low deviation alarm occurs, if desired.



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

Low Process Alarm Setpoint

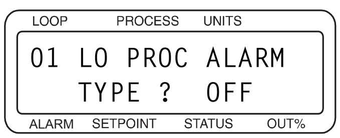
Set a low process alarm setpoint. See *Process Alarms on page 61*.



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

Low Process Alarm Type

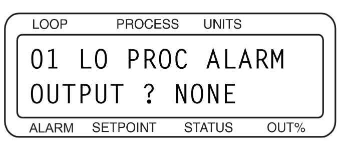
Select an alarm type for the low process alarm.



Selectable values: ALARM, CONTROL or OFF.

Low Process Alarm Output Number

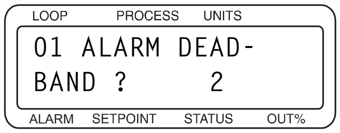
Choose a digital output to activate when the low process alarm occurs, if desired.



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

Alarm Deadband

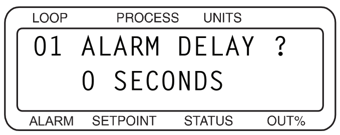
Set an alarm deadband. This deadband value applies to the high process, low process, high deviation and low deviation alarms for the loop. Use the alarm deadband to avoid repeated alarms as the process variable cycles around an alarm value.



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

Alarm Delay

Set a loop alarm delay. This parameter delays failed sensor, process and deviation 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

This menu facilitates testing of:

- Digital inputs
- Digital outputs
- The keypad buttons

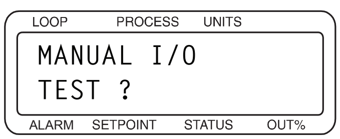


Table 4.14 shows the screens available in the `MANUAL I/O TEST` menu.

Table 4.14 — Manual I/O Test

PARAMETER	DEFAULT VALUE
DIGITAL INPUTS	HHHHHHHH
TEST DIGITAL OUTPUT?	1: IN USE
DIGITAL OUTPUT NUMBER XX?	OFF
KEYPAD TEST	N/A
DISPLAY TEST	N/A

NOTE! The `DIGITAL OUTPUT NUMBER` screen appears only if an unassigned output has been selected in the `TEST DIGITAL OUTPUT` screen.

Digital Inputs

View the logic state of the eight digital inputs as H (high) meaning the input is not pulled low, or L (low) meaning the input is connected to the controller common.

This screen shows the state of 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 screen shows the correct state for that input.

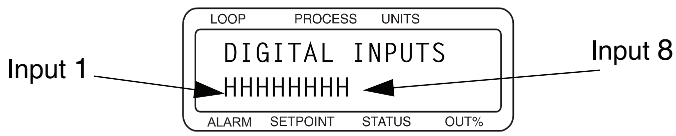


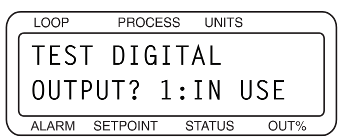
Figure 4.5 *— Digital Inputs Screen*

When you are done testing digital inputs, press **YES** or **NO** to advance to the next screen, or press BACK to return to the MANUAL I/O TEST menu.

Test Digital Output

Select one of the digital alarm outputs to test. You will test the output on the next screen.

You cannot force the state of an output enabled for control.



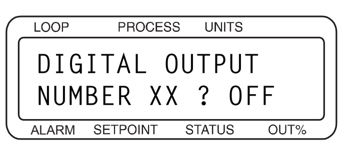
Selectable values: Any output from 1 to 34 that is not enabled for closed-loop control or for the Serial DAC clock and GA, the global alarm output.

Digital Output Number

This screen appears only if you selected an output that is not in use for control at the TEST DIGITAL OUTPUT screen.

Use this parameter 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.

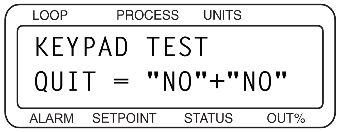
You cannot toggle outputs enabled for control. To test a control loop output, first disable it using the SETUP LOOP OUTPUTS menu.



Selectable values: ON or OFF.

Keypad Test

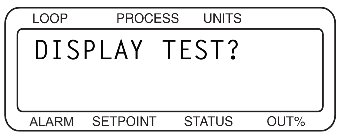
Test the keypad. The test begins automatically when the screen appears.



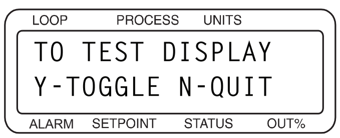
- Press any key to test the keypad. The controller will display the name of the key you have pressed.
- Press **NO** twice to end the test and return to the top of the `MANUAL I/O TEST` menu.

Display Test

Use this function to test the display.



Press **YES** to enter the test and display the instruction screen.



Press **YES** to display the pixel test 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.

Chapter 5: Enhanced Features

This chapter explains five additional features for the CLS200 controller when enabled with enhanced features option firmware:

- Process variable retransmit
- Cascade control
- Ratio control
- Remote analog setpoint
- Differential control

Enhanced Features Menus

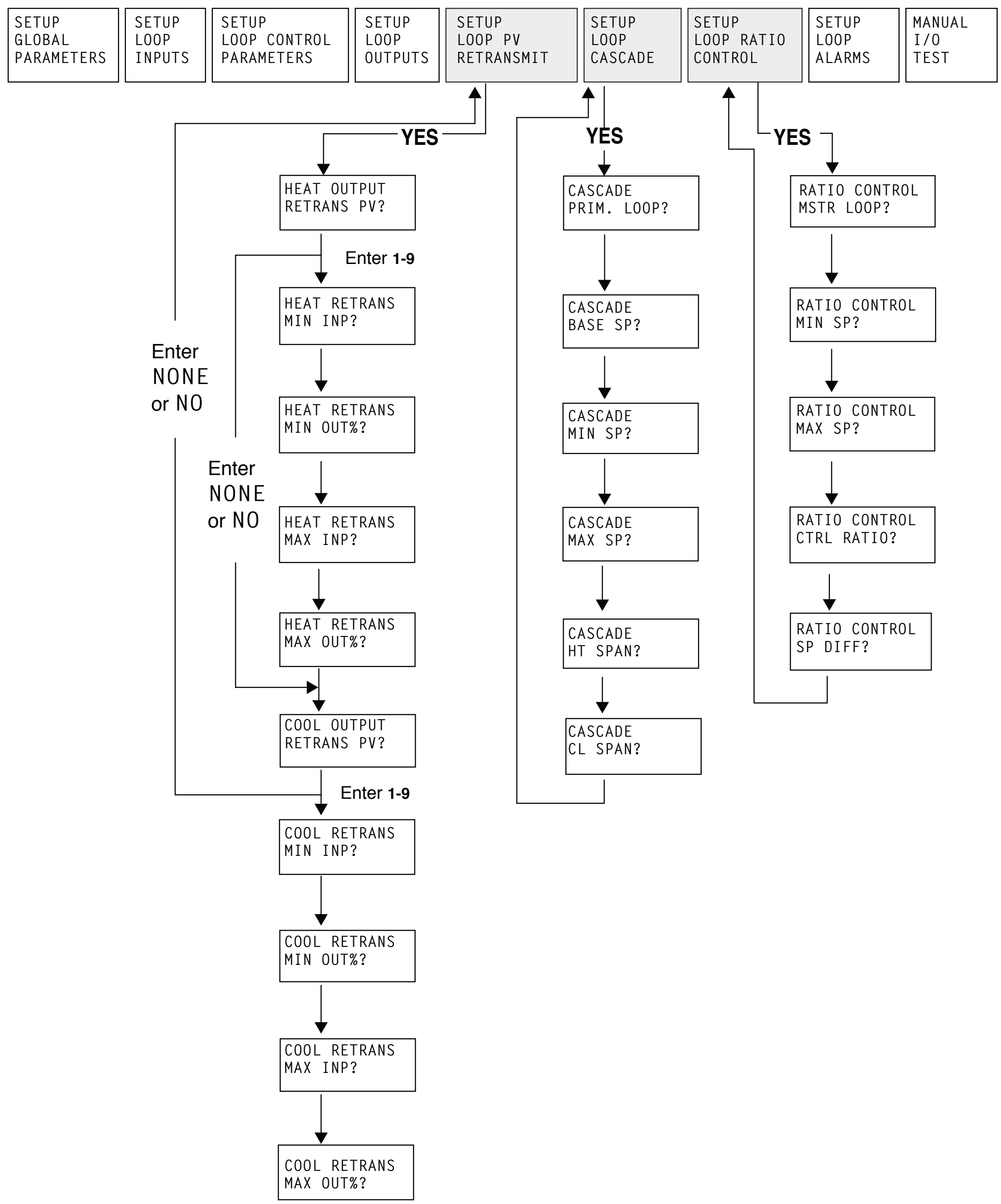


Figure 5.1 *— Enhanced Features Option Menus*

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.

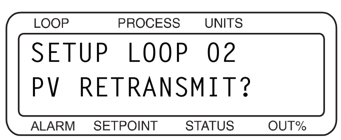
The controller output signal must be connected to a Dual DAC or Serial DAC converter to get a 4 to 20mA DC or 0 to 5VDC signal. The choice of converter depends on application requirements.

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.

Process Variable Retransmit Menu

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

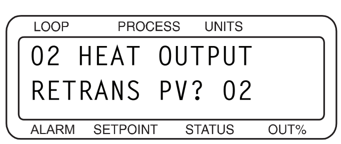


Press **YES** to view the process variable retransmit parameters.

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.

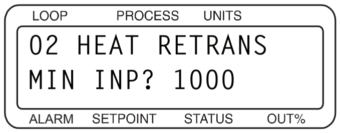


Selectable values: Any loop or NONE.

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.

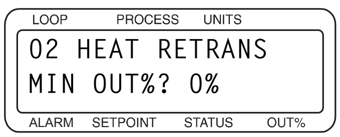


Selectable values: Any value in the input loop's range.

Minimum Output

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

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.

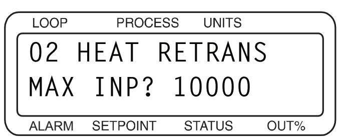


Selectable values: `0` to `100%`.

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 5.2*.

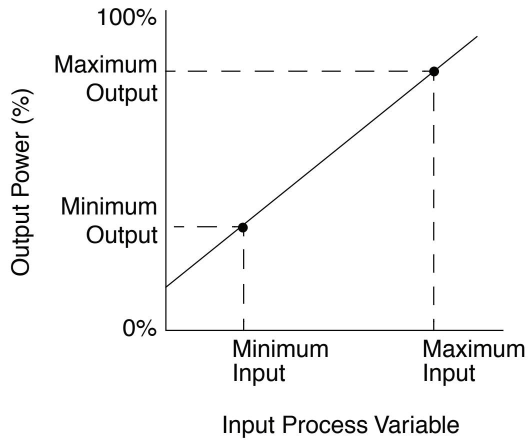
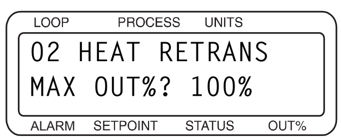


Figure 5.2 *— Linear Scaling of Process Variable for Retransmit*

Maximum Output

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

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



Selectable values: 0 to 100%.

Process Variable Retransmit Example: Data Logging

The CLS200 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 20mA DC signal representing a process variable range of 0 to 1000°F.

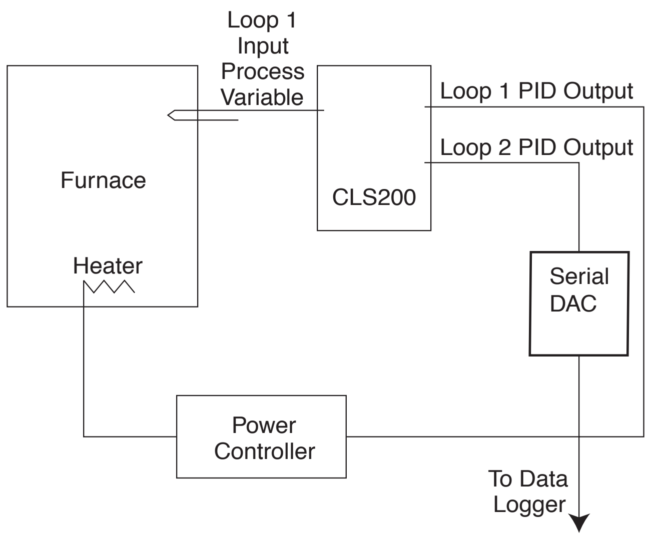


***Figure 5.3** — Application Using Process Variable Retransmit*

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 5.1*.
4. Follow the steps in *Table 5.1* to configure the process variable retransmit option.
5. After following the steps in *Table 5.1*, 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 5.1 — 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**.

DISPLAY	USER INPUT
LOOP PROCESS UNITS 02 HEAT RETRANS MIN INP? 0 ALARM SETPOINT STATUS OUT%	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**.
LOOP PROCESS UNITS 02 HEAT RETRANS MIN OUT%? 0 ALARM SETPOINT STATUS OUT%	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**.
LOOP PROCESS UNITS 02 HEAT RETRANS MAX INP? 1000 ALARM SETPOINT STATUS OUT%	Enter the maximum input value, which corresponds to the maxi-mum output percentage. For a range of 0 to 1000° F, set the maxi-mum input value to 1000° F. Press **ENTER**.
LOOP PROCESS UNITS 02 HEAT RETRANS MAX OUT%? 100 ALARM SETPOINT STATUS OUT%	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**.
LOOP PROCESS UNITS 02 COOL OUTPUT RETRANS PV? NONE ALARM SETPOINT STATUS OUT%	The process variable retransmit section of the controller program-ming 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 20mA.
- The CLS200 Series controllers must be used with a Watlow Serial DAC.

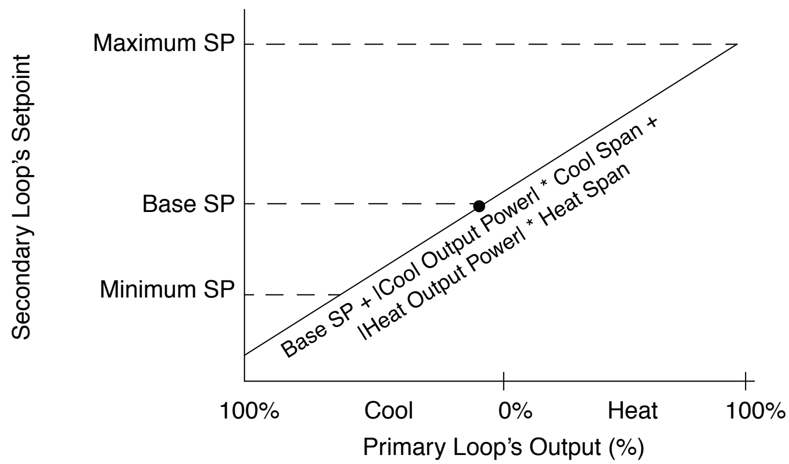
Consult *Chapter 4: Setup* for information on setting up the other options of the controller.

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 setpoint 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 setpoint of a second control loop. By adjusting the setpoint (SP) parameters, the user can adjust the influence that the primary loop has on the setpoint of the secondary loop. See *Figure 5.4*.

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 CLS200 allows you to use the primary heat output for both control and for determining the setpoint of the secondary loop.



Calculation of new secondary loop setpoint:
SP2 = Base SP + lCool Output Powerl * Cool Span + lHeat Output Powerl * Heat Span

***Figure 5.4** — Relationship Between the Primary Loop's Output and the Secondary Loop's Setpoint*

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

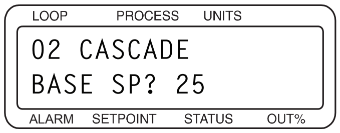
Enter the primary loop number. The output percentage of this loop will control the setpoint of the secondary loop.

```
LOOP    PROCESS    UNITS
02 CASCADE
PRIM. LOOP? 03
ALARM   SETPOINT   STATUS   OUT%
```

Selectable values: Any loop except the secondary loop.

Base Setpoint

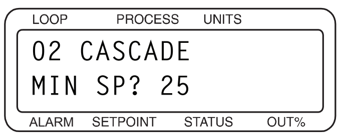
Enter the setpoint that corresponds to 0% (heat and cool) output from the primary loop (PRIM. LOOP). This value is expressed in the same engineering units as the secondary loop's process variable.



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

Minimum Setpoint

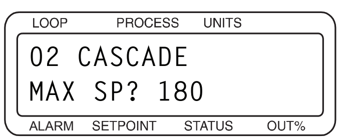
Enter the lowest value of the secondary loop setpoint. This minimum setpoint overrides any calculation caused by the primary loop calling for a lower setpoint. This value is expressed in the same engineering units as the secondary loop's process variable.



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

Maximum Setpoint

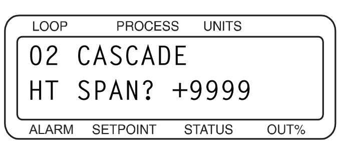
Enter the highest value of the secondary loop setpoint. This maximum setpoint overrides any calculation caused by the primary loop calling for a higher setpoint. This value is expressed in the same engineering units as the secondary loop's process variable.



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

Heat Span

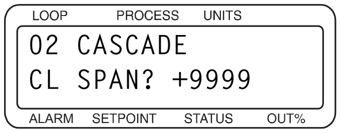
Enter the multiplier to apply to the primary loop heat output percentage



Selectable values: -9999 to +9999.

Cool Span

Enter the multiplier to apply to the primary loop cool out-put 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 setpoint range of 150 to 190°F.

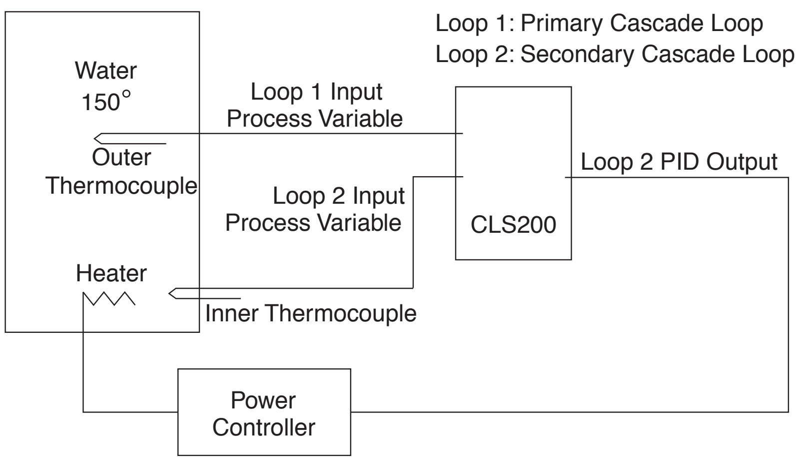


***Figure 5.5** — Application Using Cascade Control*

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 5.2*.
2. Follow the steps in *Table 5.2* to configure cascade control.

Table 5.2 – Application Example: Setting Up Cascade Control

DISPLAY	USER INPUT
SETUP LOOP 02 CASCADE?	Press **YES** to set up the cascade parameters with loop 2 as the secondary loop.
02 CASCADE PRIM. LOOP? 01	Enter 01 for loop 1 process variable. Press **ENTER**.
02 CASCADE BASE SP? 150	The base setpoint corresponds to the 0% level output of the primary loop. Enter the base setpoint of the secondary loop. For this example, we will assume a base setpoint of 150°F, which is the desired water temperature. Press **ENTER**.
02 CASCADE MIN SP? -350	Enter the minimum setpoint of the secondary loop. For this example, we will use a minimum setpoint of -350°F. Press **ENTER**.
02 CASCADE MAX SP? 1400	Enter the maximum setpoint of the secondary loop. For this example, we will use a maximum setpoint of 1400°F. Press **ENTER**.
02 CASCADE HT SPAN? 40	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 setpoint. The desired setpoint range is 150 to 190°F. We will assume a linear rise in setpoint, so the heat span is 40°F. Press **ENTER**.
02 CASCADE CL SPAN? 0	Enter the cool span of the secondary loop. For this example we will assume no low-side adjustment to the setpoint, 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 setpoint 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 setpoint should equal 150 (`BASE SP`).
2. Adjust loop 1 `MANUAL OUTPUT` to `50%`. Loop 2 setpoint should equal 170 (`BASE SP` + 50% of `HT SPAN`)
3. Adjust loop 1 `MANUAL OUTPUT` to `100%`. Loop 2 setpoint 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 setpoint 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 setpoint 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.

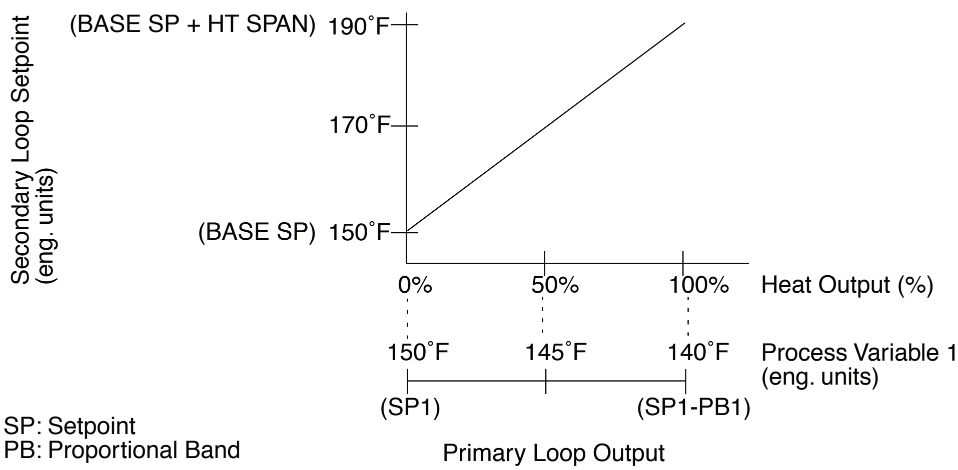


Figure 5.6 *— Secondary Loop Setpoint Related to Primary Loop Output*

As the temperature of loop 1 drops, the output of loop 1 goes up proportionally and the setpoint 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 setpoint (150°F).

With proportional control, when loop 1 is at setpoint, its output is 0%, and the setpoint of loop 2 is equal to the base setpoint (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 setpoint for loop 2 of 4°F. The loop 2 setpoint 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 setpoint 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 setpoint of another loop (ratio loop). You can assign any process variable to determine the setpoint of a ratio loop.

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

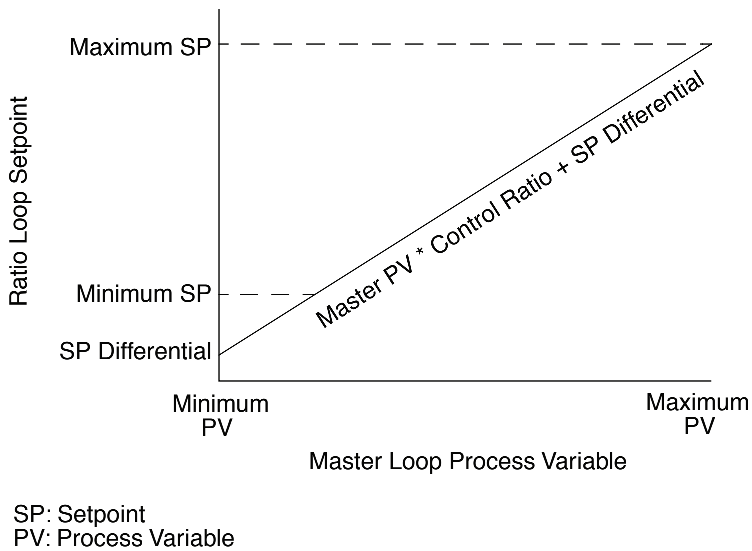
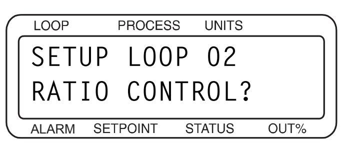


Figure 5.7 — *Relationship Between the Master Loop's Process Variable and the Ratio Loop's Setpoint*

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

Setup Loop Ratio Control Menu

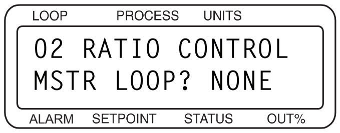
The ratio control parameters appear in the `SETUP LOOP RATIO CONTROL` menu.



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

Master Loop

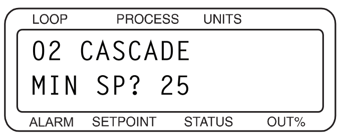
Enter the master loop which will provide the output to the internal controller setpoint calculation for the ratio loop setpoint.



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

Minimum Setpoint

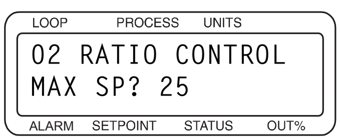
Enter the lowest allowable setpoint for the ratio loop. This minimum setpoint overrides any ratio calculation calling for a lower setpoint. This value is expressed in the same engineering units as the ratio loop's process variable.



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

Maximum Setpoint

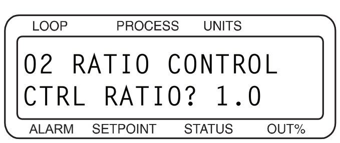
Enter the highest allowable setpoint for the ratio loop. This maximum setpoint overrides any ratio calculation calling for a higher setpoint. This value is expressed in the same engineering units as the ratio loop's process variable.



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

Control Ratio

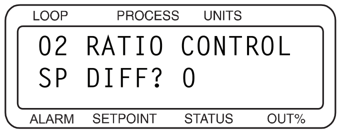
Enter the multiplier to apply to the master loop's process variable.



Selectable values: 0.1 to 999.9.

Setpoint Differential

Enter the value to add or subtract from the ratio loop setpoint calculation before using it as the setpoint. 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 CLS200, 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.

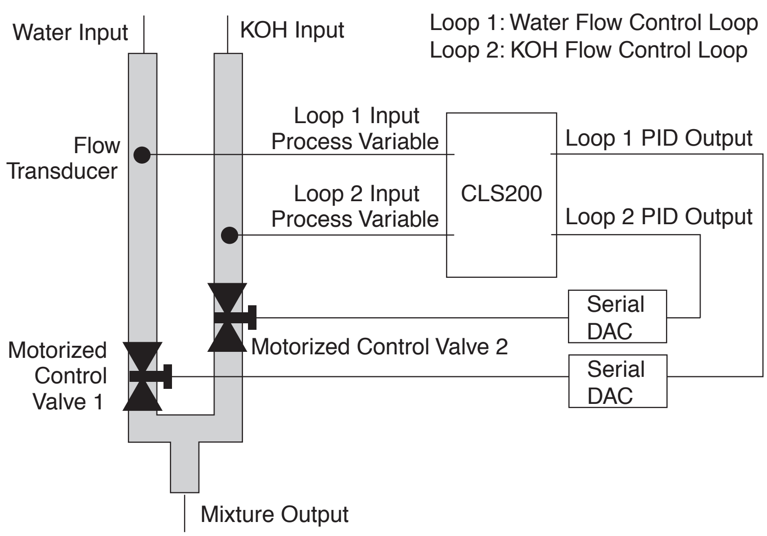


***Figure 5.8** —Application Using Ratio Control*

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 5.3*.
3. Follow the steps in *Table 5.3* to configure ratio control.

Table 5.3 — 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 or 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 setpoint. 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 setpoint. 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 flow rate is multiplied by 0.5 to obtain the KOH flow rate setpoint. Press **ENTER**.
LOOP PROCESS UNITS 02 RATIO CONTROL SP DIFF.? 0 ALARM SETPOINT STATUS OUT%	Enter the setpoint 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 setpoint 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 Setpoint

The remote analog setpoint is set up identically to ratio control. To provide a setpoint 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 setpoint 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 108*.

Remote Analog Setpoint Example: Setting a Setpoint with a PLC

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

Both the remote analog setpoint 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 5VDC signal representing 0 to 300°F will be used as a remote setpoint input to the CLS200. 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 5VDC 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 5.4*.
3. Follow the steps in *Table 5.4* to configure the process variable retransmit option.

Table 5.4 – Application Example: Setting Up Remote Setpoint

DISPLAY	USER INPUT
SETUP LOOP 02 RATIO CONTROL?	Press **YES** to set up the cascade parameters with 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 setpoint. For this example, we will use 0° F. Press **ENTER**.

DISPLAY	USER INPUT
LOOP PROCESS UNITS 02 RATIO CONTROL MAX SP? 300.0 ALARM SETPOINT STATUS OUT%	Enter the maximum ratio loop setpoint. For this example, we will use 300.0° F as a maximum. 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 setpoint 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 setpoint of loop 2 will now be equal to the process variable of loop 1.
5. To complete the remote analog setpoint 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 and enter the desired offset with the SP DIFF. parameter.

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 setpoint 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 325° F and the secondary loop at 375° F by using a differential of 50° F.

Loop 1 must be set up for PID control of the setpoint at 325° F.

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 5.5*.
2. Follow the steps in *Table 5.5* to configure the process variable retransmit option.

Table 5.5 – Application Example: Setting Up Differential Control

DISPLAY	USER INPUT
SETUP LOOP 02 RATIO CONTROL?	Press **YES** to set up the cascade parameters with loop 2.
02 RATIO CONTROL MSTR LOOP? 01	Assign loop 01 as the master loop. Press **ENTER**.
02 RATIO CONTROL MIN SP? 300.0	Enter the minimum ratio loop setpoint. For this example, we will use 300.0° F. Press **ENTER**.
02 RATIO CONTROL MAX SP? 400.0	Enter the maximum ratio loop setpoint. For this example, we will use 400.0° F. 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.? 50	Enter the setpoint 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 setpoint 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.

Chapter 6: Ramp/Soak

This chapter covers setup and operation of ramp/soak profiles in CLS200 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 setpoint 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 setpoint to the current segment's setpoint.

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

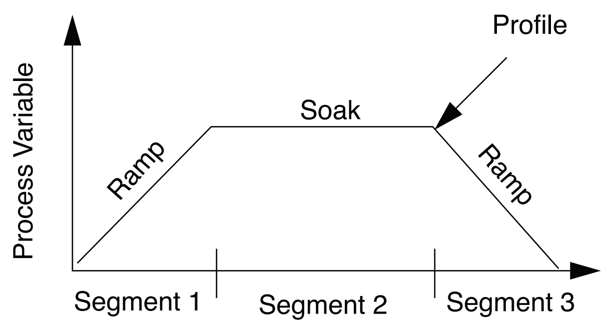


Figure 6.1 *—Sample Ramp/Soak Profile*

Features

Ramp/soak in the CLS200 includes the following features:

- **Ready segment sets loop up for profile:** Ready segment can control at setpoint 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:** The 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 Serial DAC clock.
- **Tolerance hold ensures time at temperature:** Set a limit on how far the process variable can vary above or below setpoint. The profile clock only runs when the process variable is within the limit.
- **Tolerance alarm indicates process not tracking setpoint:** Set a maximum amount of time for the tolerance hold to wait for a process deviation before notifying the operator. The operator can acknowledge the 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 6.1 summarizes the ramp/soak features of the CLS200.

Table 6.1 – Ramp/Soak Specifications

Number of possible profiles	17
Number of times to repeat a profile	1 to 99 or or continuous
Number of segments per profile	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

Ramp/Soak Menus

The SETUP R/S PROFILES menu appears between the SETUP LOOP ALARMS and MANUAL I/O TEST menus. *Figure 6.2* shows the ramp/soak setup menu tree. *See *Process Variable Retransmit on page 98*.

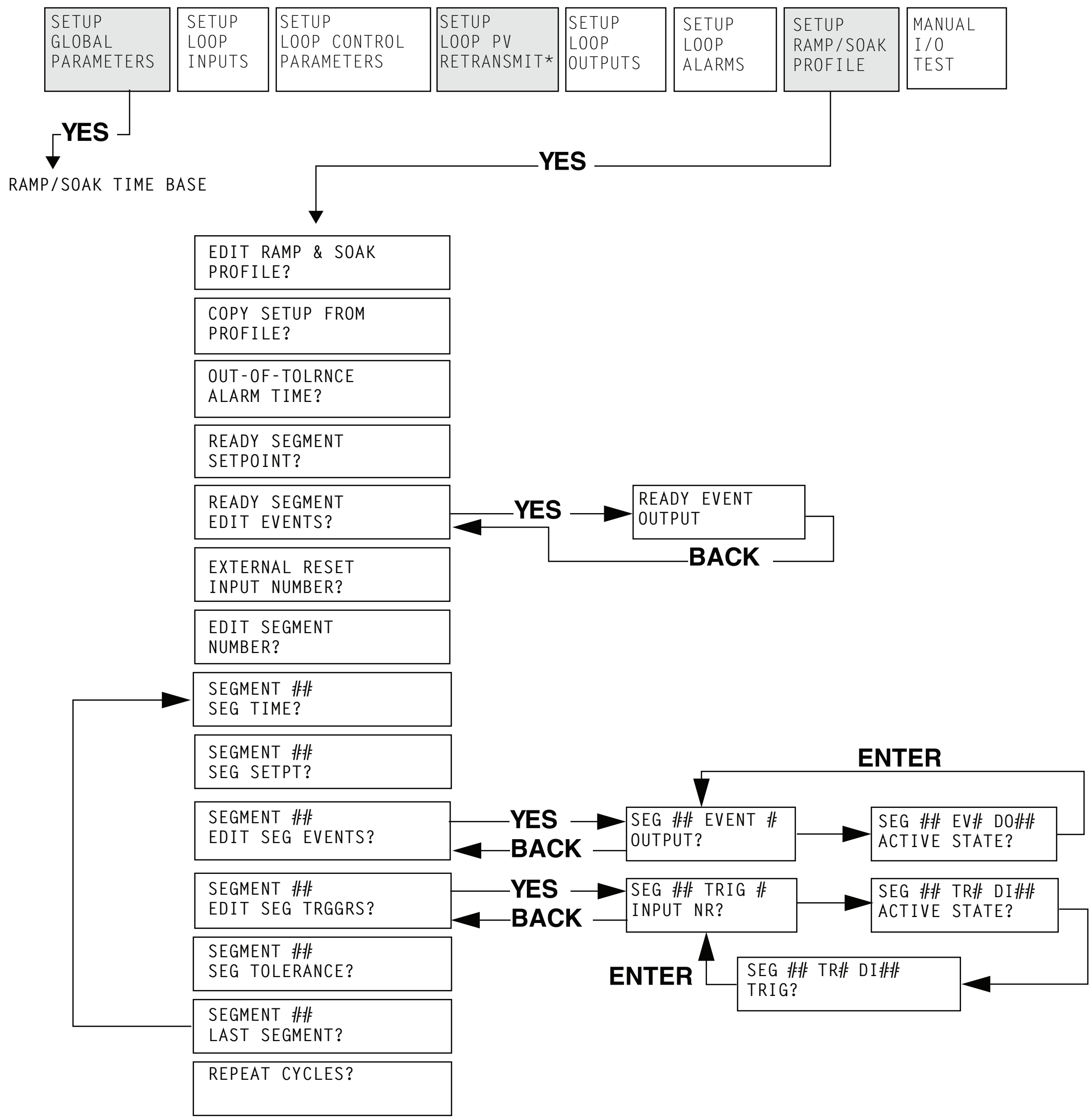


***Figure 6.2** — Setup Ramp/Soak Profiles Menu*

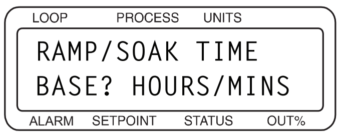
Setup Global Parameters Menu

With the Ramp and Soak option, an additional menu appears on the SETUP GLOBAL PARAMETERS menu.

Ramp/Soak Time Base

The RAMP/SOAK TIME BASE parameter is in the SETUP GLOBAL PARAMETERS menu.

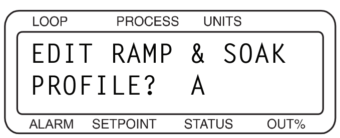
Use this parameter to set the time base in all your ramp/soak profiles. When set to HOURS/MINS, the setpoint is updated once every minute. When set to MINS/SECS, the setpoint is updated once every second.



Selectable values: HOURS/MINS (hours/minutes) or MINS/SECS (minutes/seconds).

Setup Ramp/Soak Profile Menu

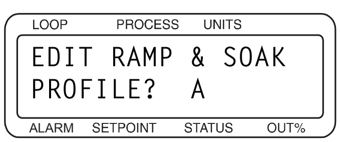
The SETUP RAMP/SOAK PROFILE menu is located between the SETUP LOOP ALARMS and the MANUAL I/O TEST menus if the ramp/soak option is installed.



Press **YES** to set up or edit ramp/soak profiles.

Edit Ramp/Soak Profile

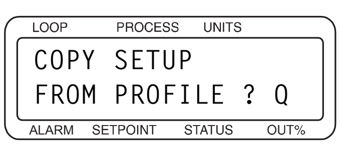
Choose a profile to set up or edit.



Selectable values: A to Q (17 profiles).

Copy Setup From Profile

Set up similar profiles quickly by copying the setup of an existing profile.

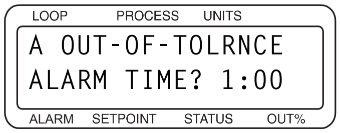


Selectable values: A to Q.

Tolerance Alarm Time

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.

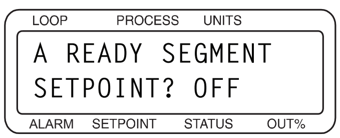


Selectable values: `0:00` to `99:59` (minutes or hours, depending on the time base setting).

Ready Segment Setpoint

When you assign a profile to a loop, the profile does not start immediately. Instead, it goes to the ready segment (segment 0) and stays there until you put the profile in run mode.

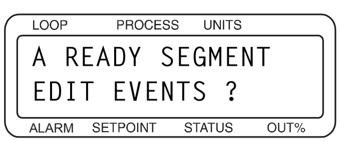
You can set a setpoint, assign events, and set event states for the ready segment. Use this parameter to set the ready segment setpoint. Setting the setpoint to `OFF` ensures that control outputs for the loop running the profile will not come on.



Selectable values: -999 to 9999, or `OFF`. See *Setpoints and Tolerances for Various Input Types on page 124*.

Ready Segment Edit Events

Press **YES** to set or edit the ready state for all outputs that are not used for control or for the Serial DAC clock. When you assign a profile, the controller starts the ready segment: it goes to the setpoint 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.

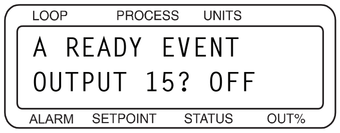


Press **NO** to advance to `EXTERNAL RESET INPUT NUMBER`.

Ready Event Output

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

This parameter appears only if you answered **YES** to READY SEGMENT EDIT EVENTS?

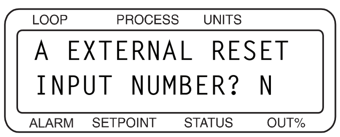


Selectable values: ON or OFF.

When you are done, press **BACK** to return to READY SEGMENT EDIT EVENTS, then press **NO** to go to the next parameter.

External Reset Input Number

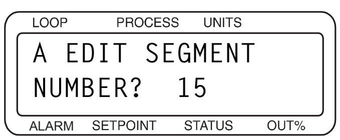
Select one of the eight digital inputs as an external reset. When the reset input is on, the profile is set to RUN mode at the beginning of the first segment. As long as the reset input is on, the profile is held at the beginning of the first segment. Once the reset input turns off the profile begins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



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). Choose the segment to edit.

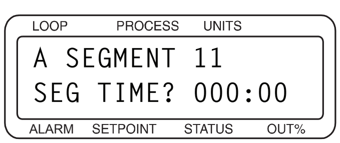


Selectable values: 1 to 20.

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

Segment Time

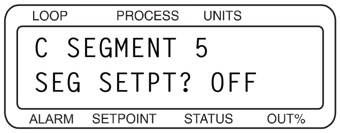
Enter the duration of the segment.



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

Segment Setpoint

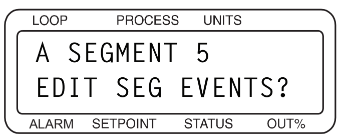
Enter the ending setpoint for the segment you are editing. For a ramp, the setpoint changes steadily over the segment time from the end setpoint of the previous segment to the value set here. For a soak, set the value here equal to the end setpoint of the previous segment.



Selectable values: `-999` to `3276`, or `OFF` (no output during segment). See *Setpoints and Tolerances for Various Input Types on page 124*.

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. Press **YES** to select outputs and specify their states.



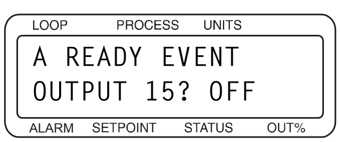
Press **NO** to advance to the `EDIT SEG TRGGRS` parameter.

NOTE! Events are set at the end of segments. If you want a segment to start with an event, 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.

Segment Event Output

Select a digital output for the event. Use a digital output that is not being used for PID control or for Serial DAC clock.

This parameter appears only if you answered **YES** to `EDIT SEG EVENTS?`

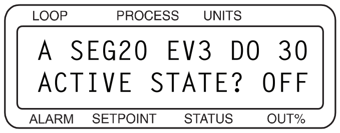


Selectable values: Any digital output from `1` to `34`, except those in use, or `NONE` (no event).

When you are done setting segment events, press **BACK** to return to `EDIT SEG EVENTS`, then press **NO** to go to the next parameter.

Segment Events Output States

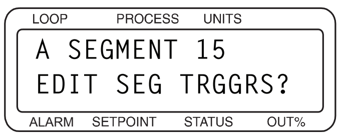
Assign a state to the event. At the end of the segment, the output goes to the state you assign here. This parameter appears only if you answered **YES** to EDIT SEG EVENTS?



Selectable values: OFF (high) or ON (low).

Edit Segment Triggers

Each segment may have up to two triggers (digital inputs). Both 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.

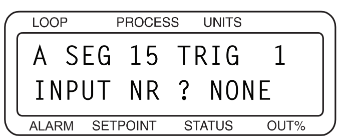


Press **YES** to edit triggers for the current segment, or **NO** to advance to the SEGMENT TOLERANCE parameter.

Trigger Input Number

Assign a digital input 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.

This parameter appears only if you answered **YES** to EDIT SEG TRGGRS?



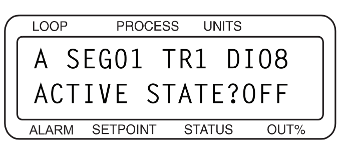
Selectable values: Any digital input from 1 to 8, or NONE (disable trigger).

When you are done editing segment triggers, press **BACK** to return to EDIT SEG TRGGRS.

Trigger Active State

Choose the state that will satisfy the trigger condition. A trigger input is ON when pulled low by an external device. A trigger input is OFF when the digital input is high.

This parameter appears only if you answered **YES** to EDIT SEG TRGGRS?



Selectable values: OFF or ON.

Trigger Latch Status

Choose whether the trigger is latched or unlatched.

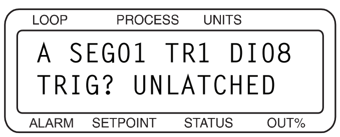
- A latched trigger is checked once, at the beginning of a segment.
- An unlatched trigger is checked constantly while a a segment is running. If an unlatched trigger becomes false, the segment timer stops and the loop goes into trigger wait state.

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

Table 6.2 — Trigger Latch Logic

TRIGGER SETTINGS	TRIGGER LOGIC
Both Triggers Latched	ORed Trigger starts a segment
Both Triggers Unlatched	ANDed Triggers start/continue a segment
One Trigger Latched, One Trigger Unlatched	• The unlatched trigger starts/continues a segment. • The latched trigger has no effect.

This parameter appears only if you answered **YES** to EDIT SEG TRGGRS?



Selectable values: LATCHED or UNLATCHED.

Segment Tolerance

Set a positive or negative tolerance value for each segment. Tolerance works as shown in *Figure 6.3*.

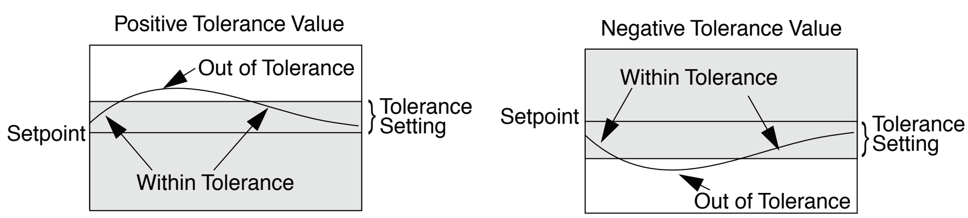
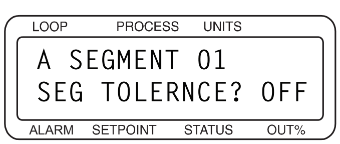


Figure 6.3 — *Positive and Negative Tolerances*

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

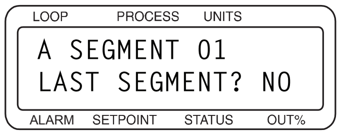
If you enter a negative tolerance, the process goes out of tolerance when the process variable goes below the setpoint minus the tolerance.



Selectable values: -99 to 99, or OFF (no tolerance limit). See *Setpoints and Tolerances for Various Input Types on page 124*.

Last Segment

Specify whether the current segment is the last one in the profile.

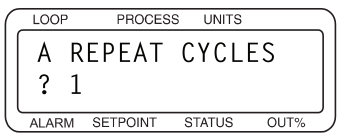


Selectable values: NO or YES.

Repeat Cycles

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).

Setpoints and Tolerances for Various Input Types

Setpoints and tolerances are set in segments before the profile is assigned to a particular loop. When the profile is used with a loop, the INPUT TYPE and DISP FORMATS settings are applied to the following parameters:

- Ready setpoint
- Segment setpoint
- Segment tolerance

Refer to *Table 6.3* to determine how these parameters are affected for the various INPUT TYPE and DISP FORMAT settings.

Table 6.3 – Display Formats

INPUT TYPE	DISPLAY FORMAT	YOU ENTER IN THE PROFILE	RESULTING VALUE WHEN PROFILE IS ASSIGNED TO A LOOP
Thermocouples and RTDs	N/A	300	300.0
Linear	-999 to 3000	300	300.0
	-9999 to 30000	300	300.0
	-999.9 to 3000.0	300	300.0
	-99.99 to 300.0	300	30.00
	-9.999 to 30.000	300	3.000
	-9999 to 3.0000	300	0.3000

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. *Figure 6.4* shows the ramp/soak screens.

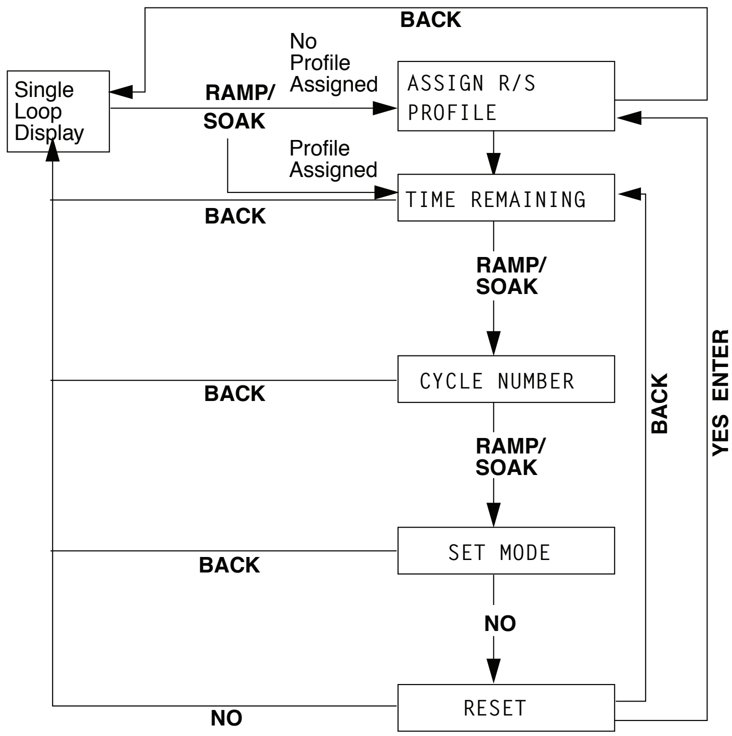


***Figure 6.4** — Ramp/Soak Screens*

Ramp/Soak Displays

The single loop and bar graph displays show additional codes when ramp/soak firmware is installed.

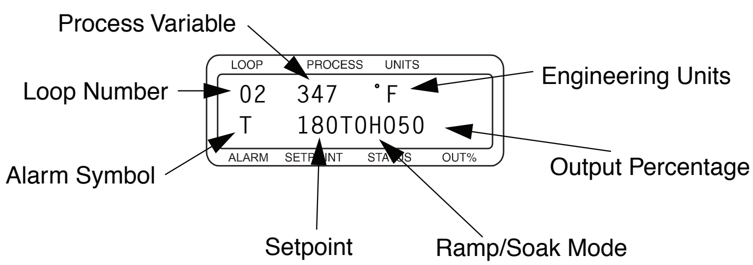
Single Loop Display

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 6.4* describes the modes.

Table 6.4 — Ramp/Soak Single Loop Display

RAMP/SOAK MODE	DESCRIPTION
STRT	The profile is in the ready segment.
RUN	The profile is running.
HOLD	The user has put the profile in hold mode.
TOHO	The profile is in tolerance hold.
WAIT	The profile is in trigger wait state.

This is the single loop display when a profile is running. If a tolerance alarm occurs, the controller displays a flashing T in the alarm symbol position.



Bar Graph Display

The ramp/soak mode is also displayed on the bar graph display. *Table 6.5* describes the control status symbols used for loops with ramp/soak profiles assigned.

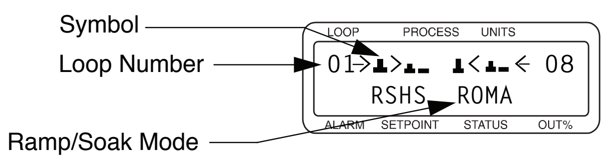


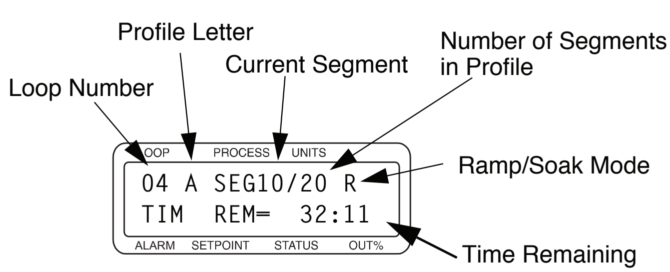
Table 6.5 — Ramp/Soak Control Status Symbols

RAMP/SOAK SYMBOL	DESCRIPTION
R	A profile is running
H	A profile is holding.
S	A profile is in ready state/start mode.
0	A profile is in tolerance hold.
W	A profile is in trigger wait.

Time Remaining Display

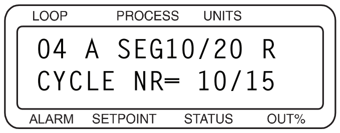
From the single loop display, press the **RAMP/SOAK** key once.

This screen shows how much time remains to complete the profile. All screens that are accessed by pressing RAMP/SOAK key have the same information on the top line.



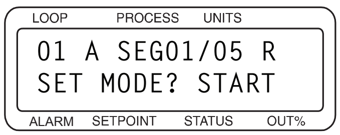
Cycle Number Display

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 Display

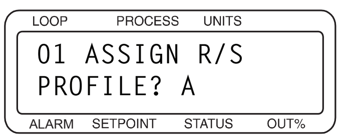
From the single loop display, press the **RAMP/SOAK** key three times. The `SET MODE` parameter allows you to change the ramp/soak mode.



See *Running a Profile on page 128* and *Holding a Profile or Continuing from Hold on page 128* 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 does not 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 `ASSIGN R/S PROFILE` parameter appears.
3. Choose one of the available profiles and press **ENTER**
   - or -
   press **BACK** to return to single loop display without sending profile data to the controller.

Assigning, Changing and Unassigning a Profile

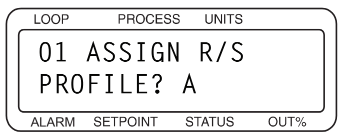
To assign a new profile to a loop that already has one assigned:

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 130*.
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 127*.
5. Choose one of the available profiles or `NONE` (to unassign) and press **ENTER**.
6. To return to the single loop display without changing the profile assignments, press **BACK**.

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 the `SET MODE` parameter to start a profile (put it in `RUN` mode).



Starting a Profile

You can start a profile only when it is 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` parameter 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. Set up 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` parameter to select the ramp/soak profile mode. *Table 6.6* shows the available modes.

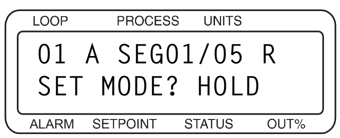
Table 6.6 — Ramp/Soak Profile Modes

CURRENT MODE	AVAILABLE MODE	DESCRIPTION
STRT	RUN	Begin running the assigned profile.
HOLD	CONT	Continue from user-selected hold. The profile runs from the point when you put the profile in HOLD mode. (You cannot continue from a tolerance hold or a trigger wait.) After you choose this mode, the controller switches back to RUN mode.
RUN	HOLD	Hold the profile.

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 into 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 parameter:



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 parameter 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

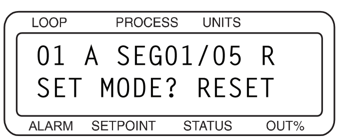
If the process variable does not return within the tolerance, the tolerance alarm will recur after the tolerance alarm time elapses again.

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` parameter.
3. Press the **NO** key. The following screen will display:



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 setpoint goes to the ready setpoint, and the event outputs go to the states you specified for the `READY EVENT OUTPUT` parameter in the `READY SEGMENT EDIT EVENTS` submenu (See *Ready Segment Edit Events on page 119*.)
- The controller shows you the `ASSIGN R/S PROFILE` screen in case you would like to assign a different profile to the loop or select `NONE` to unassign 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 UP 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.

Chapter 7: Turning and Control

This chapter describes the different methods of control available with the CLS200. This chapter covers control algorithms, control methods, PID control, starting PID values and tuning instructions to help appropriately set control parameters in the CLS200 system. For more information on PID control, consult the *Watlow Practical Guide to PID*.

Control Algorithms

This section explains the algorithms available for controlling a loop.

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 is necessary when process variable cycling is unacceptable or if the load or setpoint varies.

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

On/Off Control

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

For example, if the setpoint is 1,000°F and the spread is 20°F, the heat output switches on when the process variable drops below 980°F and off when the process rises above 1,000°F. A process using on/off control cycles around the setpoint. *Figure 7.1* illustrates this example.

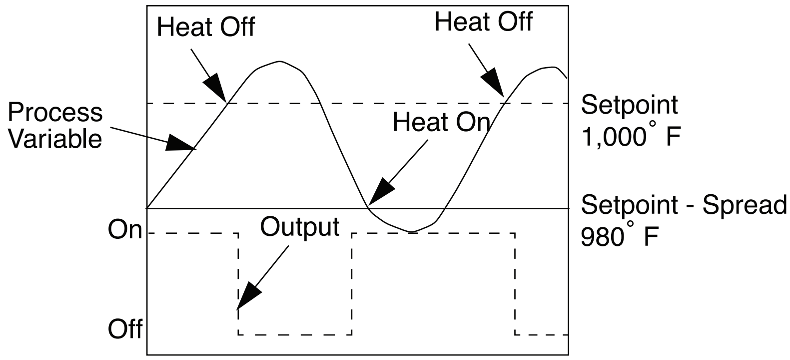


Figure 7.1 *— On/Off Control*

Proportional Control

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

The magnitude of proportional response is defined by the proportional band. 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 setpoint.

For example, if the setpoint is 1,000°F and the proportional band is 20°F, the output is:

- 0% when the process variable is 1,000°F or above
- 50% when the process variable is 990°F
- 75% when the process variable is 985°F
- 100% when the process variable is 980°F or below

However, a process which uses only proportional control settles at a point above or below the setpoint; it never reaches the setpoint by itself. This behavior is known as *offset* or *droop*.

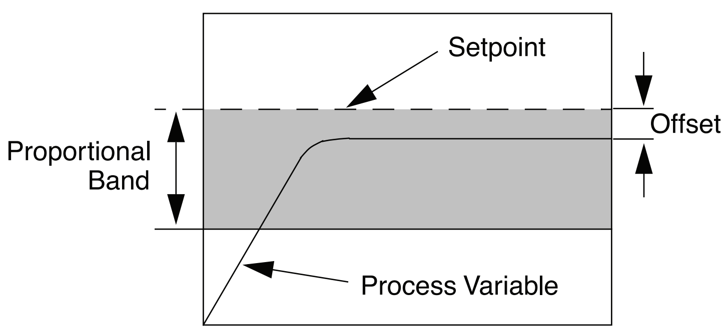


Figure 7.2 *— Proportional Control*

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 5°F below the setpoint, appropriate integral control brings it to the desired setting by gradually increasing the output until there is no deviation.

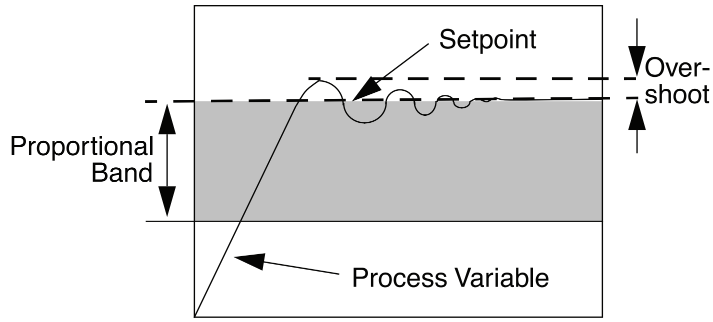


Figure 7.3 *— Proportional and Integral Control*

Proportional and integral action working together can bring a process to setpoint and stabilize it. However, with some processes the user may be faced with choosing between parameters that make the process very slow to reach setpoint and parameters that make the controller respond quickly, but introduce some transient oscillations when the setpoint or load changes. The extent to which these oscillations of the process variable exceed the setpoint is called *overshoot*.

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 setpoint from below, derivative control reduces the output, anticipating that the process variable will reach setpoint. Use it to reduce overshoot and oscillation of the process variable common to PID control. *Figure 7.4* shows a process under full PID control.

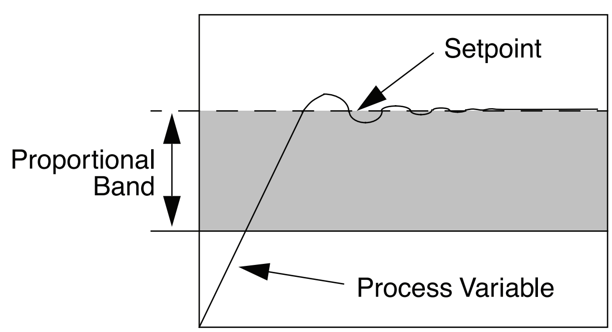


Figure 7.4 *— Proportional, Integral and Derivative Control*

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 83*. 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 (Serial DAC) which, in turn, can provide 0 to 5VDC, 0 to 10VDC or 4 to 20mA control signals to operate field output devices.

Output Control Signals

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 setpoint 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 7.5* shows examples of time proportioning and distributed zero crossing (DZC) waveforms.

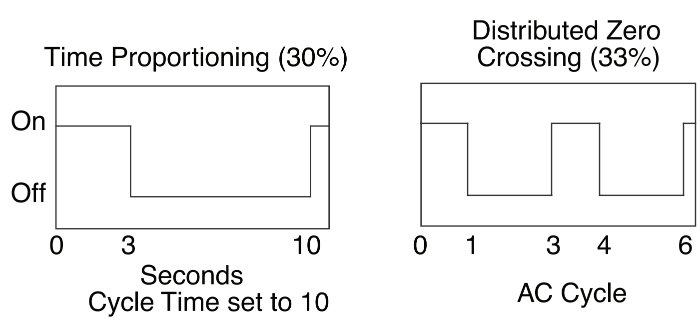


***Figure 7.5** — Time Proportioning and Distributed Zero Crossing Waveforms*

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 (SSR), 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 60Hz power is 16.6ms, the switching interval is very short and the power is applied uniformly. DZC should be used with SSRs. 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 Distributed Zero Crossing (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 Dual DAC or a Serial DAC.

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 a sixteen-loop controller, 0 to 85 seconds for an eight-loop controller or 0 to 43 seconds for a four-loop controller. 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 proportional band, making normal control methods ineffective. Using the output filter allows a smaller proportional band 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 7.1 shows proportional band settings for various temperatures in degrees Fahrenheit or Celsius.

Table 7.1 —Proportional Band Settings

TEMPERATURE SETPOINT	PB	TEMPERATURE SETPOINT	PB	TEMPERATURE SETPOINT	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 proportional band to 10% of the setpoint below 1000° and 5% of the setpoint above 1000°. This setting is useful as a starting value.

Integral Settings

The controller's integral parameter (TI) is set in seconds per repeat. Some other products use an integral term called reset, in units of repeats per minute. *Table 7.2* shows integral settings versus reset settings.

Table 7.2 — Integral Term and Reset Settings

INTEGRAL (SECONDS/REPEAT)	RESET (REPEATS/MINUTE)	INTEGRAL (SECONDS/REPEAT)	RESET (REPEATS/MINUTE)
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 (TD) 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. *Table 7.3* shows derivative versus rate.
Rate = Derivative/60.

Table 7.3 — Derivative Term Versus Rate

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. 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 setpoint. (Example: Setpoint set to 450, proportional band set to 31).

Proportional with Integral (PI)

- Set the proportional band to 10% of setpoint. (Example: Setpoint set to 450, proportional band set to 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 setpoint. (Example: Setpoint set to 450, proportional band set to 45).
- Set the integral to 60.
- Set the derivative to 15% of the integral. (Example: Integral set to 60, derivative set to 9).
- Set the output filter to 2.

Table 7.4 shows general PID constants by application.

Table 7.4 — General PID Constants

APPLICATION	PROPORTIONAL BAND	INTEGRAL	DERIVATIVE	FILTER	OUTPUT TYPE	CYCLE TIME	ACTION
Electrical heat with solid state relays	50°	60	15	4	DZC	–	Reverse
Electrical heat with electro-mechanical relays	50°	60	15	6	TP	20	Reverse
Cool with solenoid valve	70°	500	90	4	TP	10	Direct
Cool with fans	10°	Off	10	4	TP	10	Direct
Electric heat with open heat coils	30°	20	Off	4	DZC	–	Reverse
Gas heat with motorized valves	60°	120	25	8	Analog	–	Reverse
Gas heat with motorized valves Setpoint > 1200	100°	240	40	8	Analog	–	Reverse

Chapter 8: 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 Application Engineering for additional troubleshooting help. If you need to return the unit to Watlow for testing and repair, Customer Service will issue you an RMA number. See *Return Material Authorization (RMA) on page 3.*

CAUTION! 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.

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.

Table 8.1 — Controller Alarm Codes for Process and Deviation Alarms

CODE	ALARM	DESCRIPTION
HP	High Process	Process variable has risen above the high process alarm setpoint.
HD	High Deviation	Process variable has risen above the setpoint by more than the deviation alarm value.
LD	Low Deviation	Process variable has dropped below the setpoint by more than the deviation alarm value.
LP	Low Process	Process variable has dropped below the low process alarm setpoint.

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 status 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 setpoint by more than the alarm setpoint.

NOTE! In cooling applications, similar issues cause high process and high deviation alarms.

In a heating application, a high process alarm setpoint or high deviation alarm may indicate one of the following:

- The setpoint and high process alarm setpoint have been lowered and the system has not had time to cool to within the new alarm limit.
- The control status 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 setpoint by more than the alarm setpoint limit.

Resetting a Process or Deviation Alarm

Your response to an alarm depends upon the alarm type setting, as explained in *Table 8.2* below.

Table 8.2 — 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 the alarm setpoint.
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 alarm setpoints 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.

Table 8.3 — Failed Sensor Alarm Codes

CODE	ALARM	DESCRIPTION
FS	Failed Sensor	Open thermocouple.
RT	Reversed Thermocouple	Termperature 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 8.4 — Hardware Error Messages

MESSAGE	POSSIBLE CAUSE	RECOMMENDED ACTION
`LOW POWER`	Power supply failed	See *Low Power on page 143*.
`BATTERY DEAD`	RAM battery is dead	See *Battery Dead on page 143*.
`AW`	Ambient warning. Ambient temperature exceeds operating limits by less than 5°C (9°F).	See *Ambient Warning on page 144*
`H/W AMBIENT FAILURE`	Ambient temperature exceeds operating limits by 5°C (9°F). Reference voltage (5VDC) shorted to common. Hardware failed due to excessive voltage on inputs.	See *H/W Ambient Failure on page 144*.
`H/W GAIN FAILURE`	Hardware failed due to excessive voltage on inputs.	See *H/W Gain or Offset Failure on page 145*.
`H/W OFFSET FAILURE`	Hardware failed due to excessive voltage on inputs.	See *H/W Gain or Offset Failure on page 145*.

Other Behaviors

The following table indicates potential problems with the system or controller and recommends corrective actions.

Table 8.5 — Other Symptoms

SYMPTOM	POSSIBLE CAUSES	RECOMMENDED ACTION
Indicated temperature not as expected	Controller not communicating	See *Checking Analog Inputs on page 145*.
	Sensor wiring incorrect	
	Noise	
CLS200 display is not lit	Power connection incorrect	Check wiring and service. See *Wiring the Power Supply on page 29*.
	No EPROM or bad EPROM	Replace the EPROM. See *Replacing the EPROM on page 150*.
	CLS200 damaged or failed	Return the CLS200 for repair. See *Return Material Authorization (RMA) on page 3.*
CLS200 display is lit, but keys do not work	Keypad is locked	See *Keys Do Not Respond on page 145*.
	CLS200 damaged or failed	Return the CLS200 for repair. See *Return Material Authorization (RMA) on page 3.*

SYMPTOM	POSSIBLE CAUSES	RECOMMENDED ACTION
Control status of one or more loops changes from automatic to manual	Failed sensor	Check the display or sotware 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 68*.
All loops are set to manual 0%	Power is intermittent	Check wiring and service. See *Wiring the Power Supply on page 29*. 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 71*.
	Analog reference voltage is overloaded	Disconnect wiring from the +5V Ref connection on TB1.
	Hardware failure	Check the controller front panel for a hardware alarm. See *System Alarms on page 142*.
Controller does not behave as expected	Corrupt or incorrect values in RAM	Perform a NO-key reset. See *NO-Key Reset on page 150*.

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.
3. If the error message returns, check that the power supplied to the controller is at least 12.0VDC @ 1A. See *Wiring the Power Supply on page 29*.
4. If the error message returns again, make a record of the settings. Then, perform a NO-key reset. See *NO-Key Reset on page 150*.
5. If the error is not cleared, contact your supplier for further troubleshooting guidance. See *Return Material Authorization (RMA) on page 3.*

Battery Dead

The dead battery alarm indicates that the CLS200 battery is not functioning correctly or has low power or no power. If this alarm occurs, parameters have reset to the factory default settings.

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, make a record of the settings, 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 150*.
4. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Removing or Replacing the Battery on page 152*.

Ambient Warning

The ambient warning alarm indicates that the ambient temperature of the controller is too hot or too cold. Ambient warning occurs when the controller's temperature is in the range of 23 to 32°F or 122 to 131°F (-5 to 0°C or 50 to 55°C). The operating limits are 32 to 122°F (0 to 50°C).

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 (0 to 50°C). If the unit is functioning correctly, the error will clear when the ambient temperature is within range and the alarm has been acknowledged.
3. If the ambient temperature is within range and the error persists:
    a. Turn the power to the controller off.
    b. Remove the boards from the CLS200 housing. See *Replacing the EPROM on page 150*.
    c. Reseat the boards and turn the power on.
4. If the error persists, make a record of the settings then perform a NO-key reset. See *NO-Key Reset on page 150*.
5. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Return Material Authorization (RMA) on page 3*.

H/W Ambient Failure

The hardware ambient failure alarm indicates that the ambient sensor in the CLS200 is reporting that the temperature around the controller is outside of the acceptable range of 0 to 50°C. 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 0 to 50°C. 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. Remove any connections to the 5VDC reference (TB1-18) on the back of the controller. If this corrects the problem, there was an error in the wiring. You may need to consult technical

support to determine the correct wiring.

4. If the ambient temperature is within range and the error persists:
   a. Turn the power to the controller off.
   b. Remove the boards from the CLS200 housing.
   c. Reseat the boards and turn power on.
5. If the error persists, make a record of the settings, then perform a NO-key reset. See *NO-Key Reset on page 150*.
6. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Return Material Authorization (RMA) on page 3*.

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, then on again.
3. If the H/W Gain error is reported, remove any connections to the 5VDC reference (TB1-18) on the back of the controller. If this corrects the problem, there was an error in the wiring. You may need to consult technical support to determine the correct wiring.
4. If the error persists, make a record of the settings, then perform a NO-key reset. See *NO-Key Reset on page 150*.
5. If the error is not cleared, contact your supplier for further troubleshooting guidelines. See *Return Material Authorization (RMA) on page 3*.

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 CLS200 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 71*.

Checking Analog Inputs

If the process variable displayed on the controller is not as expected:

1. If the values displayed in software and on the controller do not agree, verify that the controller is communicating.

2. 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.
3. 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.

> **NOTE!** Noise in excess of 1VAC should be eliminated by correctly grounding the CLS200. See *Wiring the Power Supply on page 29*.

4. 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 20Ω is normal. Readings in excess of 200Ω indicate a problem with the sensor.
    - For RTDs, measure between the IN+ and IN- terminals of TB1. RTD inputs should read between 20 and 250Ω.
5. 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 loop you are testing.

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 2VAC 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 2VAC 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 2VAC may indicate the ground lead is not connected to the CLS200 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 (see *Scaling Resistors on page 154*) and check the input scaling parameter settings (see *Linear Scaling Parameters on page 77*).
- If readings are erratic, look for sources of electrical noise. See *Noise Suppression on page 26*.
- Eliminate possible ground loops. See *Ground Loops on page 28*.
- Contact your supplier for further troubleshooting guidance.

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 kW resistor from +5V 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 CLS200 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 TB18 and TB50

1. Turn on power to the controller.
2. Measure the +5VDC supply at the TB18 or TB50. The voltage should be +4.75 to +5.25VDC:
   a. Connect the voltmeter's common lead to the TB18 screw terminal 2 or TB50 screw terminal 3.
   b. Connect the voltmeter's positive lead to the TB18 or 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 500Ω to 100kΩ resistor between the +5V terminal (TB18 or 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 on page 93*.

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 correct protocol for the software MOD for Modbus® or ANA for Anafaze.
- **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 153* on 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.

User-Written Software

You can request a communications specification from Watlow if you want to write your own software. Watlow 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.

Replacing the EPROM

Replacing the EPROM involves minor mechanical disassembly and reassembly of the controller. You will need a Phillips screwdriver and an IC extraction tool or a small, standard, jeweler's screwdriver.

CAUTION! 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 the controller's settings.
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 8.1*.

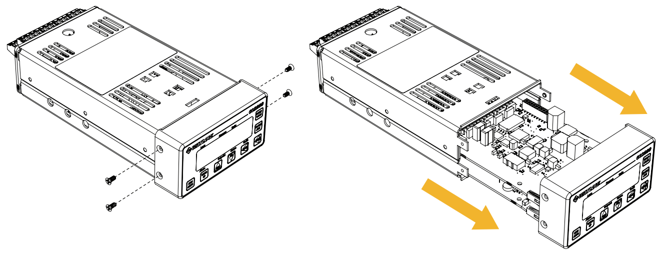


Figure 8.1 *— Remove Board Assembly from Case*

5. Unplug the front panel overlay ribbon cable from the connector on the processor board (the bottom one in the stack of two boards).

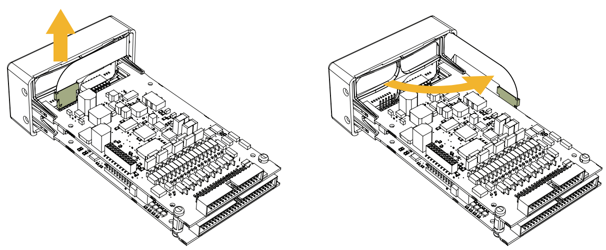


Figure 8.2 *— Disconnect Keypad Ribbon Cable from Processor Board*

6. Pull back the arms that latch the two boards in the carrier at side with the ribbon cable and rotate the boards out of the carrier as shown in Figure 8.3

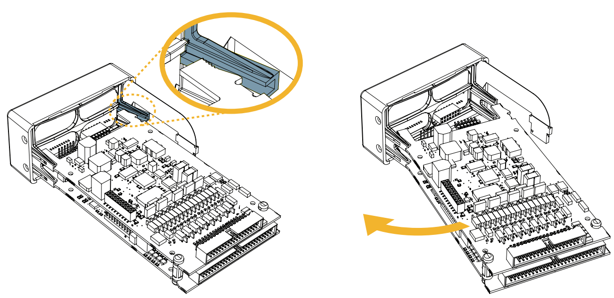


Figure 8.3 *— Unlatch Boards from Carrier*

7. Remove the two plastic standoffs that connect the analog (top) board to the processor (bottom) board and lift the analog board off the processor board.

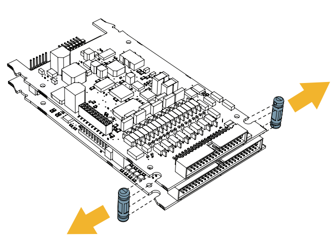


Figure 8.4 *— Remove the Standoffs*

8. Locate the EPROM on the processor board. The EPROM is a 32-pin socketed chip that is labeled with the model, version and checksum.

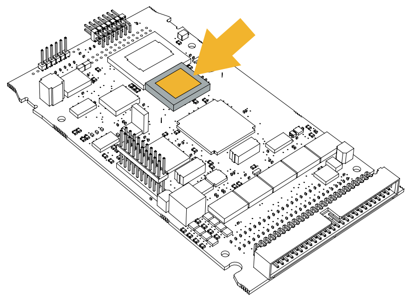


Figure 8.5 *— EPROM Location*

9. Remove the existing EPROM from its socket with an IC extraction tool or a jeweler's flathead screwdriver.

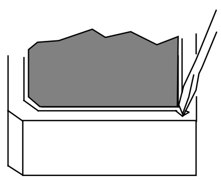


Figure 8.6 *— Remove EPROM*

10. Carefully insert the new EPROM into the socket. Make sure that the chip is oriented so that its notch fits in the corresponding corner of the socket.
11. Reverse steps 3 through 7 to reassemble the unit. However, at step 6 insert the two-board assembly straight in to the carrier making sure all four arms latch on the boards.
12. Power up the controller.
13. Re-enter the controller settings, if necessary.

Removing or Replacing the Battery

The lithium battery in the battery-backed RAM module on the processor board should be removed and disposed of properly if decommissioning the controller. It may also be replaced, if needed during the life of the controller.

To remove the battery:

1. Follow steps 1 to 7 of the procedure *Replacing the EPROM on page 150* to access the processor board.
2. Locate the battery backed RAM module. See *Figure 8.10 — Single-Ended Input Circuit in Sixteen-Loop Controllers on page 157*.
3. Insert a small flat blade screwdriver vertically into the slot on one side of the RMA module.
4. Angle the screwdriver handle toward the center of the RAM chip gently until the side with the

slot unlatches and the battery holder comes off the module.

5. Remove the battery from the holder.
6. Follow local applicable recycling requirements for Coin Cell Lithium type BR-1632 Battery.

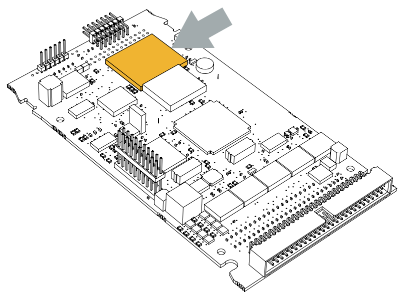


Figure 8.7 *— Battery-Backed RAM Module on the Processor Board*

To replace the battery, if desired:

1. Align the contact springs on the battery holder with the contacts on the RAM module.
2. Hook the battery holder flange under the RAM module's base board.
3. Fit the alignment ribs on the battery holder into the alignment notches in the RAM module's base board.
4. Push down and forward and latch the battery holder on the module.
5. To reassemble the unit reverse steps 3 through 7 of the procedure *Replacing the EPROM on page 150*. However, at step 6 insert the two-board assembly straight in to the carrier making sure all four arms latch on the boards.
6. Power up the controller.
7. Re-enter the controller settings, if necessary.

Changing Communications

To switch between EIA/TIA-232 and EIA/TIA-485, change the jumpers as shown in *Figure 8.8*.

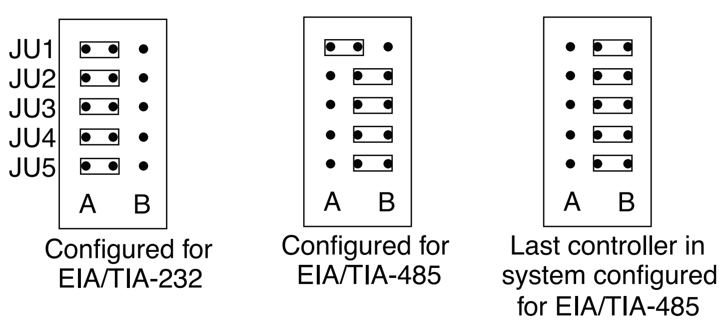


Figure 8.8 *— Jumper Configurations*

You will need tweezers and a Phillips head screwdriver to switch between EIA/TIA-232 and

EIA/TIA-485. Follow these steps:

1. Power down the unit.
2. Remove the controller’s metal casing. See *Replacing the EPROM on page 150* for step-by-step instructions.
3. On the top board find the four-jumper block on JU2, JU3, JU4 and JU5.
4. Use tweezers to carefully slide the jumper block off the pins.
5. Use tweezers to gently slide the four-jumper block onto the correct pins (see Figure 8.8).
6. If you are configuring the controller as the last device on an EIA/TIA-485 network, move JU1 to the B position.
7. Reassemble the controller.

Scaling Resistors

Resistors are installed for all inputs on the CLS200. Inputs with signal ranges between -10 and +60mV use 0Ω resistors in the RC position only. All other input signals require special input scaling resistors.

The following sections describe the scaling resistors to help you determine how a unit is configured.

NOTE! Scaling resistors cannot be changed in the field. For input types other than thermocouples, the controller must be ordered with and factory configured with scaling resistors.

Four-Loop and Eight-Loop Input Circuit

Four-loop and eight-loop controllers can accept differential thermocouple, mV DC, VDC, mADC and RTD inputs. Unless ordered with special inputs these controller accept only signals within the standard range -10 to 60mVDC. To accommodate other signals, the input circuit must be modified. When configured for thermocouple inputs, 0Ω resistors are installed in all RC locations. To accommodate voltage signals outside the standard range, milliamp current signals or RTDs, resistors are added or replaced to scale the signals to the standard range.

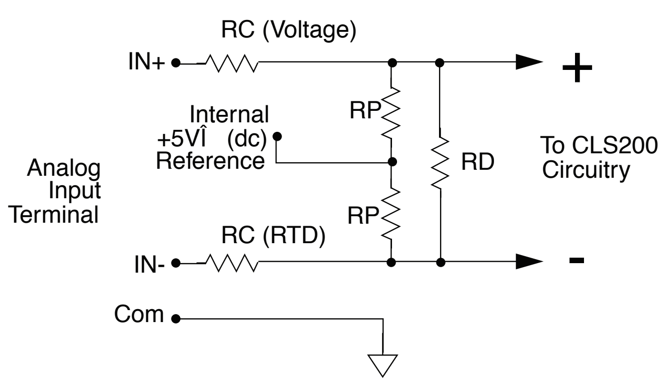


Figure 8.9 *— Differential Input Circuit in Four-Loop and Eight-Loop Controllers*

Figure 8.9 shows the input circuit for one differential, analog input. See *Current Inputs to Four-Loop and Eight-Loop Controllers on page 155* through *RTDs and Thermistor Inputs to Four-Loop and Eight-Loop Controllers on page 156* for resistor values for voltage, current and RTD inputs.

Current Inputs to Four-Loop and Eight-Loop Controllers

Each current input has a 3.0Ω resistor in the resistor pack (RP) location for the input. Resistor pack locations have three through holes. Resistors are installed as shown in the illustration below.

Table 8.6 — Resistor Values for Current Inputs to Four-Loop and Eight-Loop Controllers

INPUT RANGE	RESISTOR VALUE RD
0 to 20mA	3.0Ω

Resistor tolerance: ±0.1%

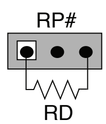


Table 8.7 — Resistor Locations for Current Inputs to Four-Loop and Eight-Loop Controllers

LOOP	RESISTOR LOCATION RD
1	RP1
2	RP2
3	RP3
4	RP4

LOOP	RESISTOR LOCATION RD
5	RP5
6	RP6
7	RP7
8	RP8

Voltage Inputs to Four-Loop and Eight-Loop Controllers

Each voltage input uses two scaling resistors one at the resistor pack (RP) and one at RC for the input. The values of the resistors determines the input range. Resistor pack locations have three pads. Resistors are installed as shown in the illustration below.

Table 8.8 — Resistor Values for Voltage Inputs to Four-Loop and Eight-Loop Controllers

INPUT RANGE	RESISTOR VALUES	
	RC	RD
0 to 5VDC	39.2Ω	475.0Ω
0 to 10VDC	49.9Ω	301.0Ω

Resistor tolerance: ±0.1%

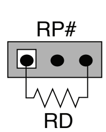


Table 8.9 — Resistor Locations for Voltage Inputs to Four-Loop and Eight-Loop Controllers

LOOP	RESISTOR LOCATIONS	
	RC	RD
1	R58	RP1
2	R56	RP2
3	R54	RP3
4	R52	RP4
5	R50	RP5
6	R48	RP6
7	R46	RP7
8	R44	RP8

RTDs and Thermistor Inputs to Four-Loop and Eight-Loop Controllers

Each RTD or thermistor input has three scaling resistors installed: one each at RA, RB and RC for the input. The values of the resistors determines the input range. RA and RB are a matched pair of resistors installed in the resistor pack (RP) location as shown in the illustration below.

Table 8.10 — Resistor Values for RTD and Thermistor Inputs to Four-Loop and Eight-Loop Controllers

INPUT RANGE	RESISTOR VALUES	
	RA/RB	RC
RTD1	10.0kΩ	80Ω
RTD2	25.0kΩ	100Ω

Resistor tolerances: RA/RB 0.1% (10 ppm/°C) matched to 0.02% (2 ppm/°C) RC 0.05%.

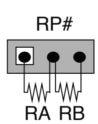


Table 8.11 — Resistor Locations for RTD and Thermistor Inputs to Four-Loop and Eight-Loop Controllers

LOOP	RESISTOR LOCATIONS	
	RA/RB	RC
1	RP1	R57
2	RP2	R55
3	RP3	R53
4	RP4	R51
5	RP5	R49
6	RP6	R47
7	RP7	R45
8	RP8	R43

Sixteen-Loop Input Circuit

Sixteen-loop controllers can accept single-ended thermocouple, mVDC, VDC and mA DC inputs. Unless ordered with special inputs, the controller accepts only signals within the standard range of -10 to 60mVDC.

To accommodate other signals, the input circuit must be modified. When configured for thermocouple inputs, 0Ω resistors are installed in all RC locations. To accommodate milliamp current signals or voltage signals outside the standard range, resistors are added or replaced to scale the signals to the standard range.

Figure 8.10 shows the schematic for one single-ended sensor input to sixteen-loop controller. See *Current Inputs to Sixteen-Loop Controllers on page 157* and *Voltage Inputs to Sixteen-Loop Controllers on page 158* for specific instructions and resistor values for voltage and current inputs.

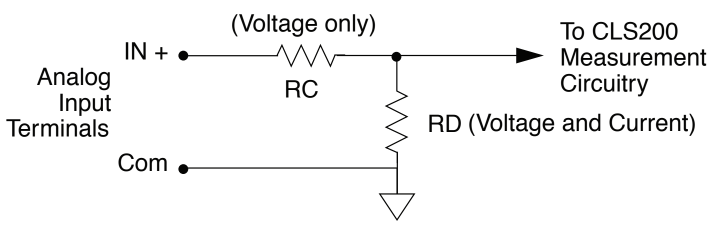


Figure 8.10 *— Single-Ended Input Circuit in Sixteen-Loop Controllers*

Current Inputs to Sixteen-Loop Controllers

Each current input has a 3.0Ω resistor in the RD location for the input.

Table 8.12 — Resistor Values for Current Inputs to Sixteen-Loop Controllers

INPUT RANGE	RESISTOR VALUE RD
0 to 20mA	3.0Ω

Resistor tolerance: ±0.1%

Table 8.13 — Resistor Locations for Current Inputs to Sixteen-Loop Controllers

LOOP	RESISTOR LOCATION RD
1	R42
2	R40
3	R38
4	R36
5	R34
6	R32
7	R30
8	R28

LOOP	RESISTOR LOCATION RD
9	R41
10	R39
11	R37
12	R35
13	R33
14	R31
15	R29
16	R27

Voltage Inputs to Sixteen-Loop Controllers

Each voltage input has two scaling resistors installed: one at RC and one at RD for the input. The values of the resistors determines the input range.

Table 8.14 – Resistor Values for Voltage Inputs to Sixteen-Loop Controllers

INPUT RANGE	RESISTOR VALUES	
	RC	RD
0 to 5VDC	39.2Ω	475.0Ω
0 to 10VDC	49.9Ω	301.0Ω

Resistor tolerance: ±0.1%

Table 8.15 – Resistor Locations for Voltage Inputs to Sixteen-Loop Controllers

LOOP	RESISTOR LOCATIONS	
	RC	RD
1	R58	R42
2	R56	R40
3	R54	R38
4	R52	R36
5	R50	R34
6	R48	R32
7	R46	R30
8	R44	R28

LOOP	RESISTOR LOCATIONS	
	RC	RD
9	R57	R41
10	R55	R39
11	R53	R37
12	R51	R35
13	R49	R33
14	R47	R31
15	R45	R29
16	R43	R27

Scaling and Calibration

The controller provides offset calibration for thermocouple, RTD, and other fixed ranges, and offset and span (gain) calibration for linear and pulse inputs. In order to scale linear input signals, you must:

1. Have appropriate scaling resistors installed.
2. Select the display format. The smallest possible range is -.9999 to 3.0000; the largest possible range is -9,999 to 30,000.
3. Enter the appropriate scaling values for your process.

Chapter 9: Linear Scaling Examples

This chapter provides three linear scaling examples. The examples describe:

- A pressure sensor generating a 4 to 20mA signal
- A flow sensor generating a 0 to 5V signal
- A pulse encoder generating 900 pulses per inch of movement

Example 1: A 4-to-20mA Sensor

Situation

A pressure sensor that generates a 4 to 20mA signal is connected to the controller. The specifications of the sensor state it generates 4mA at 0.0 pounds per square inch (PSI) and 20mA at 50.0 PSI.

Setup

The sensor is connected to a loop input set up with a resistorscaling network producing 60mV at 20mA.

The `INPUT TYPE` for the loop is set to `LINEAR`. The sensor measures PSI in tenths, so the DISP `FORMAT` is set to -999.9 to 3000.0.

Table 9.1 — Input Readings

PROCESS VARIABLE DISPLAYED	SENSOR INPUT	READING, PERCENT OF FULL SCALE (%FS)
50.0 PSI	20mA	100%FS
0.0 PSI	4mA	100% x (4mA/20mA) = 20%FS

The scaling values setup in the `SETUP LOOP INPUT` menu are shown in *Table 9.2*.

Table 9.2 — Scaling Values

PARAMETER	PROMPT	VALUE
High Process Variable	`HIGH PV`	50.0 PSI
High Sensor Reading	`HIGH RDG`	100.0%FS
Low Process Variable	`LO PV`	0.0 PSI
Low Sensor Reading	`LO RDG`	20.0%FS

Example 2: A 0-to-5VDC Sensor

Situation

A flow sensor connected to the controller measures the flow in a pipe. The sensor generates a 0 to 5V signal. The sensor's output depends on its installation. Independent calibration measurements of the flow in the pipe indicate that the sensor generates 0.5V at three gallons per minute (GPM) and 4.75V 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 60mV at 5V. The `INPUT TYPE` for the loop is set to `LINEAR`. The calibrating instrument is precise to ±1 GPM, so the `DISP FORMAT` is set to -999 to 3000.

This table shows the input readings and the percentage calculation from the 60mV full scale input.

Table 9.3 — Input Readings and Calculations

PROCESS VARIABLE DISPLAYED	SENSOR INPUT	READING, PERCENT OF FULL SCALE (%FS)
65 GPM	4.75	(4.75V / 5.00V) x 100%=95%FS
3 GPM	0.5	(0.5V / 5.00V) x 100%=10%FS

Table 9.4 — Scaling Values

PARAMETER	PROMPT	VALUE
High Process Variable	`HIGH PV`	65 GPM
High Sensor Reading	`HIGH RDG`	95.0%FS
Low Process Variable	`LO PV`	0.0 PSI
Low Sensor Reading	`LO RDG`	10.0%FS

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 (FPM).

Setup

The encoder input is connected to the controller's pulse input. The `INPUT TYPE` for the loop is set to `PULSE`. A one second sample time gives adequate resolution of the conveyor's speed. The resolution is:

$$\frac{\text{1 pulse}}{\text{1 second}} \times \frac{\text{60 seconds}}{\text{1 minute}} \times \frac{\text{1 inch}}{\text{900 pulses}} \times \frac{\text{1 foot}}{\text{12 inches}} = \text{1.11 FPM}$$

A `DISP FORMAT` of -99.99 to 300.00 is appropriate.

The input readings are as follows:

- At 0Hz, the input reading will be 0.00 FPM.
- At the maximum pulse rate of the CLS200 (2000Hz):

$$\frac{\text{2000 pulses}}{\text{1 second}} \times \frac{\text{60 seconds}}{\text{1 minute}} \times \frac{\text{1 inch}}{\text{900 pulses}} \times \frac{\text{1 foot}}{\text{12 inches}} = \text{11.11 FPM}$$

Table 9.5 — Scaling Values

PARAMETER	PROMPT	VALUE
High Process Variable	`HIGH PV`	11.11 FPM
High Sensor Reading	`HIGH RDG`	2000Hz
Low Process Variable	`LO PV`	0 FPM
Low Sensor Reading	`LO RDG`	0Hz

Chapter 10: Specifications

This chapter contains specifications for the CLS200 series controllers and the TB50 terminal board.

CLS200 System Specifications

This section contains CLS200 series controller specifications for environmental specifications and physical dimensions, inputs, outputs, the serial interface and system power requirements.

Table 10.1 — Agency Approvals / Compliance

CE Directive	See Declaration of Conformity
UL® and C-UL	UL® 61010-1 Safety requirements for measurement, control and laboratory equipment File E185611

CLS200 Processor Physical Specifications

Table 10.2 — Environmental Specifications

Storage Temperature	-20 to 60°C
Operating Temperature	0 to 50°C
Humidity	10 to 95% non-condensing
Environment	The controller is for indoor use only

Table 10.3 — Physical Dimensions

Weight	1.98 lbs	0.9kg
Length*	8.0 inches	203 mm
Width	3.80 inches	96 mm
Height	1.98 inches	50 mm

* Without SCSI cable or with TB18 option.

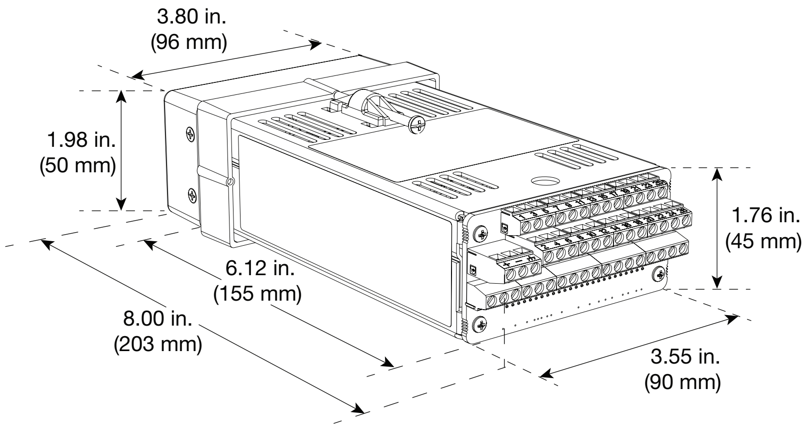


***Figure 10.1** — CLS200 Processor Module Dimensions*

Table 10.4 — Processor with Standard SCSI Cable

Length	10.0 inches	254 mm
Width	3.80 inches	96 mm
Height	1.98 inches	50 mm

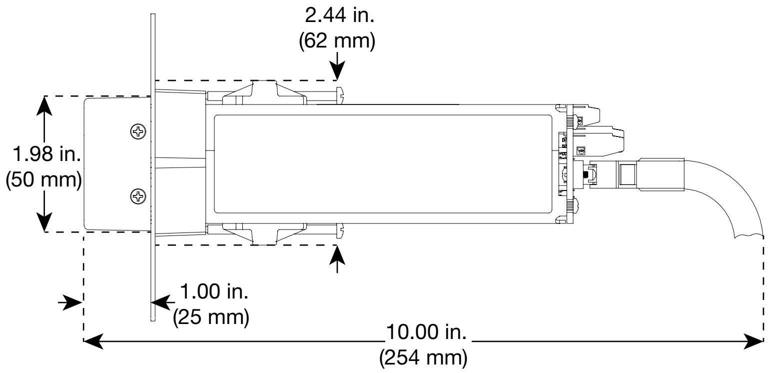


***Figure 10.2** — CLS200 Clearances with Straight SCSI Cable*

Table 10.5 — Processor with Right Angle SCSI Cable

Length	9.0 inches	229 mm
Width	3.80 inches	96 mm
Height	1.98 inches	50 mm

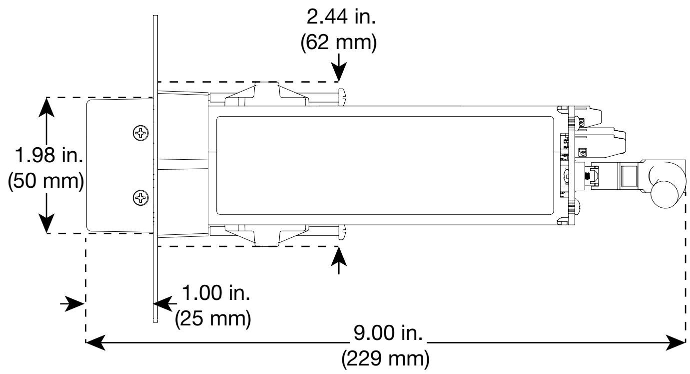


Figure 10.3 — CLS200 Clearances with Right-Angle SCSI Cable

Table 10.6 — Processor 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 0.6Nm)
Sensor Terminals (TB1)	Captive screw cage clamp
Sensor Wire Gauge (TB1)	Thermocouples: 20 AWG (0.5 mm^2) Linear: 22 to 20 AWG (0.5 mm^2) Communications: 24 AWG (0.2 mm^2)
Sensor Terminal Torque (TB1)	4.4 to 5.3 in-lb. (0.5 to 0.6Nm)
Output Terminals (TB18)	Captive screw cage clamp
Output Wire Gauge (TB18)	Multiconductor cables: 24 AWG (0.2 mm^2) Single-wire: 22 to 18 AWG (0.5 to 0.75 mm^2)
Output Terminal Torque (TB18)	4.4 to 5.3 in-lb. (0.5 to 0.6Nm)
SCSI Connector	SCSI-2 female

TB50 Physical Specifications

Table 10.7 — TB50 Physical Dimensions

Weight	0.32 lbs	0.15kg
Length*	4.1 inches	104 mm
Width	4.0 inches	102 mm
Height DIN Rail Mounted	1.5 inches	37 mm
Height Off Panel (DIN Brackets Removed)	0.92 Inches	23 mm

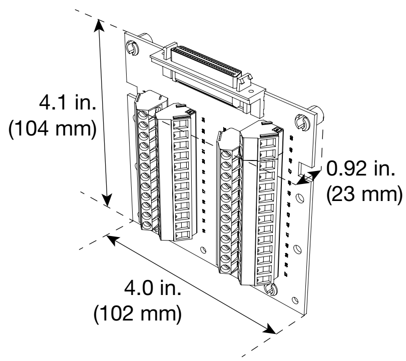


Figure 10.4 — TB50 Dimensions

Table 10.8 — TB50 Connections

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)
Screw Terminal Torque	4.4 to 5.3 in-lb. (0.5 to 0.6Nm)

Table 10.9 — TB50 with Straight SCSI Cable

Length	6.4 inches	163 mm
Width	4.0 inches	102 mm
Height DIN Rail Mounted	1.5 inches	37 mm

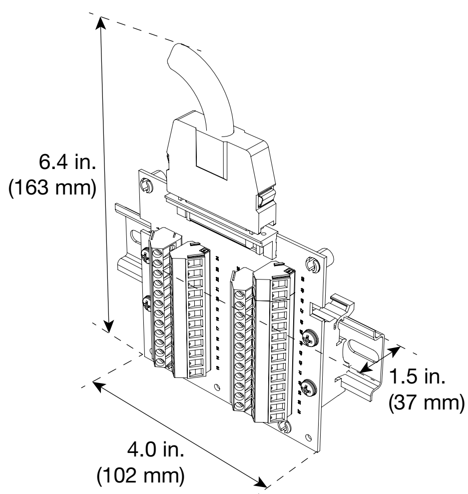


Figure 10.5 — TB50 Dimensions with Standard SCSI Cable

Table 10.10 — TB50 with Right Angle SCSI Cable

Length	5.4 inches	137 mm
Width	4.0 inches	102 mm
Height DIN Rail Mounted	1.5 inches	37 mm

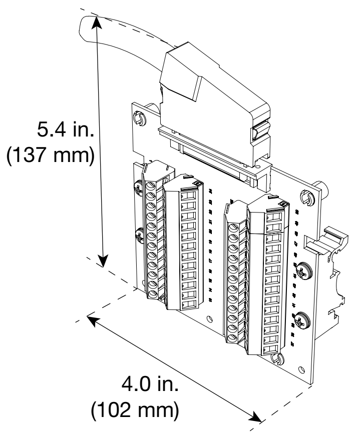


***Figure 10.6** — TB50 Dimensions with Right-Angle SCSI Cable*

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 10.11 — Analog Inputs

PARAMETER	DESCRIPTION
Number of Analog Inputs	4 with full range of input types, plus one pulse OR 8 with full range of input types, plus one pulse OR 16 with full range of input types, plus one pulse
Input Switching	4-Loop and 8-Loop: Differential solid state multiplexer 16-Loop: Single-ended, solid state multiplexer
Input Sampling Rate	4-Loop: 6Hz (167 ms) at 60Hz; 5Hz (200 ms) at 50Hz 8-Loop: 3Hz (333 ms) at 60Hz; 2.5Hz (400 ms) at 50Hz 16-Loop:1.5Hz (667 ms) at 60Hz; 1.25Hz (800 ms) at 50Hz
Analog Over Voltage Protection	±20V referenced to digital ground
Maximum Common Mode Voltage	5V input to input or input to analog common (four-loop and eight-loop models)
Common Mode Rejection (CMR)	For inputs that do not exceed ±5V, >60dB dc to 1kHz, and 120dB at selected line frequency
A/D Converter	Integrates voltage to frequency
Input Range	-10 to +60mV, or 0 to 25V with scaling resistors
Resolution	0.006%, greater than 14 bits (internal)

PARAMETER	DESCRIPTION
Accuracy	0.03% of full scale (60mV) at 25°C
	0.08% of full scale (60mV) at 0 to 50°C
Calibration	Automatic zero and full scale
DC Common to Frame Ground Maximum Potential	20V
Thermocouple Break Detection	Pulse type for upscale break detection
Milliampere Inputs	0 to 20mA (3Ω resistance) or 0 to 10mA (6Ω resistance), with scaling resistors
Linear Voltage Input Ranges Available	0 to 10V or 0 to 5V with scaling resistors
Source Impedance	For 60mV thermocouple, measurements are within specification with up to 500Ω source resistance For other types of analog signals, the maximum source impedance is 5,000Ω

Table 10.12 — Pulse Inputs

PARAMETER	DESCRIPTION
Number	1
Frequency Range	0 to 2,000Hz
Input Voltage Protection	Diodes to supply and common
Voltage Levels	<1.3V: Low >3.7V: High (TTL)
Maximum Switch Resistance to Pull Input Low	2kΩ
Minimum Switch Off Resistance	30kΩ

Table 10.13 — Thermocouple Range and Resolution

THERMOCOUPLE TYPE	RANGE IN °F	RANGE IN °C	ACCURACY* AT 25°C AMBIENT		ACCURACY* AT 0 TO 50°C AMBIENT	
			°F	°C	°F	°C
J	-350 to 1,400	-212 to 760	±2.2	±1.2	±3.3	±1.8
K	-450 to 2,500	-268 to 1,371	±2.4	±1.3	±3.8	±2.1
T	-450 to 750	-268 to 399	±2.9	±1.6	±5.8	±3.2
S	0 to 3,200	-18 to 1,760	±5.0	±2.8	±8.8	±4.9
R	0 to 3,210	-18 to 1,766	±5.0	±2.8	±8.8	±4.9
B	150 to 3,200	66 to 1,760	±7.2	±4.0	±22.1	±12.3
E	-328 to 1,448	-200 to 787	±1.8	±1.0	±2.9	±1.6

* True for 10% to 100% of span except type B, which is specified for 800°F to 3200°F.

Table 10.14 — RTD Range and Resolution

NAME	RANGE IN °F	RANGE IN °C	RESOLUTION IN °C	MEASUREMENT TEMPERATURE IN °C	ACCURACY* AT 25°C AMBIENT		ACCURACY* AT 0 TO 50°C AMBIENT	
					°F	°C	°F	°C
RTD1	-148.0 to 527.0	-100.0 to 275.0	0.023	25	±0.7	±0.4	±1.0	±0.6
				275	±1.9	±1.1	±2.8	±1.6
RTD2	-184 to 1544	-120 to 840	0.023	25	±2.5	±1.4	±5.9	±3.3
				840	±2.9	±1.6	±8.6	±4.8

Table 10.15 — Input Resistance for Voltage Inputs

RANGE	INPUT RESISTANCE
0 to 10V	50kΩ
0 to 5V	40kΩ

Table 10.16 — Digital Inputs

PARAMETER	DESCRIPTION
Number	8
Configuration	8 selectable for output override, remote job selection
Input Voltage Protection	Diodes to supply and common. Source must limit current to 10mA for override conditions
Voltage Levels	<1.3V: Low >3.7V: High (TTL) 5V maximum, 0V minimum
Maximum Switch Resistance to Pull Input Low	1kΩ
Minimum Switch Off Resistance	11kΩ
Update Rate	6Hz

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.

An open-collector CPU watchdog output is also provided so that an external device may monitor the CPU state.

Analog Outputs

Analog outputs may be accomplished by using Dual DAC or Serial DAC modules in conjunction with the digital outputs. Contact your supplier or Watlow for more information on these accessory products.

Digital Outputs

Table 10.17 — Digital Outputs Control / Alarm

PARAMETER	DESCRIPTION
Number	35 via TB50 and/or SCSI option, 13 via TB18
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, Serial DAC 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	<0.01mA to dc common
Maximum Current	60mA for each output. 5V power supply (from the processor module) can supply up to 350mA total to all outputs.
Maximum Voltage Switched	24VDC

Table 10.18 — 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	10mA (5V power supply in the processor module can supply up to 350mA total to all outputs)
Maximum Voltage Switched	5VDC

Table 10.19 — 5VDC Output (Power to Operate Solid-State Relays)

PARAMETER	DESCRIPTION
Voltage	5VDC
Maximum Current	350mA

Table 10.20 — Reference Voltage Output (Power to Operate Bridge Circuit Sensors)

PARAMETER	DESCRIPTION
Voltage	5VDC
Maximum Current	10mA

Table 10.21 — Serial Communication

PARAMETER	DESCRIPTION
Type	EIA/TIA-232 3-wire or EIA/TIA-485 4-wire
Isolation	None
Baud Rate	2,400, 9,600 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 upon protocol
Protocol	Form of ANSI X3.28-1976 (D1, F1), compatible with Allen Bradley PLC/2, full duplex or Modbus® RTU

Table 10.22 — Power Requirements

PARAMETER	DESCRIPTION
Voltage	15 to 24VDC ±3VDC
Current (Maximum Load)	1A

Glossary

A

AC
See Alternating Current.

AC Line Frequency
The frequency of the AC power line measured in Hertz (Hz), usually 50 or 60Hz.

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 setpoint. 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 (6.25×10^{18} electrons) per second.

Analog Output
A continuously variable signal that is used to represent a value, such as the process value or setpoint value. Typical hardware configurations are 0 to 20mA, 4 to 20mA or 0 to 5VDC.

Automatic Mode
A feature that allows the controller to set PID control outputs in response to the Process Variable (PV) and the setpoint.

Autotune
A feature that automatically sets temperature control PID values to match a particular thermal system.

AWG
See American Wire Gauge.

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. See also *Cyclic Redundancy Check*.

Bumpless Transfer
A smooth transition from automatic (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:

°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 also Serial Communications, Baud Rate.

Control Action
The response of the PID control output relative to the error between the process variable and the setpoint. For reverse action (usually heating), as the process decreases below the setpoint the output increases. For direct action (usually cooling), as the process increases above the setpoint, the output increases.

Control Status
The type of action that a controller uses. For example, on/off, time proportioning, PID, automatic or manual, and combinations of these.

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 also Block Check Character.

D

DAC
See Digital-to-Analog Converter.

Data Logging
A method of recording a process variable over a period of time. Used to review process performance.

DC
See Direct Current.

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 Parameter Settings
The values that the user adjustable parameters have when a controller ships from Watlow or after the user programmed setting are cleared.

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 setpoint.

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 in which the output on/off state is calculated for every ac line cycle. Power is switched at the zero cross, which reduces electrical noise. See also Zero Cross.

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.

EIA/TIA
See Serial Communications.

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:

°C = 5/9 (°F - 32).

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 slows 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 digital output that alerts the operator when an alarm 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 setpoint, but below the high process alarm setpoint. It can be used as either an alarm or control function.

High Power
(Relative to the CLS200 power.) Any voltage above 24VAC or VDC and any current level above 50mA AC or mA DC.

High Process Alarm
Indicates that a process value has risen above the high process alarm setpoint. It can be used as either an alarm or control function.

High Process Variable
See Process Variable (PV).

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 (IR)
A region of the electromagnetic spectrum with wavelengths ranging from one to 1,000 microns. These wavelengths are 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 setpoint and actual process temperature.

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 form a 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.

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 setpoint, but above the low process alarm setpoint. It can be used as either an alarm or control function.

Low Process Alarm
Indicates that a process value has dropped below the low process alarm setpoint. It 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.

MMI
Man-machine interface.

N

NO-Key Reset
A method for resetting the controller's memory.

Noise
Unwanted electrical signals that may produce signal interference in sensors and sensor circuits. See also Electromagnetic Interference.

Noise Suppression
The use of components to reduce electrical interference that is caused by making or breaking electrical contact, or by inductors.

Nonlinear
A firmware feature that reduces the actual output signal from the automatically calculated level. Often used with cool outputs.

O

Offset
The difference in temperature between the setpoint 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 setpoint 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 setpoint and process variable.

Output Type
The form of PID control output, such as time proportioning, distributed zero crossing, Serial DAC or analog. Also the description of the electrical hardware that makes up the output.

Overshoot
The amount by which a process variable exceeds the setpoint before it stabilizes.

P

Panel Lock
A feature that prevents operation of the front panel by unauthorized people.

PID
Proportional, Integral, Derivative. A control status 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 setpoint. For example, if the proportional band is 20° and the process is 10° below the setpoint, 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 also 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 change in the temperature of a setpoint 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 setpoint and actual process temperature. See also Integral Control.

Automatic Reset
The integral function of a PI or PID temperature controller that adjusts the process temperature to the setpoint after the system stabilizes. The inverse of integral.

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/TIA-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 [15 m] or less) and to a single device.

EIA/TIA-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 (15 m) are required.

Setpoint (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 also Deadband.

Stability
The ability of a device to maintain a constant output with the application of a constant input.

T

T/C 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 (T/C)
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 converts temperature or other process data from a sensor to an analog voltage or current. 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 setpoint before it stabilizes.

V

Volt (V)
The unit of measure for electrical potential, voltage or electromotive force (EMF). See also 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.

Index

A

AC LINE FREQ
  default value 67
  description 73
  location 66
AC Line Frequency 73
A control status symbol 52
agency compliance
  controller 162
ALARM ACK key
  acknowledging alarms 55
  description 50
  does not work 145
ALARM DEADBAND
  default value 90
  description 92
  location 66
ALARM DELAY
  default value 90
  description 93
  location 66
  using 59
Alarm High SP parameter 62
Alarm Low SP parameter 62
alarms
  acknowledging 55
  codes 140, 141
  deadband 92
  delaying 59, 93
  deviation 140
  digital output polarity 73
  disabling control on alarm outputs 85
  displays 53
  failed sensor 59, 141
  global 62, 63, 174
  global alarm output 14, 38, 41, 42, 43, 50, 53, 60, 61, 73, 94, 130, 169
  high deviation alarm settings 91
  high process alarm settings 90
  hysteresis 61, 62
  loop delay 59
  low deviation alarm settings 91, 92
  low process alarm settings 92
  messages 141, 142
  process 140
  resetting 141
  restoring control after sensor failure 83
  reversed thermocouple 77
  SCRs 38
  sensor fail percent output power 88
  setting up 61
  setup parameters 89
  solid state relays 38
  startup delay 59, 70
  system 55, 142
  T/C BREAK, switching to manual mode 88
  tolerance 119, 129
  troubleshooting 140, 141
  wiring 38
ambient temperature
  H/W AMBIENT FAILURE message 144
  operating range 20, 162
AMBIENT WARNING 144
analog output 135
ASSIGN R/S PROFILE 127
AUTO 52
automatic control, selecting 56
autotuning 57

B

BACK key 50
bar graph display 51, 52
  control status symbols 52
  navigating in 52
  ramp/soak symbols 126
  symbols 51, 52, 54
  when running ramp/soak profile 126
battery 17, 152
BATTERY DEAD 142, 143, 152
baud rate 72
block check character 72
boost output 62
bridge circuits 34

C

cables
  communications 18, 45, 46
  SCSI 16, 18
  tie wrapping 37
  troubleshooting 149
CALCULATING CHECKSUM 31
CANNOT LOAD JOB 68
CANNOT SAVE JOB 68
CASCADE BASE SP
  description 104
  location 97
CASCADE CL SPAN
  description 105
  location 97
cascade control 102
  application, example 105
  relationship of secondary setpoint to primary output 107
  setting up, example 105
  testing setup, example 106
CASCADE HT SPAN
  description 104
  location 97
CASCADE MAX SP
  description 104
  location 97
CASCADE MIN SP
  description 104
  location 97
CASCADE PRIM. LOOP
  description 103
  location 97
case, removing 150
CHNG SP key
  changing the setpoint 56
  description 50
  does not work 145
  locking and unlocking 71
communications
  baud rate 72
  cable 18, 45, 46
  controller address 72
  error checking algorithm 72
  ground loops 28, 149
  installation 44
  jumper configurations 153
  protocol 72
  software problems 149
  specifications 170
  troubleshooting 148
  wire sizes and lengths 26
COMMUNICATIONS BAUD RATE
  default value 67
  description 72
  location 66
COMMUNICATIONS ERR CHECK
  default value 67
  description 72
  location 66
COMMUNICATIONS PROTOCOL
  default value 67
  description 72
  location 66
computer 148
Connecting TB50 to CLS200 31
control algorithms 131
  on/off 131
  proportional, integral and derivative (PID) 133, 138
  proportional (P) 132, 138
  proportional with integral (PI) 133, 138
Control and Alarm Output Connections 38
controller
  agency compliance 162
  clearance 21, 163, 164
  connecting to TB50 31
  dimensions 162
  environment 162
  input specifications 166
  mounting 20
  output specifications 168
  specifications 162
  terminal specifications 164
  wire sizes 164
CONTROLLER ADDRESS
  default value 67
  description 72
  location 66
control outputs 134
  action 87
  curve 88
  cycle time 86
  direct action 87, 135
  disabling 85
  distributed zero crossing 85, 135
  enabling 85
  filter 83, 135
  limit 87
  on/off 85, 134
  process variable retransmit 98
  reverse action 87, 135
  SCRs 38
  solid state relays 38
  spread 83
  status on power up 71
  time proportioning 85, 134
  troubleshooting 147
  wiring 38
control parameters 81

control status 56
symbols on display 52
unexpected switches from automatic to manual 143
COOL 52
COOL CONTROL FILTER
default value 81
description 83
location 66
COOL CONTROL OUTPUT
default value 84
description 85
location 66
COOL CONTROL PB
default value 81
description 82
location 66
COOL CONTROL TD
description 82
location 66
COOL CONTROL TI
default value 81
description 82
location 66
COOL OUTPUT
curves 88
description 88
location 66
COOL OUTPUT ACTION
description 87
location 66
COOL OUTPUT CYCLE TIME
description 86
location 66
COOL OUTPUT LIMIT
description 87
location 66
COOL OUTPUT LIMIT TIME
description 87
location 66
COOL OUTPUT RETRANS PV
description 98
location 66
COOL OUTPUT TYPE
description 85
location 66
COOL RETRANS MAX INP
description 99
location 97
COOL RETRANS MAX OUT%
description 100
location 97
COOL RETRANS MIN INP
description 99
location 97
COOL RETRANS MIN OUT%
description 99, 100
location 97
COOL T/C BRK OUT AVG
description 88
location 66
COPY SETUP FROM PROFILE
description 118
location 117
CPU watchdog timer 39, 169
current inputs
scaling resistors 35, 154, 157
wiring 35
CYCLE NR= 127
cycle time 86
cyclic redundancy check 72

D

derivative
description 133
guidelines for setting 137
setting a value 82
settings from other controllers 137
term versus rate settings 137
DEV ALARM VALUE
default value 90
description 91
location 66
differential control 113
digital inputs
external switching devices 40
functions activated 40
output override 70
ramp/soak external reset 120
ramp/soak triggers 122
remote job selection 68
restoring control after sensor failure 83
specifications 168
technical information 40
testing 31, 94
thermocouple short detection 71
troubleshooting 148
wiring 41
DIGITAL INPUTS
description 94
location 66
using for testing 31
DIGITAL OUTPUT NUMBER
default value 93
description 94
location 66
digital outputs
polarity for alarms 73
ramp/soak events 121

specifications 169
testing 31, 94
troubleshooting 147
will not turn on 27
wiring 36
DIG OUT POLARITY ON ALARM
default value 67
description 73
global alarm output 63
location 66
dimensions 162
TB50 164
DISP FORMAT
default value 74
effect on ramp/soak parameters 124
location 66
scaling parameters 77
values 79
display
does not work 142
job display 55
process variable not correct 142, 145
Display Format 79
distributed zero crossing 85, 135
down-arrow key 49
Dual DAC
process variable retransmit 98
wiring 44

E

EDIT RAMP & SOAK PROFILE
description 118
location 117
EDIT SEGMENT NUMBER
description 120
location 117
EIA/TIA-232 44
connections 45
jumpers in connectors 45
specifications 170
troubleshooting 148
EIA/TIA-485 46
EIA/TIA-232-to-485 converter 46
network connections 46
signal common 47
specifications 170
termination 47
troubleshooting 148
electrotatic discharge 150
encoders 35
enhanced features option 96
firmware code shown on display 74
menu tree 97
ENTER key 50
environment
controller 162
EPROM
checksum 73
replacing 150
error checking 72
external bridge circuit 34, 170
EXTERNAL RESET INPUT NUMBER
description 120
location 117
external safety devices 18
external switching devices 40

F

failed sensor alarms 141
restoring automatic control after sensor repair 61
RTD open 60
RTD shorted 60
setting up 59
thermocouple open 60
thermocouple short 60
Failed Sensor Alarms 141
filter
output 83, 135, 174
sensor input 80
firmware
custom 74
version 73
frequency 73
front panel 17
navigation 48
overview 49
FS alarm code 141
functions activated by digital inputs 40

G

grounding, troubleshooting 146
ground loops 28
and personal computers 28
and thermocouples 34
communications 46
isolation 36
paths 28
troubleshooting 146, 149

H

HD alarm code 140
HEAT 52
HEAT CONTROL FILTER
default value 81
description 83
location 66

HEAT CONTROL OUTPUT
  default value 84
  description 85
  location 66
HEAT CONTROL PB
  default value 81
  description 82
  location 66
HEAT CONTROL TD
  default value 81
  description 82
  location 66
HEAT CONTROL TI
  default value 81
  description 82
  location 66
HEAT/COOL SPREAD
  default value 81
  description 83
  location 66
Heat/Cool Thermocouple Break Out 60
Heat or Cool Cycle Time 86
HEAT OUTPUT
  curves 88
  default value 84
  description 88
  location 66
HEAT OUTPUT ACTION
  default value 84
  description 87
  location 66
HEAT OUTPUT CYCLE TIME
  default value 84
  description 86
  location 66
HEAT OUTPUT LIMIT
  default value 84
  description 87
  location 66
HEAT OUTPUT LIMIT TIME
  default value 84
  description 87
  location 66
HEAT OUTPUT RETRANS PV
  description 98
  location 97
HEAT OUTPUT TYPE
  default value 84
  description 85
  location 66
HEAT RETRANS MAX INP
  description 99
  location 97
HEAT RETRANS MAX OUT%
  description 100
  location 97
HEAT RETRANS MIN INP
  description 99
  location 97
HEAT RETRANS MIN OUT%
  description 99
  location 97
HEAT T/C BRK OUT AVG
  default value 84
  description 88
  location 66
HI DEV ALARM OUTPUT
  default value 90
  description 91
  location 66
HI DEV ALARM TYPE
  default value 90
  description 91
  location 66
HI PROC ALARM OUTPUT
  default value 90
  description 90
HI PROC ALARM SETPT
  default value 90
  description 90
  location 66
HI PROC ALARM TYPE
  default value 90
  description 90
  location 66
HP alarm code 140
humidity
  controller 162
H/W AMBIENT FAILURE 142, 144
H/W GAIN FAILURE 142, 145
H/W OFFSET FAILURE 142, 145

I

INPUT FILTER
  default value 74
  description 80
  location 66
  setting before autotuning 59
INPUT PULSE SAMPLE TIME
  default value 74
  description 77
  location 66
INPUT READING OFFSET
  default value 74
  description 76
  location 66
  values 77
inputs
  filter 80

- scaling resistors 154
- specifications 166

INPUT SCALING HI PV
- default value 74
- description 79
- location 66
- scaling parameters 77

INPUT SCALING HI RDG
- default value 74
- description 79
- location 66
- scaling parameters 66, 77

INPUT SCALING LO PV
- default value 74
- description 80
- location 66
- scaling parameters 77

INPUT SCALING LO RDG
- default value 74
- description 80
- location 66
- scalaing parameters 77

INPUT TYPE
- default value 74
- description 75
- effect on ramp/soak parameters 124
- location 66
- values 75

INPUT UNITS
- default value 74
- description 76
- location 66

installation 19
- alarm wiring 38
- clearance 21, 163, 164
- communications 44
- controller 21
- CPU watchdog timer 39
- digital output wiring 36
- environment 20
- location 20
- overview 19
- panel hole dimensions 23
- panel thickness 23
- power supply 25, 29
- reference voltage terminals 34
- sensor input wiring 32
- TB50 31
- testing 31
- tie-wrapping cables 37
- tools 20
- torque for screw terminals 30
- typical 19
- wire recommendations 25, 33, 36, 46
- wire sizes 26
- wiring 25, 32

integral
- description 133
- guidelines for setting 136
- setting a value 82
- settings from other controllers 137
- term versus reset settings 136

J

JOB RUNNING 55

JOB RUNNING DATA MODIFIED 55

JOB RUNNING REMOTELY LOADED 56

jobs
- loading from memory 67
- remote selection 68
- saving to memory 68

JOB SEL DIG INS ACTIVE
- default value 67
- description 69
- location 66

JOB SELECT DIG INPUTS
- default value 67
- description 68
- location 66

jumpers
- communication 153
- in EIA/TIA-232 connectors 45
- power supply common 29
- unused inputs 33
- when using 2-wire RTD 34

K

KEYBOARD LOCK STATUS
- default value 67
- description 71
- location 66

keypad
- keys do not work 142, 145
- locking 71
- overview 49
- testing 95
- unlocking 71

KEYPAD TEST
- description 95
- how to quit 95
- location 66

L

LD alarm code 140

limit controller 18

limit, output 87

linear inputs
- decimal shift in ramp/soak parameters 124

display format 79
engineering units 76
scaling and calibration 158
scaling examples 159
scaling parameters 77
LOAD SETUP FROM JOB
CANNOT LOAD JOB 68
default value 67
description 67
job display 55
location 66
locking the keypad 71
LO DEV ALARM OUTPUT
default value 90
description 92
location 66
LO DEV ALARM TYPE
default value 90
description 91
location 66
LOOP NAME
default value 74
description 76
location 66
loops
naming 76
number available 166
ramp/soak profiles, see ramp/soak 127
tuning 136
LO PROC ALARM OUTPUT
default value 90
description 92
location 66
LO PROC ALARM SETPT
default value 90
description 92
location 66
LO PROC ALARM TYPE
default value 90
description 92
location 66
LOW POWER 142
LP alarm code 140

M

MAN 52, 57
MAN/AUTO CONTROL OUTPUTS DISABLED 56
MAN/AUTO key 50
does not work 145
locking and unlocking 71
switching control statuses 57
manual control
selecting 57
setting the output level 57
MANUAL I/O TEST 93
location 66
parameters in menu 93
M control status symbol 52
menus
accessing 64
global parameters 67
loop alarms 89
loop control 81
loop outputs 84
manual I/O test 93
process variable retransmit 98
ramp/soak profile 117
ratio control 108
menu tree
enhanced features 97
ramp/soak profiles 117
standard setup menus 66
model information
accessing through display 73
location in firmware 66
model number description 15

N

noise
eliminating problems with 27
isolation 27
reducing with zero-cross switching 135
suppression 26
symptoms 27
NO key
description 49
NO-key reset 150

O

on/off control
control signal 134
description 131
selecting 85
spread 83
operator displays 48
OUT-OF-TOLRNCE ALARM TIME
description 119
location 117
output override 70, 88
OUTPUT OVERRIDE DIG INPUT
default value 67
description 70
location 66
outputs
5VDC output power 168, 169
boost ouput 62

filter 83
ramp/soak ready state 119
setup parameters 84
solid state relays 38
specifications 168
OVERRIDE DIG IN ACTIVE
default value 67
description 70
location 66
over-temperature shutdown devices 18

P

parameters
accessing 64
alarm 89
cascade control 103
changing values 64
control 81
global 67
input 74
output 84
process variable retransmit 98
ramp/soak profile 118
ratio control 108
storage of in RAM 17
test 93
parts list 15
personal computer, see communications 148
PID
autotuning 57
settings for various applications 138
settings from other controllers 137
tuning 57, 136
PLC
transmitting process data to 98
using to set a setoint, example 112
power failure 18
output status upon restart 71
ramp/soak profile upon restart 130
power supply
mounting 25
powering loads with 37
requirements 25, 170
wiring 29
POWER UP OUTPUT STATUS
default value 67
description 71
effect on ramp/soak profiles 130
location 66
process alarms
alarm high 62
alarm low 62
boost output 62
function 61
high deviation 62
low deviation 62
outputs 61
setting up 61
PROCESS POWER DIGIN
default value 67
description 71
location 66
process variable
not displayed correctly 27, 142, 145
process variable retransmit 98
application example 100
setting up, example 101
setup paramaters 98
proportional band
and cascade control 107
description 132
guidelines for setting 136, 138
setting a value 82
settings for various temperature ranges 136
settings from other controllers 137
protocol 72
pulse inputs
display format 79
encoder signals 35
engineering units 76
loops available on 35
sample time 77
scaling and calibration 158
scaling parameters 77, 79
setting a value 82
specifications 167
technical information 35
wiring 35

R

RAM 16, 150
ramp/soak 115
assigning profiles to loops 127
continuing from hold 128
cycle number 127
decimal shift 124
editing a profile while it is running 128
events 119, 121
firmware option code 74
holding a profile 128
mode, setting 127
mode symbols on display 125
overview 115
power failure while running profile 130
profile setup parameters 118
resetting a profile 130
running a profile 128
screens for RAMP/SOAK key 125

specifications 116
time base 118
time remaining 126
tolerance 123
triggers 122
RAMP/SOAK key 50
assigning profiles 127
cycle number 127
does not work 63, 145
locking and unlocking 71
screens accessed by pressing 125
set mode 127
time remaining 126
RAMP/SOAK TIME BASE
default value 67
description 118
location 66, 117, 118
ratio control 108
application example 110, 112, 113
differential control 113
remote analog setpoint 112
setting up, example 110, 112, 114
setup parameters 108
RATIO CONTROL CTRL RATIO
description 109
location 97
RATIO CONTROL MAX SP
description 109
location 97
RATIO CONTROL MIN SP
description 109
location 97
RATIO CONTROL MSTR LOOP
description 109
location 97
RATIO CONTROL SP DIFF
description 110
location 97
READY EVENT OUTPUT
description 120
location 117
READY SEGMENT EDIT EVENTS
description 119
location 117
READY SEGMENT SETPOINT
description 119
location 117
reference voltage 34, 170
repair, returning controller for 3
REPEAT CYCLES
description 124
location 117
reset
external 120
NO-key reset 150
RESET PROFILE 128
RESET WITH DEFAULTS 150
RestoreAuto parameter 61
RESTORE PID DIGIN
deafult value 81
description 83
location 66
returning the controller 3
REVERSED T/C DETECT
default value 74
description 77
location 66
RMA number 3
RO alarm code 141
RS alarm code 141
RT alarm code 141
RTD
accuracy 168
offset 76
range 168
recommended type 34
resolution 168
scaling resistors 34, 156
troubleshooting 145
wiring 34
RTD open alarm 60
RTD shorted alarm 60

S

safety
external safety devices 18
output status on power up 18
symbols and signal words in this manual 13
SAVE SETUP TO JOB
CANNOT SAVE JOB 68
default value 67
description 68
location 66
scaling parameters
example settings, flow sensor with 0-5VDC signal 160
example settings, pressure sensor with 4-20mA signal 159
example settings, pulse encoder 161
linear inputs 77
process variable retransmit 99, 100
pulse inputs 77
scaling resistors 154
for current inputs 35, 155, 157
for RTD inputs 34, 156
for thermistor inputs 156
for voltage inputs 34, 155, 158
four-loop and eight-loop input circuit 154
sixteen-loop input circuit 157

SCSI cable 16, 18
clearance 21, 163, 164
installing 31
SDAC HI VALUE
default value 84
description 86
location 66
SDAC LO VALUE
default value 84
description 86
location 66
SDAC MODE
default value 84
description 86
location 66
SEG ## EV# DO## ACTIVE STATE
description 122
location 117
SEG ## EVENT # OUTPUT
description 121
location 117
SEGMENT ## EDIT SEG EVENTS
description 121
location 117
SEGMENT ## EDIT SEG TRGGRS
description 122
location 117
SEGMENT ## LAST SEGMENT
description 124
location 117
SEGMENT ## SEG SETPT
description 120, 121
location 117
SEGMENT ## SEG TIME
description 120
location 117
SEGMENT ## SEG TOLERANCE
description 123
location 117
SEG ## TR# DI## ACTIVE STATE
description 122
location 117
SEG ## TR# DI## TRIG
description 123
location 117
SEG ## TRIG # INPUT NR
description 122
location 117
SENSOR FAIL CL OUTPUT 68
and reversed thermocouple detection 71, 77
description 88
location 66
Sensor Fail Cool Output parameter
and failed sensor alarm 60
Sensor Fail Heat Output parameter
and failed sensor alarm 60
SENSOR FAIL HT OUTPUT
and reversed thermocouple detection 71, 77
default value 84
description 88
location 66
sensor inputs
engineering units 76
failed sensor alarms 141
filter 80
offset 76
ranges 75
specifications 166
troubleshooting 145
type, setting 75
wiring 32
Serial DAC
configuring the controller output 85, 86
process variable retransmit 98, 102
wiring 44
SET COOL OUTPUT 57
SET HEAT OUTPUT 57
SET MODE 127
setpoint
changing 56
ramp/soak ready setpoint 119
using cascade control to set 102
using PLC to set, example 112
using ratio control to set 108
SETPOINT 56
SETUP GLOBAL PARAMETERS 67
location 66
parameters in menu 67
SETUP LOOP ALARMS
location 66
parameters in menu 89
SETUP LOOP CASCADE 103
location 97
SETUP LOOP CONTROL PARAMS 81
location 66
parameters in menu 81
SETUP LOOP INPUT 74
location 66
parameters in menu 74
SETUP LOOP OUTPUTS 84
location 66
parameters in menu 84
SETUP LOOP PV RETRANSMIT
description 98
location 97
SETUP LOOP RATIO CONTROL
description 108
location 97
SETUP RAMP/SOAK PROILE 118
location 117

shutdown devices 18
single loop display 52
  control status symbols 52
  navigating 53
  ramp/soak symbols 125
  when running ramp/soak proile 125
solid state relays
  5VDC power from controller 169
  distributed zero crossing 135
  troubleshooting controller connections 147
specifications 162
  communications 170
  controller 162
  controller inputs 166
  controller outputs 168
  CPU watchdog timer 169
  power supply 170
  TB50 164
spread 83
SPREAD
  default value 81
  description 83, 134
  location 66
ST alarm code 141
STARTUP ALARM DELAY
  default value 67
  description 70
  location 66

T

TB18
  alarm outputs 39
  connections 41
  CPU watchdog timer output 40
  digital output wiring 36
  testing after installation 31
  to power encoders 35
  troubleshooting 147
TB50
  alarm outputs 39
  connecting to controller 31
  connections for eight-loop controller 42
  connections for four-loop controller 42
  connections for sixteen-loop controller 43
  CPU watchdog timer output 39
  digital output wiring 36
  dimensions 165, 166
  for powering Serial DAC 44
  mounting on DIN rail 24
  mounting with standoffs 24
  specifications 164
  technical description 17
  terminal specifications 165
  testing after installation 31
  to power encoders 35
  troubleshooting 147
T control status symbol 52
temperature
  incorrect on display 142, 145
  operating 162
  storage 162
terminal specifications
  controller 164
  TB50 165
TEST DIGITAL OUTPUT
  default value 93
  description 94
  location 66
testing
  TB18 after installation 31
  TB50 after installation 31
Thermistor inputs, scaling resistors for 156
thermocouples
  accuracy 167
  ground loops 34
  manual mode if break occurs 88
  offset 76
  polarity checking 77
  range 167
  resolution 167
  reversed detection 77
  short detection 71
  troubleshooting 145
  type supported 75
  wiring 33
Thermocouple Short Alarm parameter 60
thermoforming example 113
three-key sequence 64
tie wraps 37
time proportioning 85
  cycle time 86
  description 134
TIM REM= 126
TOHO 129
triggers, ramp/soak 122
troubleshooting 139
  alarms 140, 141
  all loops are set to manual 0% 143
  AMBIENT WARNING 144
  check these things first 139
  communications 148
  control outputs 146, 147
  control status switches unexpectedly 143
  digital inputs 31, 94, 148
  digital outputs 31, 94, 147
  display does not work 142
  grounding problems 149
  H/W AMBIENT FAILURE 144
  H/W GAIN FAILURE 145

H/W OFFSET FAILURE 145
keypad 95, 142, 145
LOW POWER 143
process variable incorrect on display 142, 145
sensor inputs 145
software 148
TB18 147
TB50 147
tolerance alarms 129
unexpected behavior 143
TUNE 52, 56, 59
tuning control loops 57, 136

U

under-temperature shutdown devices 18
unlocking the keypad 71
up-arrow key 49

V

voltage inputs
ranges 168
resistance 168
scaling resistors 34, 155, 158
wiring 34

W

weight
controller 162
TB50 164
wire sizes
controller 164

Y

YES key 49

Menu Structure

SETUP GLOBAL PARAMETERS	SETUP LOOP INPUT	SETUP LOOP CONTORL 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	HI PROC ALARM OUTPUT	DIGITAL OUTPUT NUMBER XX
JOB SEL DIG INS ACTIVE	INPUT READING OFFSET	HEAT CONTROL FILTER	SDAC MODE	DEV ALARM VALUE	KEYPAD TEST
OUTPUT OVERRIDE DIG INPUT	REVERSED T/C DETECT	COOL CONTROL PB	SDAC LO VALUE	HI DEV ALARM TYPE	TEST DISPLAY
OVERRIDE DIG IN ACTIVE	INPUT PULSE SAMPLE TIME	COOL CONTROL TI	SDAC HI VALUE	HI DEV ALARM OUTPUT	
STARTUP ALARM DELAY	DISP FORMAT	COOL CONTROL TD	HEAT OUTPUT ACTION	LO DEV ALARM TYPE	
RAMP/SOAK TIME BASE	INPUT SCALING HI PV	COOL CONTROL FILTER	HEAT OUTPUT LIMIT	LO DEV ALARM OUTPUT	
KEYBOARD LOCK STATUS	INPUT SCALING HI RDG	SPREAD	HEAT OUTPUT LIMIT TIME	LO PROC ALARM SETPT	
POWER UP OUTPUT STATUS	INPUT SCALING LO PV	RESTORE PID DIGIN	SENSOR FAIL HT OUTPUT	LO PROC ALARM TYPE	
PROCESS POWER DIGIN	INPUT SCALING LO RDG		HEAT T/C BRK OUT AVG	LO PROC ALARM OUTPUT	
CONTROLLER ADDRESS	INPUT FILTER		HEAT OUTPUT	ALARM DEADBAND	
COMMUNICATIONS BAUD RATE			COOL CONTROL OUTPUT	ALARM DELAY	
COMMUNICATIONS PROTOCOL			COOL OUTPUT TYPE		
COMMUNICATIONS ERR CHECK			COOL OUTPUT CYCLE TIME		
AC LINE FREQ			SDAC PARAMETERS		
DIG OUT OLARITY ON ALARM			COOL OUTPUT ACTION		
CLS200 [FIRMWARE INFO.]			COOL OUTPUT LIMIT		
			COOL OUTPUT LIMIT TIME		
			SENSOR FAIL CL OUTPUT		
			COOL T/C BRK OUT AVG		
			COOL OUTPUT		

Additional Enhanced Features Option Menus

SETUP LOOP PV RETRANSMIT	SETUP LOOP CASCADE	SETUP LOOP RATIO CONTROL
HEAT OUTPUT RETRANS PV	CASCADE PRIM LOOP	RATIO CONTROL MSTSR LOOP
HEAT RETRANS MIN INP	CASCADE BASE SP	RATIO CONTROL MIN SP
HEAT RETRANS MIN OUT%	CASCADE MIN SP	RATION CONTROL MAX SP
HEAT RETRANS MAX INP	CASCADE MAX SP	RATION CONTROL CTRL RATIO
HEAT RETRANS MAX OUT%	CASCADE HT SPAN	RATIO CONTROL SP DIFF
COOL OUTPUT RETRANS PV	CASCADE CL SPAN	
COOL RETRANS MIN INP		
COOL RETRANS MIN OUT%		
COOL RETRANS MAX INP		
COOL RETRANS MAX OUT%		

Additional RAMP/SOAK Option Menus

SETUP LOOP PV RETRANSMIT	SETUP RAMP/SOAK PROFILE
HEAT OUTPUT RETRANS PV	EDIT RAMP & SOAK PROFILE
HEAT RETRANS MIN INP	COPY SETUP FROM PROFILE
HEAT RETRANS MIN OUT%	OUT-OF-TOLRNCE ALARM TIME
HEAT RETRANS MAX INP	READY SEGMENT SETPOINT
HEAT RETRANS MAX OUT%	READY SEGMENT EDIT EVENTS
COOL OUTPUT RETRANS PV	READY EVENT OUTPUT
COOL RETRANS MIN INP	EXTERNAL RESET INPUT NUMBER
COOL RETRANS MIN OUT%	EDIT SEGMENT NUMBER
COOL RETRANS MAX INP	SEGMENT ## SEG TIME
COOL RETARNS MAX OUT%	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

CE

CLS200 Multi-Loop Temperature Controller

WATLOW Electric Manufacturing Company
1241 Bundy Blvd.
Winona, MN 55987 USA

Declares that the following products:

Designation:	CLS200
Classification:	Temperature Control, Installation Category II, Pollution degree 2, IP20
Rated Supply:	15 to 24 V⎓ (dc) 610 mA maximum

Meets the essential requirements of the following European Union Directives by using the relevant standards show below to indicate compliance.

2014/30/EU Electromagnetic Compatibility Directive

EN 61326-1: 2013	**Electrical equipment for measurement, control and laboratory use – EMC requirements (Industrial Immunity, Class A Emissions)** *CAUTION: This equipment not intended for use in residential environments and may not provide adequate protection to radio reception in such environments*
IEC 61000-4-2:2008	Electrostatic Discharge Immunity Test
IEC 61000-4-3:2007 + A1/2008, A2/2010	Radiated Radio-frequency, Electromagnetic Field Immunity 10V/m 80 MHz-1GHz, 3V/m 1.4GHz-2.7GHz
IEC 61000-4-4:2012	Electrical Fast-Transient / Burst Immunity Test
IEC 61000-4-5:2014 + A1/2017	Surge Immunity Tests
IEC 61000-4-6:2013 + Corrigendum 2015	Immunity to conducted disturbances induced by radio-frequency fields.
IEC 61000-4-11:2004 + A1/2017	Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests
EN 61000-3-2:2018	Limits for harmonic current emissions ≤ 16A per phase.
EN 61000-3-3:2013 + A/1 2017	Limitations of Voltage changes, Fluctuations and Flicker ≤ 16A per phase.
SEMI F47:0812	Specification for Semiconductor Sag Immunity Figure R1-1

2014/35/EU Low-Voltage Directive

EN 61010-1:2010	**Safety Requirements of electrical equipment for measurement, control and laboratory use. Part 1: General requirements**

Per 2012/19/EU WEEE Directive ***Please Recycle Properly***

RoHS compliant to 2011/65/EU Directive.

Models contain a type BR1632 lithium coin cell battery embedded within Maxim Semiconductor DS1230Y / DS9034 RAM which shall be recycled at end of life per 2006/66/EC Battery Directive as amended by 2013/56/EU Directive.

Doug Kuchta	Winona, Minnesota, USA
Name of Authorized Representative	Place of Issue
Director of Operations	July 2019
Title of Authorized Representative	Date of Issue

Signature of Authorized Representative

How to Reach Us

Corporate Headquarters

Watlow Electric Manufacturing Company
12001 Lackland Road
St. Louis, MO 63146
Sales: 1-800-WATLOW2
Manufacturing Support: 1-800-4WATLOW
Email: info@watlow.com
Website: www.watlow.com
From outside the USA and Canada:
Tel: +1 (314) 878-4600
Fax: +1 (314) 878-6814

Latin America

Watlow de México S.A. de C.V.
Av. Fundición No. 5
Col. Parques Industriales
Querétaro, Qro. CP-76130
Mexico
Tel: +52 442 217-6235
Fax: +52 442 217-6403

Europe

Watlow Plasmatech GmbH
Brennhoflehan — Kellau 156
431 Kuchl
Austria
Tel: +3 0244 20129 0
Email: austria@watlow.com
Website: www.watlow.com

Watlow France
Tour d'Asnières.
4 Avenue Laurent Cély
92600 Asnières sur Seine
France
Tél: +33 (0)1 41 32 79 70
Télécopie: +33(0)1 47 33 36 57
Email: info@watlow.fr
Website: www.watlow.com

Watlow GmbH
Postfach 11 65, Lauchwasenstr. 1
D-76709 Kronau
Germany
Tel: +49 (0) 7253 9400-0
Fax: +49 (0) 7253 9400-900
Email: germany@watlow.de
Website: www.watlow.com

Watlow Italy S.r.l.
Viale Italia 52/54
20094 Corsico Milano
Italy
Tel: +39 024588841
Fax: +39 0245869954
Email: italyinfo@watlow.com
Website: www.watlow.com

Watlow Ibérica, S.L.U.
C/Marte 12, Posterior, Local 9
E-28850 Torrejón de Ardoz
Madrid - Spain
T. +34 91 675 12 92
F. +34 91 648 73 80
Email: info@watlow.es
Website: www.watlow.com

Watlow Ltd.
Roby Close, Linby Ind. Estate
Linby
NG15 8AA Nottingham
United Kingdom
Email: info@watlow.co.uk
Website: www.watlow.com
From outside The United Kingdom:
Tel: +44 (0) 115 964 0777
Fax: +44 (0) 115 964 0071

Asia and Pacific

Watlow Singapore Pte Ltd.
20 Kian Teck Lane, 4th Floor
Singapore 627854
Tel: +65 6773 9488
Fax: +65 6778 0323
Email: info@watlow.com.sg
Website: www.watlow.com.sg

瓦特隆电子科技（上海）有限公司
中国上海市
上海市杨浦区国定东路275-8号
绿地汇创1306室 200433
中国
本地： 4006 Watlow (4006 928569)
国际： +86-21-3532 8532
传真： +86-21-3532 8568
电子邮件： info-cn@watlow.com
网站： www.watlow.com

Watlow Electric Manufacturing Company (Shanghai) Co. Ltd.
Greenland International Plaza Room 1306
275-8 East Guoding Road, Yangpu District
Shanghai 200433
China
Local Phone: 4006 Watlow (4006 928569)
International: +86 21 3381 0188
Fax: +86 21 6106 1423
Email: info-cn@watlow.com
Website: www.watlow.cn

Watlow Thermal Solutions India Pvt., Ltd.
401 Aarohan Plaza, 4th Floor
No. 6-3-678/1 Panjagutta
Hyderabad 500082 Telangana
India
Tel: +91-40-666 12700
Email: infoindia@watlow.com
Website: www.watlow.com

ワトロー・ジャパン株式会社
〒101-0047 東京都千代田区内神田1-14-4
四国ビル別館9階
Tel: 03-3518-6630
Fax: 03-3518-6632
Email: infoj@watlow.com
Website: www.watlow.co.jp

Watlow Japan Ltd.
Shikoku Building Annex 9th Floor
1-14-4 Uchikanda, Chiyoda-Ku
Tokyo 101-0047
Japan
Tel: +81-3-3518-6630
Fax: +81-3-3518-6632
Email: infoj@watlow.com
Website: www.watlow.co.jp

Watlow Korea Co., Ltd.
#2208, Hyundia KIC Building B, 70 Doosan-ro
Geumcheon-gu, Seoul
Republic of Korea
Tel: +82 (2) 2169-2600
Fax: +82 (2) 2169-2601
Website: www.watlow.co.kr

瓦特龍電機股份有限公司
80143 高雄市前金區七賢二路189號 10樓之一
電話: 07-2885168
傳真: 07-2885568
电子邮件: ryeh@watlow.com
网站: www.watlow.com

Watlow Electric Taiwan Corporation
10F-1 No.189 Chi-Shen 2nd Road Kaohsiung 80143
Taiwan
Tel: +886-7-2885168
Fax: +886-7-2885568
Email: ryeh@watlow.com
Website: www.watlow.com

TOTAL CUSTOMER SATISFACTION
3 Year Warranty