

Auto-Tuning PID Controllers

SD31

The SERIES SD family of PID temperature controllers utilizes today's advanced micro-electronics technology to provide the value, benefits and accuracy you've come to expect from Watlow. The SERIES SD31 offers improved accuracy of 0.1 percent of span as well as a faster sampling rate of 6.5Hz in a ½ DIN package.

The SERIES SD31 controller delivers many flexible, user-friendly options. Easily choose factory or user defaults and display either process or set point values. Process inputs are scalable and invertible from the front panel. Other features include Variable Burst Fire and flexible Outputs, that users can select as On-Off, Heat/Cool or as Process or Deviation Alarms. Users can also select between 11 different Thermocouples, a 100 Ohm RTD, a 0 to 20mA or 0 to 10V process input - all from the front panel - which eliminates the need for dip-switches.

With optional EIA-485 communications, you can configure, monitor and data log with such optional software products like WATVIEW.

Features and Benefits

Simplified navigation

- Allows users to navigate forwards or backwards from any menu

INFOSENSE™ sensor technology

- Thermal sensing technology improves accuracy by a minimum of 50 percent

Watlow's patented User Defined Menu System

- Allows users to define, save, and access their most important Menu settings

Agency approvals

- UL®, C-UL®, CE IP65/NEMA 4X, plus CSA and NSF

UL® and C-UL® are registered trademarks of Underwriter's Laboratories, Inc.

Modbus™ is a registered trademark of Schneider Automation, Inc.



Variable burst fire

- Prolongs heater life
- Reduces replacement costs

“Save and Restore” feature

- Allows the user to save individual or factory settings

Specifications

Line Voltage/Power

- 100 to 240V~(ac), +10/-15 percent; (85-264V~[ac]) 50/60Hz, ±5 percent
- 24V~(ac/dc), +10/-15 percent; 50/60Hz, ±5 percent
- 10VA maximum power consumption
- Data retention upon power failure via nonvolatile memory

Environment

- -18 to 65°C (0 to 149°F) operating temperature
- -40 to 85°C (-40 to 185°F) storage temperature
- 0 to 90 percent RH, non-condensing

Accuracy

- Calibration accuracy and sensor conformity: ±0.1 percent of span, ±1°C @ the calibrated ambient temperature and rated line voltage
- Calibration ambient temperature = 25°C ±3°C (77°F ±5°F)
- Accuracy span: 540°C (1000°F) minimum
- Temperature stability: ±0.1°C/°C (±0.2°F/°F) rise in ambient maximum

Agency Approvals

- UL® 3121, C-UL®, CSA, CE, IP65/NEMA 4X
- NSF for Type J, K, T and E thermocouples

Auto-Tuning PID Controllers

F.O.B.: Winona, Minnesota

SD31

Specifications Cont.

Controller

- Microprocessor based user-selectable control modes
- Single universal input, up to three outputs
- Control sampling rates: Input = 6.5Hz, Display = 10Hz and Outputs = 6.5Hz

Operator Interface

- Single 4 digit, 7 segment LED display
- "Set" infinity and up down keys
- Isolated EIA-485 Modbus™ serial communications, 9600, 19.2K or 38.4K baud rates

Wiring Termination-Touch Safe Terminals

- Input power and control outputs 12 to 22 AWG
- Sensor inputs and process outputs 20 to 28 AWG

Universal Input

- Thermocouple, grounded or ungrounded sensors
- RTD 2- or 3-wire, platinum, 100Ω @ 0°C calibration to DIN-curve (0.00385 Ω/Ω/°C)
- Process, 0-20mA @ 100Ω, or 0-10V_{rms}(dc) @ 20kΩ input impedance; Scalable
- Inverse scaling
- >20MΩ input impedance
- Maximum of 20Ω source resistance

Allowable Operating Range

Type J:	0 to 815°C (32 to 1500°F)
Type K:	-200 to 1370°C (-328 to 2500°F)
Type T:	-200 to 400°C (-328 to 750°F)
Type N:	0 to 1300°C (32 to 2372°F)
Type E:	-200 to 800°C (-328 to 1470°F)
Type C:	0 to 2315°C (32 to 4200°F)
Type D:	0 to 2315°C (32 to 4200°F)

Type PT11:	0 to 1395°C (32 to 2543°F)
Type R:	0 to 1760°C (32 to 3200°F)
Type S:	0 to 1760°C (32 to 3200°F)
Type B:	0 to 1816°C (32 to 3300°F)
RTD (DIN):	-200 to 800°C (-328 to 1472°F)
Process:	-1999 to 9999 units

Control Outputs

Outputs 1 or 2

- User selectable for heat/cool as on-off, P, PI, PD, PID or Alarm action.
- Electromechanical relay. Form A, rated 2A @ 120V_{rms}(ac), 2A @ 240V_{rms}(ac) or 2A @ 30V_{rms}(dc)
- Switched dc non-isolated minimum turn on voltage of 6V_{rms}(dc) into a minimum 500Ω load with a maximum on voltage of not greater than 12V_{rms}(dc) into an infinite load. Maximum switched dc power supply

current available for up to two outputs is 60mA

- Solid state relay, Form A, 0.5A @ 24V_{rms}(ac) minimum, 264V_{rms}(ac) maximum, opto-isolated, without contact suppression
- Process output (Non Isolated) User-selectable 0-10V_{rms}(dc), 0-5V_{rms}(dc), 1-5V_{rms}(dc) @ 1KΩ minimum, 0-20mA, 4-20mA @ 800Ω maximum
- Open collector 42V_{rms}(dc) @ 250mA maximum
- EIA-485 serial communications with Modbus™ protocol (output 2 only)
- 9600, 19.2K or 38.4 baud rates

Communications

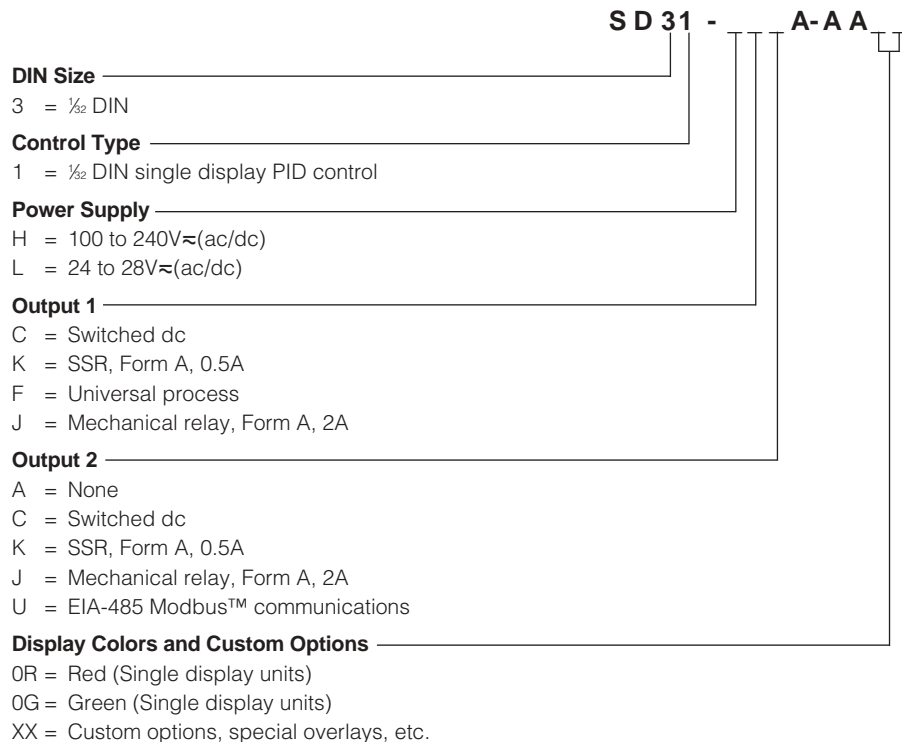
- Modbus™ EIA-485
- WATVIEW

Dimensions

- ½ DIN size
- 97.8 mm (3.85 in.) behind panel maximum
- Width 52.6 mm (2.07 in.)
- Height 29.7 mm (1.17 in.)

Ordering Information

To order, complete the model number on the right with the information below.



Auto-Tuning PID Controllers

SD_C

The features and performance offered by SERIES SD_C controllers make them ideally suited for a broad range of applications in temperature and process control.

The SERIES SD_C controllers include a universal sensor input with up to three outputs that can be programmed for heat or cool temperature control or to operate as process or deviation alarms. Programming inverse scaling is also simplified with the user-friendly set-up menu, providing additional value without additional cost.

Advanced features of SERIES SD_C controllers include EIA-485 Modbus™ serial communications, Watlow's INFOSENSE™ sensor technology, infrared remote communications operation, Watlow's patented User Definable Menu System and a "Save and Restore" feature that allows the restoration of either factory or user-defined settings.

Available in 1/2, 1/6, 1/8 and 1/4 DIN-panel mount sizes, Watlow's SERIES SD_C controllers are backed by an industry leading three-year warranty from Watlow Winona. The SERIES SD_C controllers are NSF, UL® and C-UL® listed, CSA and CE certified and include the NEMA 4X (IP65) seal.

Features and Benefits

INFOSENSE™ sensor technology

- Improves sensor accuracy by a minimum of 50 percent

User Defined Menu System

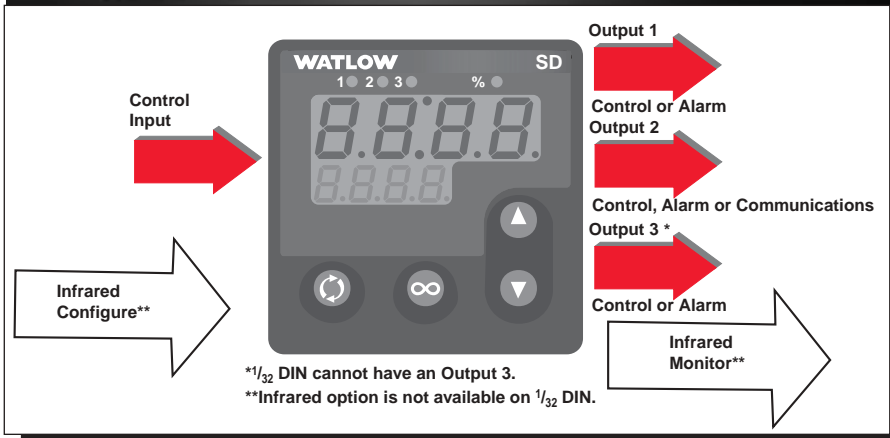
- Allows the user to assign up to 20 parameters in the operations menu
- Improves operational efficiency

"Save and Restore" feature

- Allows the user to save individual or factory settings

Variable burst fire

- Prolongs heater life
- Reduces replacement costs



Single-Loop
Auto-Tuning PID

WATVIEW HMI (Human Machine Interface)

- Permits operation, configuration and data logging via a standard Windows® PC

Infrared communications (optional)

- Facilitates recipe management and data logging
- Allows easier controller setup, operation and monitoring

Dual displays

- Provides better recognition of process changes

Specifications

Line Voltage/Power

- 100 to 240V~(ac), +10/-15 percent; (85-264V~[ac]) 50/60Hz, ±5 percent
- 24V≈(ac/dc), +10/-15 percent; 50/60Hz, ±5 percent
- 10VA maximum power consumption
- Data retention upon power failure via nonvolatile memory

Environment

- -18 to 65°C (0 to 149°F) operating temperature
- -40 to 85°C (-40 to 185°F) storage temperature
- 0 to 90 percent RH, non-condensing

Windows® is a registered trademark of Microsoft Corporation.

Auto-Tuning PID Controllers

SD_C

Specifications Cont.

Accuracy

- Calibration accuracy and sensor conformity: ± 0.1 percent of span, $\pm 1^\circ\text{C}$ @ the calibrated ambient temperature and rated line voltage
- Calibration ambient temperature = $25^\circ\text{C} \pm 3^\circ\text{C}$ ($77^\circ\text{F} \pm 5^\circ\text{F}$)
- Accuracy span: 540°C (1000°F) minimum
- Temperature stability: $\pm 0.1^\circ\text{C}/^\circ\text{C}$ ($\pm 0.2^\circ\text{F}/^\circ\text{F}$) rise in ambient maximum

Agency Approvals

- UL® 3121, C-UL®, CSA, CE, NEMA 4X/IP65
- Limit version features FM approval
- NSF for Type J, K, T and E thermocouples

Controller

- Microprocessor based user-selectable control modes
- Single universal input, up to three outputs
- Control sampling rates: Input = 6.5Hz, Display = 10Hz, and Outputs = 6.5Hz

Dimensions

DIN Size	Behind Panel (max.)	Width	Height
$\frac{1}{32}$ DIN	97.8 mm (3.85 in.)	52.6 mm (2.07 in.)	29.7 mm (1.17 in.)
$\frac{1}{16}$ DIN	97.8 mm (3.85 in.)	52.1 mm (2.05 in.)	52.1 mm (2.05 in.)
$\frac{1}{8}$ DIN Vertical	97.8 mm (3.85 in.)	52.8 mm (2.08 in.)	99.8 mm (3.93 in.)
$\frac{1}{8}$ DIN Horizontal	97.8 mm (3.85 in.)	99.8 mm (3.93 in.)	52.8 mm (2.08 in.)
$\frac{1}{4}$ DIN	101.1 mm (3.98 in.)	99.8 mm (3.93 in.)	99.8 mm (3.93 in.)

Operator Interface

- Dual 4 digit, 7 segment LED displays
- Advance, infinity and up down keys
- Optional IrDA infrared port (not available on $\frac{1}{32}$ DIN)
- Isolated EIA-485 Modbus™ serial communications. 9600, 19.2K or 38.4K baud rates

Wiring Termination -Touch Safe Terminals

- Input power and control outputs 12 to 22 AWG
- Sensor inputs and process outputs 20 to 28 AWG

Universal Input

- Thermocouple, grounded or ungrounded sensors
- RTD 2- or 3-wire, platinum, 100Ω @ 0°C calibration to DIN-curve ($0.00385 \Omega/\Omega/^\circ\text{C}$)
- Process, 0-20mA @ 100Ω , or 0-10V \rightleftharpoons (dc) @ $20k\Omega$ input impedance; Scalable
- Inverse scaling
- $>20M\Omega$ input impedance
- Maximum of 20Ω source resistance

Allowable Operating Range

Type J:	0 to 815°C (32 to 1500°F)
Type K:	-200 to 1370°C (-328 to 2500°F)
Type T:	-200 to 400°C (-328 to 750°F)
Type N:	0 to 1300°C (32 to 2372°F)
Type E:	-200 to 800°C (-328 to 1470°F)
Type C:	0 to 2315°C (32 to 4200°F)
Type D:	0 to 2315°C (32 to 4200°F)
Type PT111:	0 to 1395°C (32 to 2543°F)
Type R:	0 to 1760°C (32 to 3200°F)
Type S:	0 to 1760°C (32 to 3200°F)
Type B:	0 to 1816°C (32 to 3300°F)
RTD (DIN):	-200 to 800°C (-328 to 1472°F)
Process:	-1999 to 9999 units

Control Outputs

Outputs 1, 2, 3 (Output 3 not available on $\frac{1}{32}$ DIN)

- User selectable for heat/cool as on-off, P, PI, PD, PID or Alarm action. Not valid for limit controls
- Electromechanical relay. Form A, rated 2A @ 120V~(ac), 2A @ 240V~(ac) or 2A @ 30V \rightleftharpoons (dc)
- Switched dc non-isolated minimum turn on voltage of 6V \rightleftharpoons (dc) into a minimum 500Ω load with a maximum on voltage of not greater than 12V \rightleftharpoons (dc) into an infinite load. Maximum switched dc power supply current available for up to two outputs is 60mA
- Solid state relay, Form A, 0.5A @ 24V~(ac) minimum, 264V~(ac) maximum, opto-isolated, without contact suppression

Auto-Tuning PID Controllers

SD_C

Specifications Cont.

- Process output (Non Isolated)
User-selectable 0-10V_{rms}(dc),
0-5V_{rms}(dc), 1-5V_{rms}(dc) @
1K Ω minimum, 0-20mA, 4-20mA
@ 800 Ω maximum
- Electromechanical relay. Form C,
rated 5A @ 120V_{rms}(ac),
5A @ 240V_{rms}(ac) or 5A @
30V_{rms}(dc)
- Open collector 42V_{rms}(dc) @
250mA maximum
- EIA-485 serial communications
with Modbus™ protocol
- 9600, 19.2K or 38.4K baud rates



Advantages of IDC include automated logging of key process variables, increased accuracy and ease of use for recipe or configuration setups. Infrared data communications enhances controller data exchange in physically restricting environments (such as semiconductor clean rooms, governmental radio-active test labs or those hard to reach areas) and reduces the use of paper to record instrument information as well as human transposition errors.

Infrared Communications

The Infrared Data Communications (IDC) option is available on all SERIES SD controller models except the 1/2 DIN and can support complete SERIES SD parameter configuration and operation. The IDC option supports wireless communications with PDAs (personal digital assistants) or other devices equipped with infrared communications that support the Infrared Data Association (IrDA) 1.0 Standard.

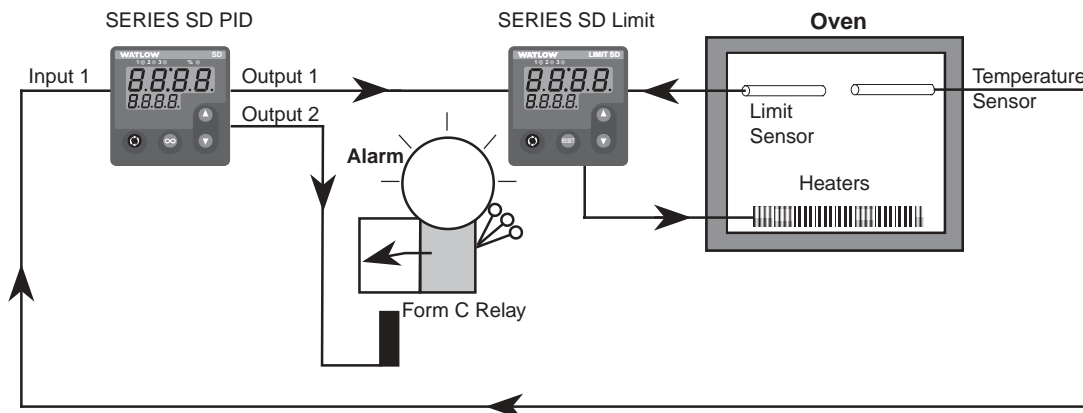
The actual user interface or configuration is dependent on the master device application software. A source for this software is Instant HMI from Software Horizons. For more information, visit www.instanthmi.com/watlow.



WATVIEW HMI

WATVIEW, Watlow's Windows® based HMI (Human Machine Interface) software, supports the SERIES SD controllers. The software can be used to setup, monitor and edit the values of controller parameters, to monitor and manage alarms and to log and graph process data.

Typical Block Diagram



Note: Consult user manual for proper wiring.

Auto-Tuning PID Controllers

F.O.B.: Winona, Minnesota

SD_C



INFOSENSE™ Sensor Technology

Watlow's INFOSENSE™ sensor technology improves temperature sensing accuracy by 50 percent. Each INFOSENSE “smart” sensor contains four numeric values located on tags attached to each sensor that are programmed into the SERIES SD controller memory. These values characterize Watlow sensors and allow the controller to provide enhanced accuracy.

Ordering Information

To order, complete the model number on the right with the information below.

SERIES SD_C = Single channel PID controllers

DIN Sizes

- 3 = 1/2 DIN
- 6 = 1/6 DIN
- 8 = 1/6 DIN Vertical
- 9 = 1/6 DIN Horizontal
- 4 = 1/4 DIN

Control Type

- C = PID Control Dual Display

Power Supply

- H = 100 to 240V \approx (ac/dc)
- L = 24 to 28V \approx (ac/dc)

Output 1

- C = Switched dc
- K = SSR, Form A, 0.5A
- F = Universal process
- J = Mechanical relay, Form A, 2A

Output 2

- A = None
- C = Switched dc
- K = SSR, Form A, 0.5A
- J = Mechanical relay, Form A, 2A
- U = EIA-485 Modbus™ communications

Output 3 (Not available on 1/2 DIN)

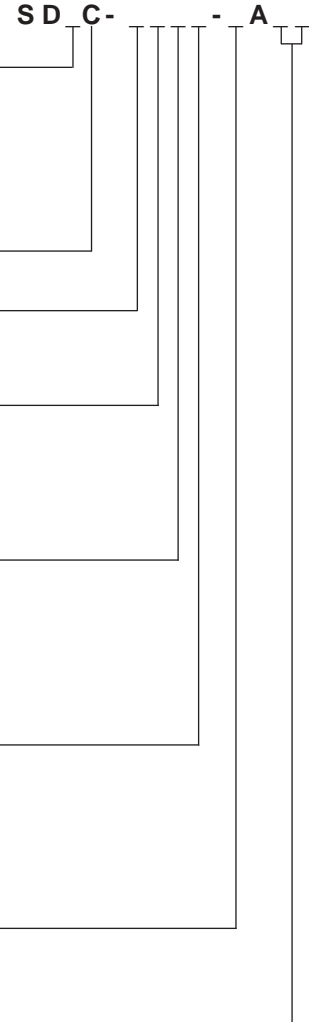
- A = None
- C = Switched dc/open collector
- K = SSR, Form A, 0.5A
- F = Universal process
- E = Mechanical relay, Form C, 5A

Infrared Comms Options (IrDA)

- A = None (Default selection on 1/2 DIN)
- R = IrDA ready (Not available on 1/2 DIN)

Display Colors and Custom Options

- RG = Red Green (Dual display units)
- RR = Red Red (Not available on 1/2 DIN Dual Display)
- XX = Custom options, special overlays, etc.



Auto-Tuning PID Controllers

SD6C_D

Watlow SERIES SD6C_D offers excellent static Set Point control and application flexibility in a 1/16th DIN panel mount package. The SERIES SD6C_D controller has been successfully tested for use with both ODVA and Semi-conductor SIG standards for DeviceNet™ on CAN networks.

The SD6C_D single channel controller includes a universal sensor input with two outputs that can be configured as heat or cool or alarm. The DeviceNet™ communications interface is supplied with either a five pin circular DIN connector for Semiconductor SIG specific applications, or with a five position removable screw terminal connector for traditional market applications.

Additional features of the SD6C_D family of controllers include Watlow's INFOSENSE™ sensor technology, a user definable menu system and a Save and Restore feature that allows the restoration of factory and user defined parameter values.

Watlow SD6C_D DeviceNet™ controllers offer a three year warranty; are UL®, C-UL® listed, CSA, CE and NSF certified and include IP65/NEMA 4 ratings.

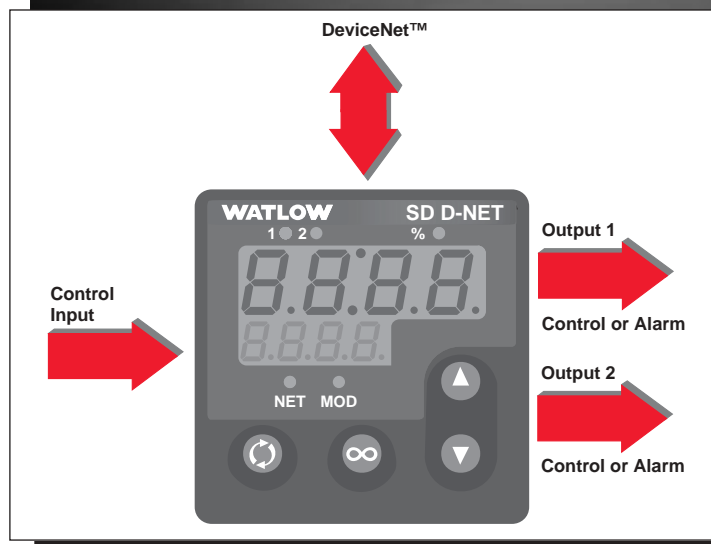
Features and Benefits

Variable burst fire

- Prolongs heater life

Ordering Options including DeviceNet™ on CAN or SEMI-SIG-ODVA protocols

- Provides DeviceNet™ on CAN for Semiconductor applications
- DeviceNet™ on CAN for the packaging or general industrial markets



Specifications

Line Voltage/Power

- 100 to 240V~(ac), +10/-15 percent; (85-264V~[ac]) 50/60Hz, ±5 percent
- 24V~(ac/dc), +10/-15 percent; 50/60Hz, ±5 percent
- 10VA maximum power consumption
- Data retention upon power failure via nonvolatile memory

Environment

- -18 to 65°C (0 to 149°F) operating temperature
- -40 to 85°C (-40 to 185°F) storage temperature
- 0 to 90 percent RH, non-condensing

Accuracy

- Calibration accuracy and sensor conformity: ±0.1 percent of span, ±1°C @ the calibrated ambient temperature and rated line voltage
- Calibration ambient temperature = 25°C ±3°C (77°F ±5°F)
- Accuracy span: 540°C (1000°F) minimum
- Temperature stability: ±0.1°C/°C (±0.2°F/°F) rise in ambient maximum

DeviceNet™ is a trademark of the Open DeviceNet Vendors Association.

Auto-Tuning-PID Controllers

F.O.B.: Winona, Minnesota

SD6C_D

Specifications Cont.

Agency Approvals

- UL® 3121, C-UL®, CSA, CE, IP65/NEMA 4X and NSF-2
- Microprocessor based user-selectable control modes
- Single universal input, up to three outputs
- Control sampling rates: Input = 6.5Hz, Display = 10Hz and Outputs = 6.5Hz

Operator Interface

- Dual 4 digit, 7 segment LED displays
- Advance, infinity and up down keys
- DeviceNet™ on CAN or SEMI-SIG-ODVA protocols

Allowable Operating Range

Type J:	0 to 815°C (32 to 1500°F)
Type K:	-200 to 1370°C (-328 to 2500°F)
Type T:	-200 to 400°C (-328 to 750°F)
Type N:	0 to 1300°C (32 to 2372°F)
Type E:	-200 to 800°C (-328 to 1470°F)
Type C:	0 to 2315°C (32 to 4200°F)
Type D:	0 to 2315°C (32 to 4200°F)
Type PTII:	0 to 1395°C (32 to 2543°F)
Type R:	0 to 1760°C (32 to 3200°F)
Type S:	0 to 1760°C (32 to 3200°F)
Type B:	0 to 1816°C (32 to 3300°F)
RTD (DIN):	-200 to 800°C (-328 to 1472°F)
Process:	-1999 to 9999 units

Control Outputs

Outputs 1 and 2

- User selectable for heat/cool as on-off, P, PI, PD, PID or Alarm action.
- Electromechanical relay. Form A, rated 2A @ 120V~(ac), 2A @ 240V~(ac) or 2A @ 30V=(dc)
- Switched dc non-isolated minimum turn on voltage of 6V=(dc) into a minimum 500Ω load with a maximum on voltage of not greater than 12V=(dc) into an infinite load. Maximum switched dc power supply current available for up to two outputs is 60mA
- Solid state relay, Form A, 0.5A @ 24V~(ac) minimum, 264V~(ac) maximum, opto-isolated, without contact suppression

- Process output (Non Isolated) User-selectable 0-10V=(dc), 0-5V=(dc), 1-5V=(dc) @ 1KΩ minimum, 0-20mA, 4-20mA @ 800Ω maximum
- Electromechanical relay. Form C, rated 5A @ 120V~(ac), 5A @ 240V~(ac) or 5A @ 30V=(dc)
- Open collector 42V=(dc) @ 250mA maximum

Dimensions

SD6C_D or SD6R_D or SD6L_D

- 1/6 DIN Size
- 97.8 mm (3.85 in.) behind panel maximum
- Width 52.1 mm (2.05 in.)
- Height 52.1 mm (2.05 in.)

Ordering Information

To order, complete the model number on the right with the information below.

SD6C- A-D

SERIES SD6C_D = 1/6 DIN panel mount PID controller with DeviceNet™

Control Type
C = PID controller

Power Supply
H = 100 to 240V=(ac/dc)
L = 24 to 28V=(ac/dc)

Output 1
C = Switched dc
K = SSR, Form A, 0.5A
F = Universal process
J = Mechanical relay, Form A, 2A

Output 2
A = None
C = Switched dc
K = SSR, Form A, 0.5A
J = Mechanical relay, Form A, 2A
U = EIA-485 Modbus™ communications

DeviceNet™ Communications
N = DeviceNet™ on CAN (packaging or general industrial markets)
S = SEMI-SG-ODVA compliant (semi-conductor markets)

Display Colors and Custom Options
RG = Red Green (with Watlow name and SD logo)
RR = Red Red (with Watlow name and SD logo)
AA = Red Green (SD logo only)
AB = Red Red (SD logo only)

Auto-Tuning PID Controllers

SERIES 96

Watlow's SERIES 96 is a powerful $\frac{1}{6}$ DIN dual display controller that offers many advanced functions. This controller can be tailored to perform hardware and software needs with hardware modules that are pluggable and exchangeable, and software menus that may be user programmed to fit exact application requirements.

With one universal input, a second auxiliary input and four outputs the SERIES 96 can be programmed to perform: temperature measurement, input event switching, remote set point input, heating, boost heating, cooling, alarms, digital communications and retransmit.

With fast 10Hz sampling, variable time base burst firing outputs, NEMA 4X front panel and 0.1 percent calibration accuracy, this controller can easily handle some of the toughest application needs.

Features and Benefits

Burst fire

- Increases heater life / better temperature controllability

One input, one auxiliary input, four outputs

- Powerful flexibility at a competitive price

No dipswitches

- Easily configurable from the front panel

Multiple set points

- Flexible automatic control

Pluggable output modules

- Field expandable

Fast 10Hz sampling

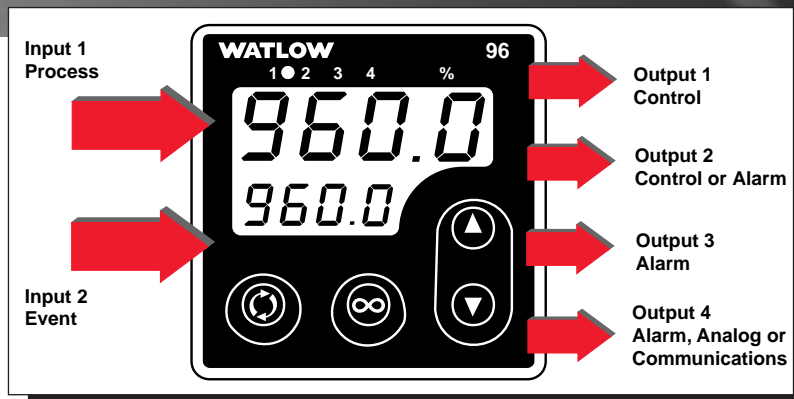
- Improved control responsiveness

Programmable menus (Patented)

- Can be self-tailored for exact user needs

Open loop break protection

- Indication of thermal loop problem



NEMA 4X (IP65)^①

- Water and corrosion resistant front panel can be washed down

16 programmable ramp and soak steps

- Profiles of dynamic production processes can be programmed into the controller

Automatic-tuning

- Easy one step tuning of PID control parameters

Applications

- Packaging
- Semiconductor
- Food processing
- Lab equipment
- Furnace and ovens
- Plastics

Specifications

Operating Environment

- 0 to 65°C (32 to 149°F)

Controller

- Microprocessor-based, user selectable control modes
- Heat and cool auto-tune for control outputs
- Universal input one, auxiliary input two, four outputs
- Control outputs user selectable as on-off, P, PI, PID

Warranty^②

- Industry leading three-years

^① To effect NEMA 4X (IP65) rating requires a minimum mounting panel thickness of 1.5 mm (0.06 in.) and surface finish not rougher than 0.000812 mm (0.000032 in.).

^② Electromechanical relays warranted for 100,000 closures only. Solid state switching devices recommended for applications requiring fast cycle times or extended service life.

Auto-Tuning PID Controllers

SERIES 96

Specifications Cont.

- Input sampling rates: Single input 10Hz (100ms), dual input 5Hz (200ms) digital filter adjustable
- Display update: 2Hz (500ms), time filter adjustable
- Output update: burst, 0.1 to 999.9 seconds
- Input/Output/Communication isolation
- Displayed in °C, °F, or process units

Operator Interface

- Dual four-digit LED displays: upper 10.2 mm (0.4 in.), lower 6.2 mm (0.244 in.)
- Advance, Up Arrow, Down Arrow, Infinity tactile keys

Standard Conditions For Specifications

- Ambient temperature 25°C (77°F) ±3°C, rated line voltage, 50 to 60Hz, 0 to 90 percent RH non-condensing, 15 minute warm-up

Universal Input 1

Thermocouple

- Type J, K, T, N, C (W5), E, Pt 2, D (W3), B, R, S thermocouple
- >20MΩ input impedance
- Maximum 20Ω source resistance
- 30μA open detection bias

RTD

- 2- or 3-wire platinum, 100Ω
- JIS and DIN-curves
- Whole or tenth degree indication
- 150μA nominal RTD excitation current

Process

- Range selectable: 0-10V_{rms}(dc), 0-5V_{rms}(dc), 1-5V_{rms}(dc), 0-20mA, 4-20mA
- Voltage input impedance 20kΩ
- Current input impedance 100Ω
- Minimum current source resistance 1MΩ

- Input resolution 50,000 bits (approx.) at full scale
- mV input impedance 20MΩ

Input 2

Event Input

- Contact or voltage
- 20KΩ input impedance
- Voltage input: event high state 3 to 36V_{rms}(dc), event low state 0 to 2V_{rms}(dc)
- Resistance/contact input: event high state >23kΩ, event low state 0 to 2kΩ

Remote Set Point Input: mA or V_{rms}(dc) Range Selectable

- Voltage input impedance 20kΩ
- Current input impedance 100Ω

Output Types

Open Collector/Switched DC

- Open collector configuration: Maximum voltage 42V_{rms}(dc) Maximum current 200mA Maximum on resistance 1.1Ω Maximum off state leakage current 100μA
- Switched dc configuration: Switched dc supply voltage 22 to 28V_{rms}(dc) dc supply current limited to 30mA

Solid State Relay

- Optically isolated
- Zero cross switched
- Without contact suppression
- Minimum load current 0.5mA rms
- Maximum current 0.5A rms at 20 to 280V_{rms}(ac)
- Maximum off state leakage current 10μA rms
- For resistive loads only, must use RC suppression for inductive loads

Electromechanical Relay

- Form C contact configuration
- Minimum load current 10mA @ 5V_{rms}(dc)
- Rated resistive and inductive loads: 2A @ 250V_{rms}(ac) or 30V_{rms}(dc) maximum

- Electrical life 100,000 cycles at rated current
- For resistive loads only, must use RC suppression for inductive loads

Process

- Range selectable: 0-20mA, 4-20mA, 0-5V_{rms}(dc), 1-5V_{rms}(dc), 0-10V_{rms}(dc)
- Reverse or direct acting
- 0 to 10V_{rms}(dc) voltage output into 1000Ω minimum load resistance
- 0 to 20mA current output into 800Ω maximum load resistance
- Resolution: V_{rms}(dc) ranges = 2.5mV nominal mA ranges = 5μA nominal
- Calibration accuracy: V_{rms}(dc) ranges = ±15mV mA ranges = ±30μA
- Temperature stability 100ppm/°C

Retransmit

- Range selectable: 0-20mA, 4-20mA, 0-5V_{rms}(dc), 1-5V_{rms}(dc), 0-10V_{rms}(dc)
- 0 to 10V_{rms}(dc) voltage output into a 1,000Ω minimum load resistance
- 0 to 20mA current output into an 800Ω maximum load resistance
- Resolution: V_{rms}(dc) ranges = 2.5mV nominal mA ranges = 5μA nominal
- Calibration accuracy: V_{rms}(dc) ranges = ±15mV mA ranges = ±30μA
- Temperature stability 100ppm/°C

Communications

- EIA/TIA-485, EIA/TIA-232
- Opto-isolated
- Modbus™ RTU protocol
- 1200, 2400, 4800, 9600, 19200 baud rates
- 32 maximum units can be connected (With additional 485 repeater hardware, up to 247 units may be connected)

Auto-Tuning PID Controllers

SERIES 96

Specifications Cont.

Accuracy

- Input ranges

Type J	0 to 750°C (32 to 1382°F)
Type K	-200 to 1250°C (-328 to 2282°F)
Type T	-200 to 350°C (-328 to 662°F)
Type N	0 to 1250°C (32 to 2282°F)
Type E	-200 to 900°C (-328 to 1470°F)
Type C(W5)	0 to 2315°C (32 to 4200°F)
Type D(W3)	0 to 2315°C (32 to 4200°F)
Pt 2	0 to 1393°C (32 to 2540°F)
Type R	0 to 1450°C (32 to 2642°F)
Type S	0 to 1450°C (32 to 2642°F)
Type B	870 to 1700°C (1598 to 3092°F)
DIN	-200 to 800°C (-328 to 1472°F)
JIS	-200 to 630°C (-328 to 1166°F)
Process	-1999 to 9999 units

Thermocouple Inputs

- Calibration accuracy ± 0.1 percent of span $\pm 1^\circ\text{C}$ at standard conditions
 Exceptions:
 Type T: 0.12 percent of span for -200°C to -50°C (-328°F to -58°F)
 Types R and S: 0.15 percent of span for 0°C to 100°C (32°F to 212°F)
 Type B: 0.24 percent of span for 870°C to 1700°C (1598°F to 3092°F)
- Accuracy span: 540°C (1000°F) minimum
- Temperature stability: ± 0.1 degree per degree change in ambient

RTD Inputs

- Calibration accuracy ± 0.1 percent of span $\pm 1^\circ\text{C}$ at standard conditions
- Accuracy span: 540°C (1000°F) minimum
- Temperature stability: ± 0.05 degree per degree change in ambient

Process Inputs

- Voltage input ranges
 Accuracy $\pm 15\text{mV} \pm 1$ LSD at standard conditions
 Temperature stability $\pm 100\text{ppm}/^\circ\text{C}$ maximum
- Milli-amp input ranges
 Accuracy $\pm 30\mu\text{A} \pm 1$ LSD at standard conditions
 Temperature stability $\pm 100\text{ppm}/^\circ\text{C}$ maximum

Agency Approvals

- UL® 916, File #E185611, C-UL®, CE, NEMA 4X

Terminals

- Touch safe
- 22 to 12 AWG

Power

- 100-240V~(ac) +10 percent, -15 percent; 50/60Hz, ± 5 percent
- 24-28V~(ac) or V=(dc) +10 percent, -15 percent; 50/60Hz, ± 5 percent
- 7.0VA maximum power consumption
- Data retention upon power failure via nonvolatile memory

Operating Environment

- 0 to 65°C (32 to 149°F)
- 0 to 90 percent RH, non-condensing
- Storage temperature: -40 to 85°C (-40 to 185°F)

Controller Weight (approx.)

- 0.2 kg (0.4 lb)

Allowable Operating Ranges

Type J	1.0	0 to 815°C (32 to 1500°F)
	0.1	0 to 815°C (32 to 1500°F)
Type K	1.0	-270 to 1370°C (-454 to 2500°F)
	0.1	-200 to 1000°C (-328 to 1832°F)
Type T	1.0	-270 to 400°C (-454 to 750°F)
	0.1	-200 to 400°C (-328 to 750°F)
Type N	1.0	0 to 1300°C (32 to 2372°F)
	0.1	0 to 1000°C (32 to 1832°F)
Type E	1.0	-270 to 800°C (-454 to 1470°F)
	0.1	-200 to 800°C (-328 to 1472°F)
Type C	1.0	0 to 2315°C (32 to 4200°F)
	0.1	0 to 1000°C (32 to 1832°F)
Type D	1.0	0 to 2315°C (32 to 4200°F)
	0.1	0 to 1000°C (32 to 1832°F)
Pt 2	1.0	0 to 1395°C (32 to 2543°F)
	0.1	0 to 1000°C (32 to 1832°F)
Type R	1.0	0 to 1760°C (32 to 3200°F)
Type S	1.0	0 to 1760°C (32 to 3200°F)
Type B	1.0	0 to 1816°C (32 to 3300°F)
DIN	1.0	-200 to 800°C (-328 to 1472°F)
	0.1	-200 to 800°C (-328 to 1472°F)
JIS	1.0	-200 to 630°C (-328 to 1166°F)
	0.1	-200 to 630°C (-328 to 1166°F)
Process	-1999 to 9999 units	

Auto-Tuning PID Controllers

F.O.B.: Winona, Minnesota

SERIES 96

Functionality Matrix

	Universal Input	Event & Remote Set Point	Control	Alarm	Retransmit	232 485 Comm
Input 1						
Input 2						
Output 1						
Output 2						
Output 3						
Output 4						

Dimensions

Overall

Height: 52 mm (2.05 in.)
 Width: 52 mm (2.05 in.)
 Length: 107 mm (4.2 in.)

Depth behind panel surface

98.4 mm (3.875 in.)

Ordering Information

To order, complete the code number on the right with the information below:

SERIES 96 = Microprocessor-based 1/6 DIN, with universal input 1. Options include: software, power supply, input 2, outputs and display color.

Power Supply

A = 100-240V \approx (ac/dc)
 B = 24-28V \approx (ac/dc)

Input 2

0 = None
 1 = Event input and 0-5V \approx (dc)/4-20mA (Remote set point input)

Output 1

C = Switched dc/open collector
 D = Electromechanical relay, Form C, 2A, without RC suppression
 F = Universal Process, range selectable: 0-20mA, 4-20mA, 0-5V \approx (dc), 1-5V \approx (dc), 0-10V \approx (dc)
 K = 0.5A solid state relay without RC suppression

Output 2

A = None
 C = Switched dc/open collector
 D = Electromechanical relay, Form C, 2A, without RC suppression
 F = Universal Process, range selectable: 0-20mA, 4-20mA, 0-5V \approx (dc), 1-5V \approx (dc), 0-10V \approx (dc)
 K = 0.5A solid state relay without RC suppression

Output 3

A = None
 D = Electromechanical relay, Form C, 2A, without RC suppression

Output 4

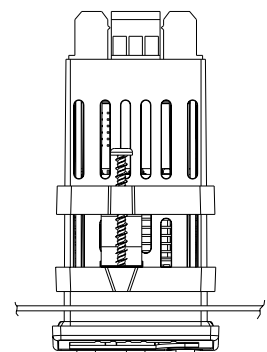
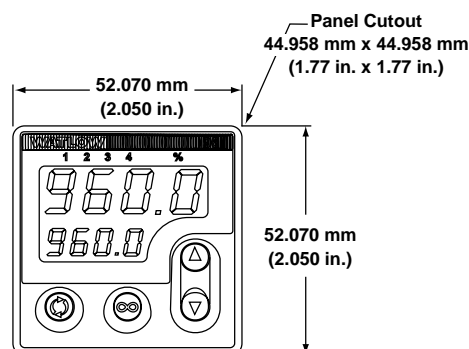
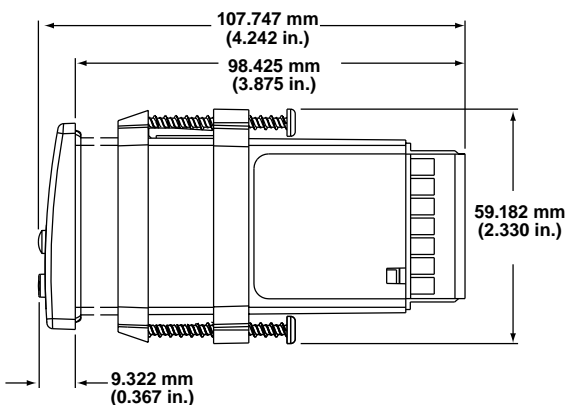
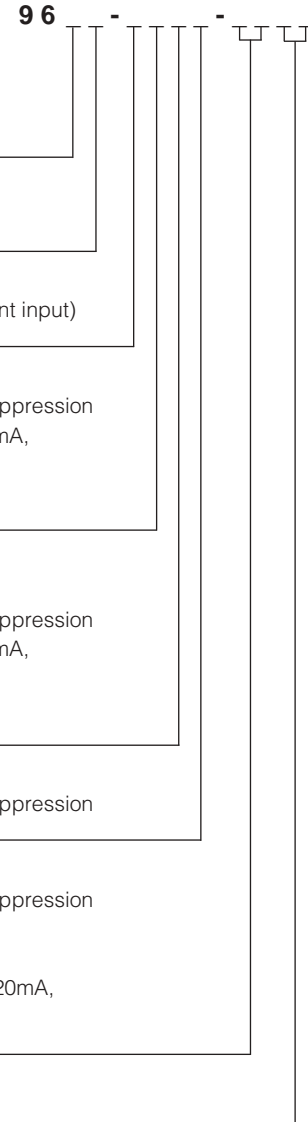
A = None
 D = Electromechanical relay, Form C, 2A, without RC suppression
 R = 232 Communications
 U = 485 Communications
 M = Universal Retransmit, range selectable: 0-20mA, 4-20mA, 0-5V \approx (dc), 1-5V \approx (dc), 0-10V \approx (dc)

Software/Preset Parameters

00 = Standard software

Display/Overlay

Upper/Lower Upper/Lower
 RR = Red/Red display GR = Green/Red display
 RG = Red/Green display GG = Green/Green display



Auto-Tuning PID Controllers

SERIES 988/989

Watlow's SERIES 988 (vertical) and SERIES 989 (horizontal) temperature/process controllers are designed and manufactured for the demanding requirements of the industrial controller market. No other controller offers the flexibility, compact size and durability of the SERIES 988/989. The controller's industry leading feature set is its compact 1/2 DIN size and NEMA 4X[®] (IP65) water and corrosion resistant front panel.

The SERIES 988/989 has the auto-tuning and alarm features you would expect. Additionally, several unique control algorithms, not common to this price range, extend the SERIES 988/989's application potential. From the long list of product features, the SERIES 988/989's ability to provide single unit cascade control of a process is perhaps the most unique. Other features include heater current monitoring, remote set point input, differential or ratio control.

Performance Capabilities

- Accuracy to 0.1 percent of span
- Operating environment 0 to 65°C (32 to 149°F)

Features and Benefits

Three inputs and four outputs

- Provide application versatility

Universal high or low voltage power supply, horizontal or vertical mounting and display color options

- Add to application versatility

A 10Hz sampling rate, along with the burst fire

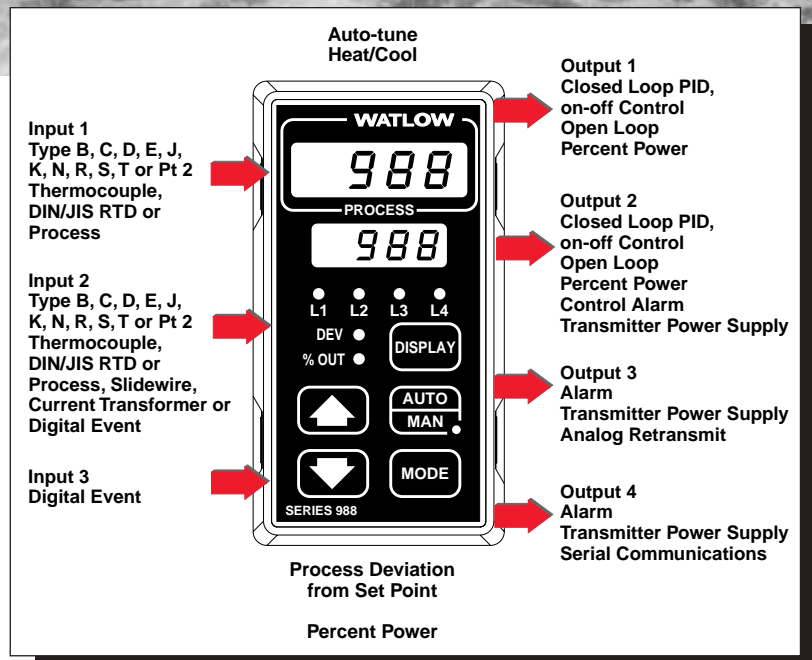
- Provides precise process control

Enhanced software option

- Provides advanced cascade, ratio or dual PID control

Signal conditioner power supply options

- Eliminate the need for external devices



Serial communications

- Support for one-on-one as well as remote networking of controllers

UL[®], CE and NEMA 4X (IP65) approvals

- Help ensure product and operator safety

Dual digital displays

- Provide simultaneous viewing of the set point and the actual process

Three-year warranty^②

- Provides Control Confidence[®]

Applications

- Any process requiring cascade, ratio, burst fire or slidewire feedback control
- Food processing
- Packaging
- Plastics processing
- Semiconductor manufacturing

^① To effect NEMA 4X (IP65) rating requires a minimum mounting panel thickness of 1.5 mm (0.06 in.) and surface finish not rougher than 0.000812 mm (0.000032 in.).

^② Electromechanical relays warranted for 100,000 closures only. Solid state switching devices recommended for applications requiring fast cycle times or extended service life.

Auto-Tuning PID Controllers

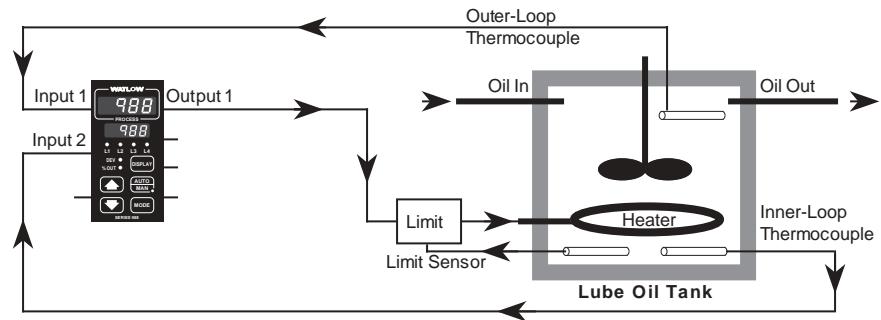
SERIES 988/989

Enhanced Software

Cascade Control

Cascade control is a control strategy in which one control loop provides the set point for another loop. It allows the process or part temperature to be reached quickly while minimizing overshoot. Cascade is used to optimize the performance of thermal systems with long lag times.

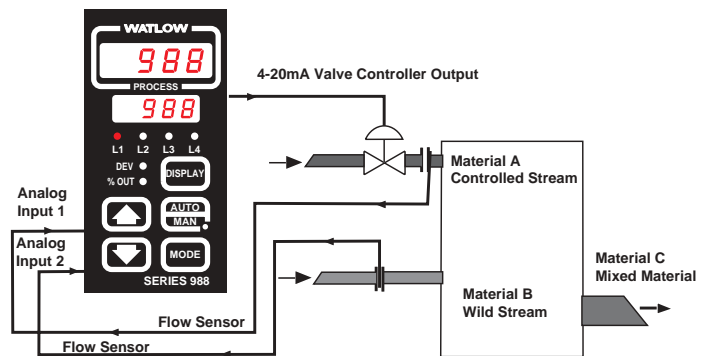
- Precise control via cascade configuration
- Display of both process variables
- Low cost; one unit does the work of two
- Increased operator productivity with fast setup



Ratio Control

Whether mixing materials or controlling temperature indirectly, ratio control with the SERIES 988 provides automatic set point adjustments in response to system changes.

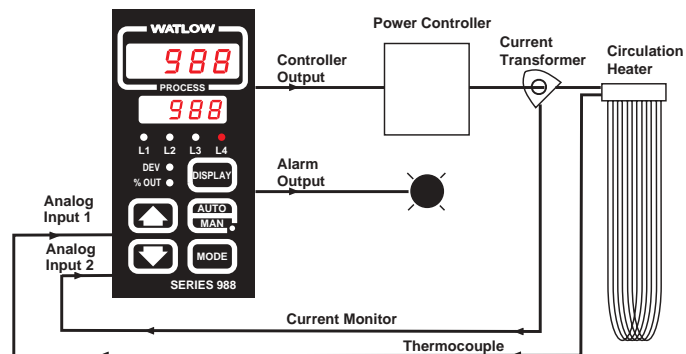
- Simplified process control; one controller does the work of two
- Low cost solution; one controller, display access - both process variables
- One controller for many applications
- Easy setup; increased operator productivity



Current Monitor

Current monitoring provides system performance and status information. The SERIES 988 accepts current transformer signal with no conditioning.

- Easily accessible heater status
- System performance data for troubleshooting or design enhancements
- System protection; fast shut down with overcurrent
- Easy setup: no external signal conditioner required



Auto-Tuning PID Controllers

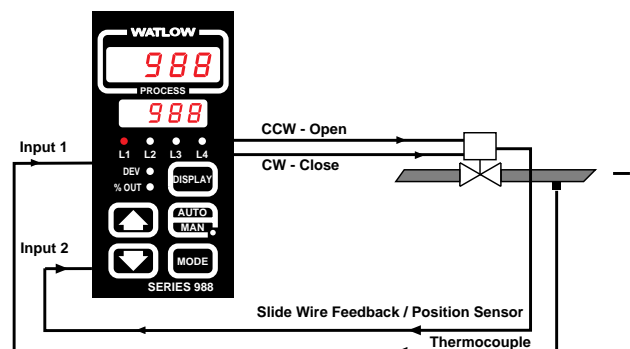
SERIES 988/989

Enhanced Software Cont.

Slidewire Feedback Valve Control

Valve positioning feedback (percent open, percent close) provides precise process control. The SERIES 988 is configurable for a wide variety of valves.

- Accepts virtually any valve input
- Front panel valve position display
- Increased valve life with anti-hunting parameter
- Greater process efficiency with precise control
- Easy setup; increased operator productivity



Product Highlights

Easy to Operate

The SERIES 988's operator interface features the simplicity you expect from a Watlow controller. The display key allows the operator to view information pertinent to the process, including, among others, deviation from set point, percent output and units of measurement.

The display key also returns the operator to the process and set point display from anywhere in the menu system. The setup menu is segmented into input, output, global, and communication parameters and you can move forward or backward throughout the parameter sequence.

Use Up To Four Outputs

The controller can have up to four outputs total, including the standard Watlow output options, along with retransmit and communications. Up to three outputs can be defined as a power supply output to power external signal conditioners, eliminating the need for an external power supply. The output types are recognized by the controller to simplify setup and operation, with no need for DIP switches.

Three Inputs Allow Greater Flexibility

To accommodate unique system configurations, the SERIES 988 offers two universal analog inputs and one event (digital) input. The event input allows the operator to select a function at the close of a switch. This can lock out the front panel, switch PID values, go to a remote or second set point, etc. The inputs are optically isolated from all outputs, eliminating the need for external isolation circuitry.

Specifications

Control Mode

- Dual input, quad output, optional retransmit of set point or process variable
- Programmable direct and reverse acting control outputs
- One step auto-tuning

Agency Approvals

- CE
- 89/336/EEC Electromagnetic Compatibility Directive

- EN 50081-2: 1994 Emissions
- EN 50082-2: 1994 Immunity
- 73/23/EEC Low Voltage Directive
- EN 61010-1: 1993 Safety
- UL® #873, C-UL® File #43684
- NEMA 4X

Operator Interface

- Local/remote set point capability
- Dual, 4 digit LED displays
Upper: 10 mm (0.4 in.)
Lower: 8 mm (0.3 in.)

- MODE, AUTO/MAN, DISPLAY, UP and DOWN keys

Accuracy

- Calibration accuracy and sensor conformity: ± 0.1 percent of span, ± 1 LSD, $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($77^{\circ}\text{F} \pm 5^{\circ}\text{F}$) ambient and rated line voltage ± 10 percent
- Accuracy span: 540°C (1000°F) minimum
- Temperature stability: $0.1^{\circ}\text{C}/^{\circ}\text{C}$ ($\pm 0.2^{\circ}\text{F}/^{\circ}\text{F}$) change in ambient

Auto-Tuning PID Controllers

SERIES 988/989

Specifications Cont.

Sensors/Inputs

- Contact input for software function select (event input)
- Thermocouple Types B, C^①, D^①, E, J, K, N, R, S, T and Pt 2^②
- RTD resolution in 1° or 0.1° increments
- Process variables: 0-50mV, 0-20mA_{rms}(dc), 4-20mA_{rms}(dc), 0-5V_{rms}(dc), 1-5V_{rms}(dc), 0-10V_{rms}(dc)
- Slidewire, digital event input or heater current options
- Sensor break protection de-energizes system for safety, or selectable bumpless transfer to manual operation. Latching or non-latching
- °C or °F display or process units, user selectable

Input Range

Specified temperature ranges represent the controller's operational span. Refer to [page 228](#) for ANSI (thermocouple) and DIN/JIS (RTD) temperature sensor ranges/tolerances.

Thermocouple

Type B	870 to 1816°C (1598 to 3300°F)
Type C ^①	0 to 2316°C (32 to 4200°F)
Type D ^①	0 to 2316°C (32 to 4200°F)
Type E	-200 to 799°C (-328 to 1470°F)
Type J	0 to 816°C (32 to 1500°F)
Type K	-200 to 1371°C (-328 to 2500°F)
Type N	0 to 1300°C (32 to 2372°F)

Type R	0 to 1760°C (32 to 3200°F)
Type S	0 to 1760°C (32 to 3200°F)
Type T	-200 to 399°C (-328 to 750°F)
Pt 2 ^②	0 to 1395°C (32 to 2543°F)

RTD Resolution (DIN or JIS)

1° (DIN)	-200 to 800°C (-328 to 1472°F)
1° (JIS)	-200 to 630°C (-328 to 1166°F)
0.1° (DIN and JIS)	-73.3 to 537.7°C (-99.9 to 999.9°F)

Process

0-5V _{rms} (dc)	-999 to 9999 units
1-5V _{rms} (dc)	-999 to 9999 units
0-10V _{rms} (dc)	-999 to 9999 units
0-20mA _{rms} (dc)	-999 to 9999 units
4-20mA _{rms} (dc)	-999 to 9999 units
0-50mV _{rms} (dc)	-999 to 9999 units
Slidewire	100 to 1200Ω
Current	0 to 50mA
Potentiometer	0 to 1200Ω

Output Options

- Solid state relay, Form A, 0.5A @ 24V_{rms}(ac) min., 253V_{rms}(ac) max., opto-isolated, burst fire switching. With or without contact suppression. Off state output impedance is 20kΩ with RC suppression, 31MΩ without contact suppression
- Open collector or switched dc signal provides a minimum turn on voltage of 3V_{rms}(dc) into a minimum 500Ω load; maximum on voltage not greater than 32V_{rms}(dc) into an infinite load, isolated

- Electromechanical relay^②, Form C, 5A @ 120/240V_{rms}(ac), 6A @ 28V_{rms}(dc), 1/8 hp @ 120V_{rms}(ac), 125VA @ 120V_{rms}(ac). With or without contact suppression. Off state output impedance with RC suppression is 20kΩ
- Process, 0-20mA_{rms}(dc), 4-20mA_{rms}(dc) into 800Ω maximum, 0-5V_{rms}(dc), 1-5V_{rms}(dc), or 0-10V_{rms}(dc) into 1kΩ minimum reverse acting, isolated
- Electromechanical relay^②, Form A/B, 5A @ 120/240V_{rms}(ac), 6A @ 28V_{rms}(dc), 1/8 hp @ 120V_{rms}(ac), 125VA @ 120V_{rms}(ac), without contact suppression
- External transmitter power supply, 5, 12 or 20V_{rms}(dc) @ 30mA
- EIA/TIA-232 communications or EIA/TIA-485, EIA/TIA-422 communications, opto-isolated
- Retransmit: 0-20mA_{rms}(dc), 4-20mA_{rms}(dc) with 600Ω max. load impedance, or 0-5V_{rms}(dc), 1-5V_{rms}(dc) and 0-10V_{rms}(dc) with 500Ω min. load impedance

Line Voltage/Power

- 100-240V_{rms}(ac/dc) +10 percent, -15 percent; 50/60Hz, ±5 percent
- 24-28V_{rms}(ac/dc) +10 percent, -15 percent; 50/60Hz ±5 percent
- Power consumption 16VA maximum
- Fused internally (factory replaceable only) Slo-Blo[®] type (time-lag):
2A, 250V for high voltage versions
5A, 250V for low voltage versions
- Data retention upon power failure via non-volatile memory

^① Not an ANSI symbol.

^② Electromechanical relays warranted for 100,000 closures only. Solid state switching devices recommended for applications requiring fast cycle times or extended service life.

Slo-Blo[®] is a registered trademark of Littelfuse, Inc.

Auto-Tuning PID Controllers

SERIES 988/989

Dimensions

Vertical Orientation

Overall

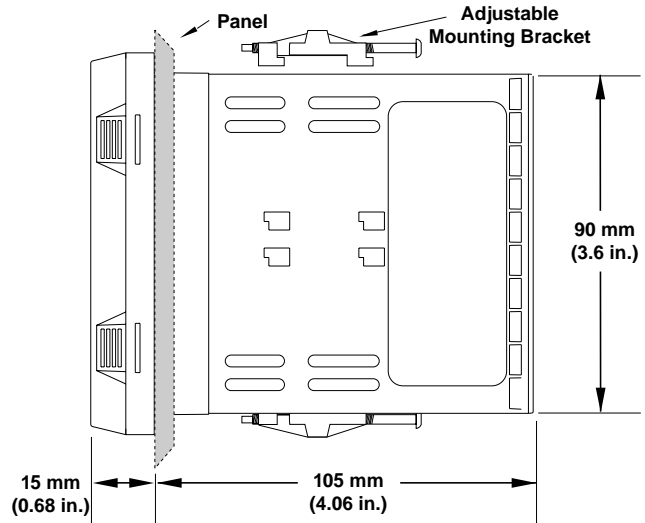
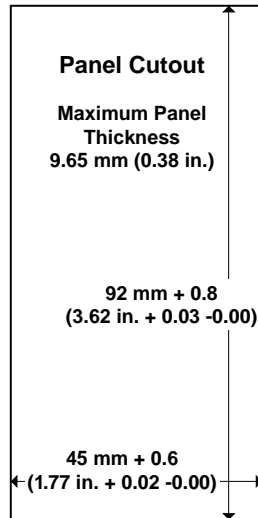
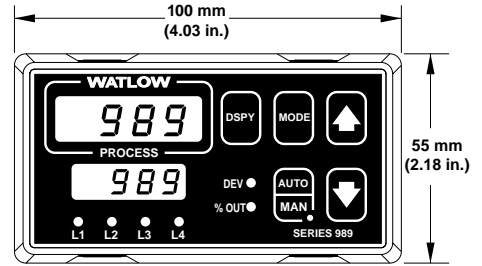
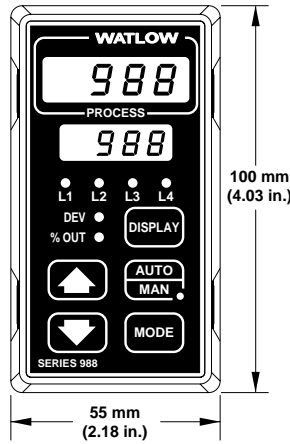
Height: 100 mm (4.03 in.)
 Width: 55 mm (2.18 in.)
 Depth: 120 mm (4.74 in.)

Bezel

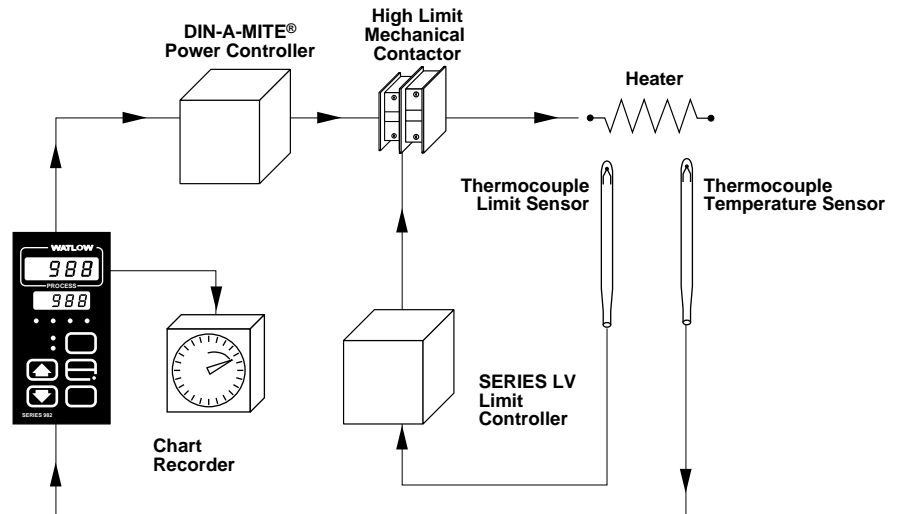
Height: 100 mm (4.03 in.)
 Width: 55 mm (2.18 in.)
 Depth: 15 mm (0.68 in.)

Chassis

Height: 90 mm (3.6 in.)
 Width: 45 mm (1.7 in.)
 Depth: 105 mm (4.06 in.)



System Diagram



Auto-Tuning PID Controllers

SERIES F4P

The SERIES F4P ¼ DIN temperature process controllers offer the performance and features to meet a wide range of industrial processing needs. The F4P process controllers are ideally suited for semiconductor manufacturing equipment, plastics processing and packaging equipment and industrial process control applications.

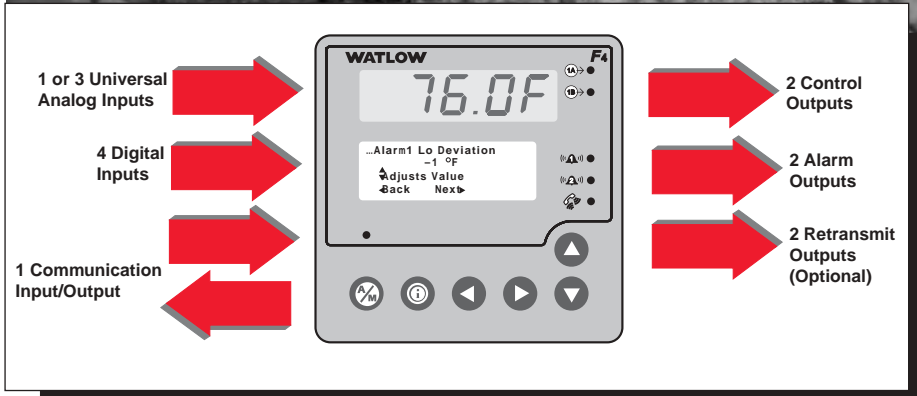
This competitively priced controller features a four line, high definition LCD interface display along with an information key that makes set up and control operation significantly easier with less chance for error. A 16 bit microprocessor supports all the accuracy and performance advantages you have come to expect from a Watlow controller.

The enhanced software option enables the SERIES F4P to support complex control applications such as cascade, ratio and differential control.

The four digital inputs can be used to remotely modify the operation of the controller or enable the display of pre-defined operator messages. Advanced features include cascade, ratio, differential, slidewire and retransmit options.

Serial communication and dual alarm relays are included in the base unit. The SERIES F4P is packaged with a NEMA 4X front face to withstand harsh environments and a four inch deep case with removable connectors for wiring convenience.

The SERIES F4P controller is manufactured by ISO 9001 registered Watlow Winona and is backed with a three-year warranty.



Features and Benefits

Guided set-up

- Removes “guess work” from the set up process
- Saves time by reducing programming errors

High definition, four-line LCD display

- Simplifies the set up process and operations
- Quickly and easily identifies process, alarm and set point values

Information “I” key

- Displays essential elements from the user manual on board

Customized menuing

- Quickly displays up to 16 parameters
- Allows users to create custom messaging and easily identify key events or alarms

High performance 16-bit microprocessor

- Provides precise process control with 20Hz update rate (input 1)
- Calibration accuracy of +/- 0.1 percent of span

Universal input

- Allows application versatility
- Eliminates the need for dip switches

Modbus™ communications ready

- Equipped to handle RS-232 or EIA-485 communications

Field upgradeable firmware

- Downloads available @ no charge from www.watlow.com/F4
- Reduces downtime
- Eliminates the need for an RMA

Auto-Tuning PID Controllers

SERIES F4P

General Purpose Control Operation

The SERIES F4P temperature process controller is a single channel PID controller that supports either closed or open loop operation. The design utilizes the latest technology to provide a controller capable to meeting very complex processing needs while maintaining an easily understood operator interface.

Full non-abbreviated parameter choices are displayed using a four line liquid crystal display. The display is back lit for wide angle viewing. The firmware guides the operator through parameter choices for feature configuration. An information key (I) provides the operator with detailed help information regarding the parameter or feature being configured. The main page menu can be programmed to display output power through 16 control variables including: bar graphs, set points and operating ranges. Up to four programmable messages can be activated remotely to let the operator know that the process requires their attention.

Five sets of PID values can be auto-tuned to support varying system reaction over the complete operating range. Up to 10 offset points can be programmed to compensate for differences between the actual process value and sensor readings caused by sensor placement.

Control Inputs

Up to three universal analog inputs are supported. These inputs are configured through software to support thermocouples, RTDs and process (voltage/current) sensors. Auxiliary inputs 2 and 3 can function as a remote set point input, sources for retransmission or as the outer loop for cascade operation.

Digital Inputs

These four inputs are programmable and can be used to remotely modify the operation of the controller as well as displaying pre-programmed messages on the operations display.

Control Outputs

Heat/cool or reverse/direct action is supported. Time based outputs can be configured for variable burst fire or a cycle time can be selected. On-off boost heat or boost cool operation is also supported. Boost operation is enabled based on load power requirements.

Alarms

Two alarms are included in the base unit. These alarms are programmable as process, deviation or rate.

Serial Communications

Both EIA-232 and EIA-485 communications are included in the base unit. The SERIES F4P operates via the Modbus™ RTU protocol. The F4P responds to requests for information only when queried. Baud rate selections are 9600 or 19200.

Retransmit

Up to two optional programmable voltage or current signal retransmit outputs are supported. Retransmit sources include up to three process variables, set point and output percent power.

Enhanced Control Operation

When the enhanced operation option is ordered, the F4P process controller is supplied with two additional universal analog inputs (inputs 2 and 3) and enhanced firmware to support numerous features that utilize the two additional inputs. The enhanced control option can be configured to support cascade control, differential control, ratio control and slidewire valve control. The enhanced control option can also alternate between control inputs, display up to three process variables and support remote set point operation.

In this sample application the SERIES F4P process controller utilizes the enhanced cascade control feature to heat lube oil to 51.6°C (125°F). Cascade control is a control strategy in which one control loop provides the set point for another loop. It allows the process or part temperature to be reached quickly while minimizing overshoot. Cascade is used to optimize the performance of thermal

systems with long lag times. Input 3 measures the lube oil temperature before it leaves the tank. Input 1 measures the heater temperature. The input 3 process value is compared to the set point which generates and internal set point used to control the heater.

Specifications

Universal Analog Inputs 1 (2 and 3 optional)

- Update rates: IN1 = 20Hz, IN2 and IN3 = 10Hz

Thermocouple

- Type J, K, T, N, C (W5), E, Pt 2, D (W3), B, R, S

RTD

- 2- or 3-wire platinum, 100Ω
- JIS or DIN-curves, 1.0 or 0.1 indication
- 500 or 1KΩ RTD available

Process

- Input resolution ≈ 50,000 bits at full scale
- Range selectable: 0-10V_{rms}(dc), 0-5V_{rms}(dc), 1-5V_{rms}(dc), 0-50mV, 0-20mA, 4-20mA
- Voltage input impedance 20KΩ
- Current input impedance 100Ω

Digital Inputs (4)

- Update rate = 10Hz
- Contact or dc voltage; 36V_{rms}(dc) max
- 10KΩ input impedance

Control Outputs (1A, 1B)

- Update rate = 20Hz

Open Collector/Switched dc

- Internal load switching (nominal): Switched dc, 22 to 28V_{rms}(dc), limited @ 30mA
- External load switching max.: Open collector 42V_{rms}(dc) @ 0.5A

Solid-state Relay

- Zero switched, optically coupled, 0.5A @ 24V_{rms}(ac) minimum, 253V_{rms}(ac) max.

Auto-Tuning PID Controllers

SERIES F4P

Specifications Cont.

Electromechanical Relay

- Form C, 2A @ 250V~(ac) or 30V=(dc) max.
- Resistive or inductive load
- Without contact suppression

Process Outputs (Optional Retransmit)

- Update rate = 1Hz
- User-selectable 0-10V=(dc), 0-5V=(dc), 1-5V=(dc) @1KΩ min., 0-20mA, 4-20mA @ 800Ω max.
- Resolution:
dc ranges = 2.5mV nominal
mA ranges = 5μA nominal
- Calibration accuracy:
dc ranges = ±15mV
mA ranges = ±30μA
- Temperature stability 100ppm/°C

Alarm Outputs

- Output update rate 1Hz
- Electromechanical relay, Form C, 2A @ 30V=(dc) or 240V~(ac) max.

Communications

- EIA-232 and EIA-485 serial communications with Modbus™ RTU protocol. 9600 or 19.2K baud rate

Safety and Agency Approvals

- UL®/C-UL® 916-listed, File # E185611 process control equipment
- NEMA 4X and IP65
- CE to EN 61010-1 and 61326

Terminals

- Touch-safe, removable terminal blocks, accepts 12 to 22-gauge wire

Power

- 100-240V~(ac), -15 percent, +10 percent; 50/60Hz, ±5 percent
- 24-28V=(ac/dc), -15 percent, +10 percent (order option)

- 39VA maximum power consumption
- Data retention upon power failure via nonvolatile memory. Sensor input isolation from input to input to output to communication circuitry is 500V~(ac).

Operating Environment

- 0 to 65°C (32 to 149°F)
- 0 to 90 percent RH, non-condensing
- Storage temperature: -40 to 70°C (-40 to 158°F)

Accuracy

- Calibration accuracy and sensor conformity: ±0.1 percent of span ±1°C @ 25°C ±3°C (77°F ±5°F) ambient, and rated line voltage ±10 percent with the following exceptions:

Type T: 0.12 percent of span for -200°C to -50°C (-328°F to -58°F)

Types R and S: 0.15 percent of span for 0°C to 100°C (32°F to 212°F)

Type B: 0.24 percent of span for 870°C to 1700°C (1598°F to 3092°F)

- Accuracy span: Less than or equal to operating ranges, 540°C (1000°F) minimum
- Temperature stability: ±0.1°C/°C (±0.1°F/°F) rise in ambient for thermocouples
- ±0.05°C/°C (±0.05°F/°F) rise in ambient for RTD sensors

Displays

- Process: 5, seven-segment LED red
- Control interface display: high-definition LCD green

Sensor Operating Ranges

Type J:	0 to 815°C (32 to 1500°F)
Type K:	-200 to 1370°C (-328 to 2500°F)
Type T:	-200 to 400°C (-328 to 750°F)
Type N:	0 to 1300°C (32 to 2372°F)

Type E:	-200 to 800°C (-328 to 1470°F)
Type C:	0 to 2315°C (32 to 4200°F)
Type D:	0 to 2400°C (32 to 4352°F)
Type Pt 2:	0 to 1395°C (32 to 2543°F)
Type R:	0 to 1760°C (32 to 3200°F)
Type S:	0 to 1760°C (32 to 3200°F)
Type B:	0 to 1816°C (32 to 3300°F)
RTD (DIN):	-200 to 800°C (-328 to 1472°F)
RTD (JIS):	-200 to 800°C (-328 to 1166°F)
Process:	-19,999 to 30,000 units

Sensor Accuracy Ranges

Input ranges

Type J:	0 to 815°C (32 to 1500°F)
Type K:	-200 to 1370°C (-328 to 2500°F)
Type T:	-200 to 400°C (-328 to 750°F)
Type N:	0 to 1300°C (32 to 2372°F)
Type E:	-200 to 800°C (-328 to 1470°F)
Type C:	0 to 2315°C (32 to 4200°F)
Type D:	0 to 2400°C (32 to 4352°F)
Type Pt 2:	0 to 1395°C (32 to 2543°F)
Type R:	0 to 1760°C (32 to 3200°F)
Type S:	0 to 1760°C (32 to 3200°F)
Type B:	0 to 1816°C (32 to 3300°F)
RTD (DIN):	-200 to 800°C (-328 to 1472°F)
RTD (JIS):	-200 to 800°C (-328 to 1166°F)
Process:	-19,999 to 30,000 units

Auto-Tuning PID Controllers

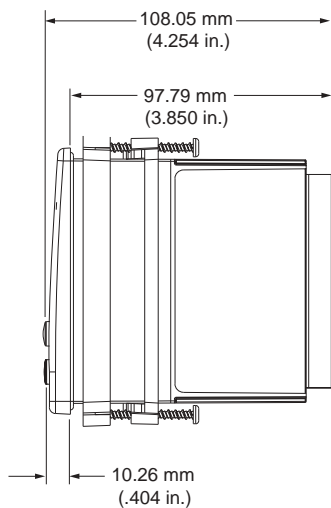
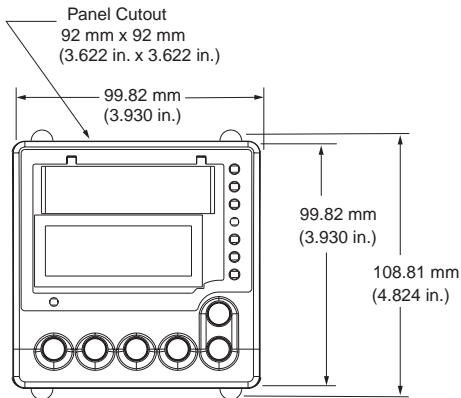
F.O.B.: Winona, Minnesota

SERIES F4P

Ordering Information

To order, complete the code number to the right with the information below:

SERIES F4P = ¼ DIN temperature process controller



Specifications Cont.

Dimensions

- Width x height x depth
99 mm x 99 mm x 97 mm panel mount (3.93 in. x 3.93 in. x 3.85 in.)

SERIES F4P

Temperature/Process Controller

Single channel temperature/process controller, two alarms, EIA-232/485 comms, four event inputs

Power Supply

- H = 100-240V \approx (ac/dc)
- L = 24-28V \approx (ac/dc)

Output 1A

- C = Open collector/switched dc
- E = Electromechanical relay, Form C
2 amp without contact suppression
- K = Solid state Form A 0.5 amp relay without contact suppression
- F = Process, 0-5, 1-5, 0-10V \approx (dc), 0-20mA, 4-20mA

Output 1B

- A = None
- E = Electromechanical relay, Form C
2A without contact suppression
- C = Open collector/switched dc
- K = Solid state Form A 0.5 amp relay without contact suppression
- F = Process, 0-5, 1-5, 0-10V \approx (dc), 0-20mA, 4-20mA

Enhanced Control Operation

- A = Standard control operation
- B = Enhanced control operation, dual universal inputs, cascade, ratio, duplex, differential, slidewire

Auxiliary Retransmit Module

- 0 = None
- 1 = Single retransmit output 0-5, 1-5, 0-10V \approx (dc), 0-20mA, 4-20mA
- 2 = Dual retransmit outputs 0-5, 1-5, 0-10V \approx (dc), 0-20mA, 4-20mA

Language and RTD Options

- 1 = English with 100 Ω RTD
- 2 = German with 100 Ω RTD
- 3 = French with 100 Ω RTD
- 4 = Spanish with 100 Ω RTD
- 5 = English with 500 & 1K Ω RTD
- 6 = German with 500 & 1K Ω RTD
- 7 = French with 500 & 1K Ω RTD
- 8 = Spanish with 500 & 1K Ω RTD

Display and Custom Options

- RG= Red/Green display
- XX = Custom options, software, setting parameters, overlays

F4 P - A -

Auto-Tuning PID Controllers

SERIES PD Single Loop

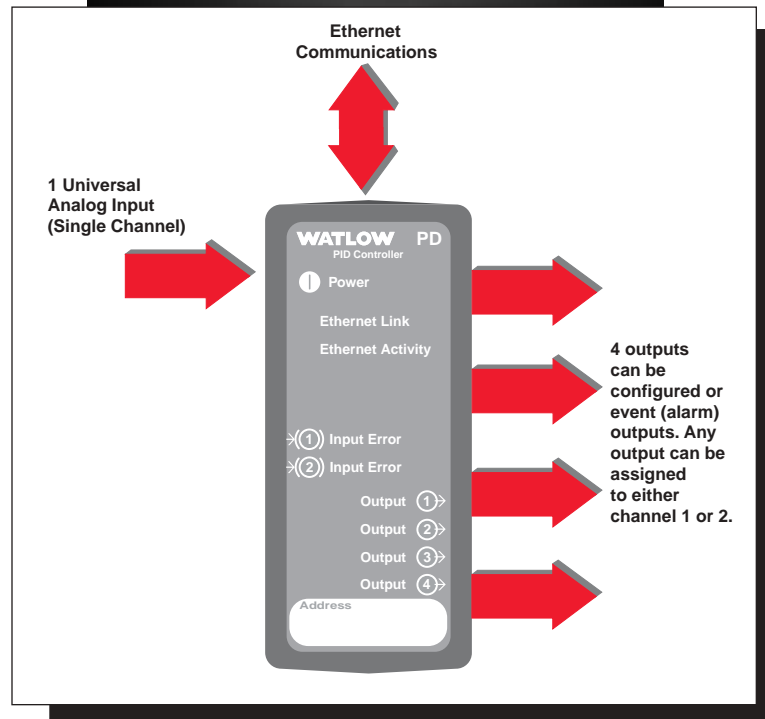
Watlow's new SERIES PD controller utilizes embedded Ethernet technology to provide a convenient, economical means for setting up and viewing key process variables such as temperature, pressure and humidity. The DIN-rail mount SERIES PD controller offers up to four control/alarm outputs, as well as a digital/current transformer input.

Watlow's SERIES PD controller is ideally suited for a wide range of temperature or process control applications where the operator interface is supported from a remote location. The SERIES PD provides interfacing via embedded firmware which serves dedicated web pages. These pages support key functions including operation, alarm monitoring, configuration and are displayed using standard web browser software. The SERIES PD is also capable of generating e-mail messages for remote alarm notification.

Ethernet-based products are rapidly gaining popularity in industrial applications because they allow an instantaneous exchange of information between processing equipment and the company's management system.

Advanced features of the SERIES PD controller include internal data logging of key control parameters, INFOSENSE-P technology, heater burn out detection and an enhanced control algorithm.

The SERIES PD controller is backed by a three-year warranty from Watlow Winona and is UL® 508, C-UL®, CSA and CE approved.



Auto-Tuning PID Controllers

SERIES PD Single Loop

Features and Benefits

Ethernet connectivity

- Convenient, easy to use operator interface
- Simplified process monitoring

DIN-rail sub panel mounting

- Quick, economic installation

Watlow INFOSENSE™ sensor technology

- INFOSENSE™ technology improves sensor accuracy by a minimum of 50 percent

Advanced control algorithm

- Tighter process control

Heater burn out detection

- Improved process yields

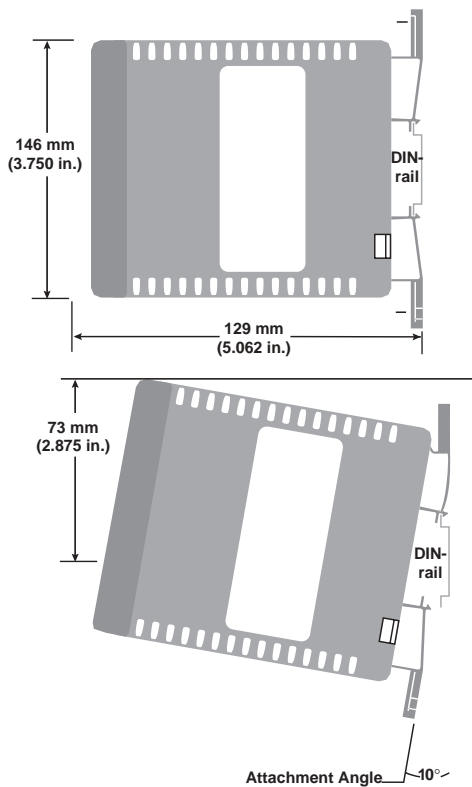
Internal data logging

- Reduces external hardware demands

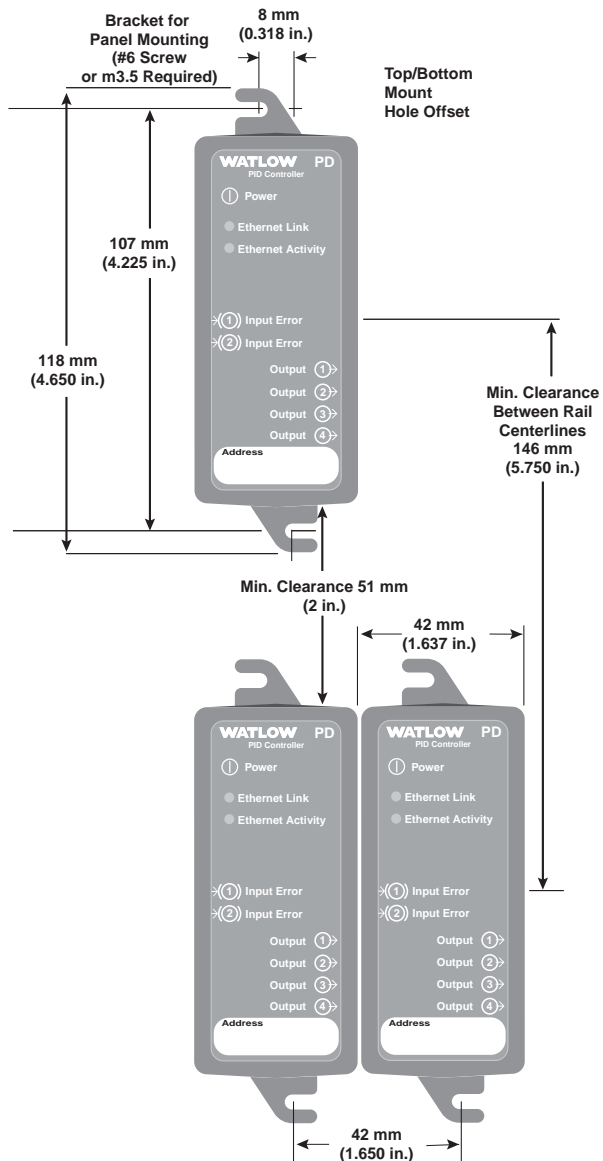
Virtual or hardware alarms with e-mail delivery

- Remote alarm notification

Side View



Front View



Auto-Tuning PID Controllers

SERIES PD Single Loop

Specifications

Power

- 24V \approx (ac/dc), +10/-15 percent, 50/60Hz, \pm 5 percent
- 12VA maximum power consumption
- Data retention upon power failure via nonvolatile memory

Environment

- 0 to 65°C (32 to 149°F) operating temperature
- -40 to 85°C (-40 to 185°F) storage temperature
- 0 to 90 percent RH, non-condensing

Accuracy

- Calibration accuracy and sensor conformity: \pm 0.1 percent of span, \pm 1°C @ the calibrated ambient temperature and rated line voltage
- Calibration ambient temperature = 25°C \pm 3°C (77°F \pm 5°F)
- Accuracy span: 540°C (1000°F) minimum
- Temperature stability: \pm 0.1°C/°C (\pm 0.2°F/°F) rise in ambient maximum

Agency Approvals

- UL® 508, C-UL®, CSA and CE

Controller

- Microprocessor based user-selectable control modes
- Single or dual channel universal inputs
- Current transformer inputs/digital inputs
- Up to four programmable outputs
- Update rates, inputs = 10Hz, outputs = 10Hz

Operator Interface

- Browser based HMI (Human Machine Interface)

Wiring Termination

- Touch safe removable terminals
- 14 to 22 AWG

Universal Inputs (Electrically Isolated)

- Thermocouple, grounded or ungrounded sensors
- RTD 2-or 3-wire, platinum, 100 Ω @ 0°C calibration to DIN-curve (0.00385 $\Omega/\Omega/^\circ\text{C}$)
- Process 0-20mA @ <100 Ω , or 0-10V \approx (dc) @ 10k Ω input impedance (50,000 bits @ full scale)

Digital Inputs

- Contact or dc voltage
- 10K Ω input impedance

Current Transformer Inputs

- 0 to 50mA CT input into 100 Ω impedance

Allowable Input Operating Range

Type J:	-200 to 1200°C	(-328 to 2192°F)
Type K:	-270 to 1370°C	(-454 to 2500°F)
Type T:	-270 to 400°C	(-454 to 750°F)
Type N:	-270 to 1300°C	(-454 to 2372°F)
Type E:	-270 to 975°C	(-454 to 1790°F)
Type C:	0 to 2315°C	(32 to 4200°F)
Type D:	0 to 2315°C	(32 to 4200°F)
Type PTII:	0 to 1395°C	(32 to 2543°F)
Type R:	0 to 1760°C	(32 to 3200°F)
Type S:	0 to 1760°C	(32 to 3200°F)
Type B:	0 to 1815°C	(32 to 3300°F)
RTD (DIN):	-200 to 800°C	(-328 to 1470°F)
Process V:	0 to 10V \approx (dc)	
Process I:	0 to 20mA	

Control/Alarm Outputs (1 - 4)

- User selectable as: on-off, P, PI, PD, PID, heat, cool, alarm action or retransmit with process output type hardware
- Open collector/switched dc
- Open collector 42V \approx (dc) maximum @ 0.5A
- Switched dc 22 to 28V \approx (dc) limited @ 30mA
- Solid state relay, Form A, 0.5A @ 24V \sim (ac) minimum, 264V \sim (ac) maximum, opto-isolated, without contact suppression
- User-selectable 0-10V \approx (dc), 1K Ω minimum, scalable, 0-20mA @ 800 Ω maximum, scalable
- Electromechanical relay. Form C, rated 5A @ 120V \sim (ac) or 5A @ 240V \sim (ac) or 5A @ 30V \approx (dc)

Communications

- TCP/IP/Ethernet
- Modbus™ TCP
- Ethernet RJ 45 connector, 10 base T
- HTTP interface
- DHCP, auto IP or fixed IP address

Dimensions

- Width x height x depth
42 mm x 116 mm x 132 mm
(1.64 in. x 4.56 in. x 5.19 in.)
DIN-rail or chassis mount, DIN-rail spec DIN 5022
35 mm x 7.5 mm (1.38 in. x 0.30 in.)

Auto-Tuning PID Controllers

MICRODIN®

The Watlow MICRODIN® SERIES controllers provide precise measurement and control with easy communication to personal computers and programmable logic controllers used in laboratories and industry. This superior controller is designed with simple and straightforward commands to make it easy to set up and operate. The MICRODIN is a high-performance controller that is capable of stand-alone operation and uses the popular Modbus™ communications protocol with a standard EIA-485 serial interface for parameter set up and viewing.

The behind-the-panel, DIN-rail mount design of the MICRODIN controller provides significant savings by eliminating the need for expensive panel hole punching and by simplifying panel wiring. Combine these savings with touch-safe removable connectors and the result is low installation costs and minimal down time for service and repair.

MICRODIN is the perfect solution for applications that require top-of-the-line dedicated temperature control loops with no user interface integrated into a complete control system using digital communications. The absence of an operator interface makes the MICRODIN excellent for use with PC-based software, such as WATVIEW.

Performance Capabilities

- Accuracy to ± 0.1 percent of span
- Operating environment
0 to 65°C (32 to 149°F)

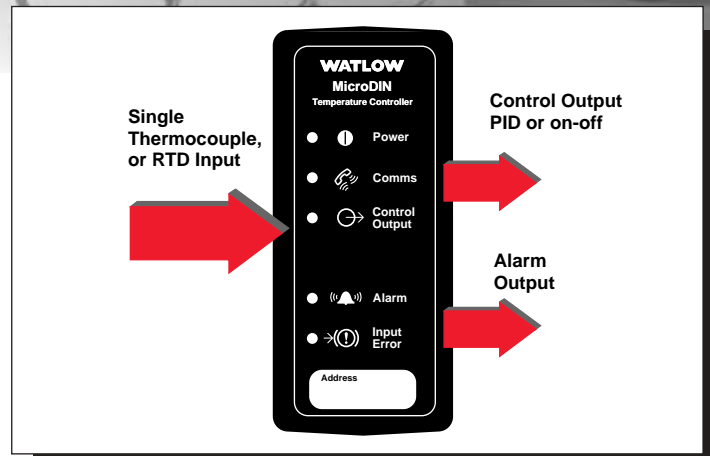
Features and Benefits:

EIA-485 serial communications with Modbus™ RTU protocol

- Provides easy remote set up and monitoring

DIN-rail/sub panel mounting

- Offers fast, low cost installation, eliminating expensive panel hole punch operations



Touch-safe removable connectors

- Easy and quick to remove for replacement and servicing

Single control output with alarm output

- Provides simple programming and operation of controller

Discrete loops of control, auto-tuning

- Gives performance equal to discrete panel-mount controllers, highly reliable

10Hz update rate

- Improves input sampling and controllability

Applications

- Food processing
- Medical and dental equipment
- Packaging
- Plastics processing
- Scientific instrumentation

Auto-Tuning PID Controllers

MICRODIN

Specifications

Control Mode

- Microprocessor-based, user selectable control modes
- Single input, single output
- Heat or cool auto-tuning

Agency Approvals

- UL®, C-UL® 508 recognized, File #E102269 Industrial Control Equipment
- CE to EN 61010

Operator Interface

- EIA-485 serial communications with Modbus™ RTU protocol
- 9600, 19200 user selectable baud rates
- One to 63 user selectable address range

Accuracy

- Calibration accuracy and sensor conformity: ± 0.1 percent of span $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ (± 1 @ $77^{\circ}\text{F} \pm 5^{\circ}\text{F}$) ambient, and rated line voltage ± 10 percent with the following exceptions:
 - Type T: 0.12 percent of span for -200°C to -50°C (-328°F to -58°F)
 - Types R and S: 0.15 percent of span for 0°C to 100°C (32°F to 212°F)
 - Type B: 0.24 percent of span for 870°C to 1700°C (1598°F to 3092°F)
- Accuracy span: Less than or equal to operating ranges, 540°C (1000°F) minimum
- Temperature stability: $\pm 0.2^{\circ}\text{C}/^{\circ}\text{C}$ ($\pm 0.2^{\circ}\text{F}/^{\circ}\text{F}$) rise in ambient maximum for thermocouples, $\pm 0.05^{\circ}\text{C}/^{\circ}\text{C}$ ($\pm 0.05^{\circ}\text{F}/^{\circ}\text{F}$) rise in ambient maximum for RTD sensors
- Voltage stability: ± 0.01 percent of span per percent of rated line voltage

Sensors Inputs

- Sensor input sampling rate: 10 samples/second 10Hz
- Thermocouple, grounded or ungrounded sensors
- RTD 2- or 3-wire, platinum, 100Ω @ 0°C calibration to JIS curve ($0.003916\Omega/\Omega/^{\circ}\text{C}$) or DIN-curve ($0.00385\Omega/\Omega/^{\circ}\text{C}$)
- Sensor break protection de-energizes control output to protect system or selectable bumpless transfer to manual operation
- $^{\circ}\text{F}$ or $^{\circ}\text{C}$, user selectable
- Sensor operating ranges:

Type B T/C	0 to 1816°C (32 to 3300°F)
Type C (W5) T/C	0 to 2315°C (32 to 4200°F)
Type D (W3) T/C	0 to 2315°C (32 to 4200°F)
Type E T/C	-200 to 800°C (-328 to 1472°F)
Type J T/C	0 to 815°C (32 to 1382°F)
Type K T/C	-200 to 1370°C (-328 to 2500°F)
Type N T/C	0 to 1300°C (32 to 2372°F)
Pt 2	0 to 1395°C (32 to 2543°F)
Type R T/C	0 to 1760°C (32 to 3200°F)
Type S T/C	0 to 1760°C (32 to 3200°F)
Type T T/C	-200 to 400°C (-328 to 750°F)
RTD (DIN)	-200 to 800°C (-328 to 1472°F)
RTD (JIS)	-200 to 630°C (-328 to 1166°F)
- Tenth degree resolution selectable over sensor operating range within limits of -199.9 to 999.9 , except for thermocouple Types B, R and S

Output 1: User selectable

- On-off; P, PI, PD, PID heat or cool action adjustable switching differential: 1 to 9999 or 0.1 to 999.9 $^{\circ}\text{C}$ or $^{\circ}\text{F}$
- Proportional band: 0 to 9999, or 0.0 to 999.9 $^{\circ}\text{C}$ or $^{\circ}\text{F}$
- Integral: 0.00 to 99.99 minutes per repeat
- Reset: 0.00 to 99.99 repeats per minute
- Derivative/rate: 0.00 to 9.99 minutes
- Cycle time: 0.1 to 60.0 seconds

Output 2: User selectable

- Process or deviation alarm with flashing alarm status indicator
- Alarm with separate high and low set points
- Hysteresis: 1 to 9999° switching differential

Primary Control Output (heating or cooling)

- Output update rate: 10 per second, 10Hz (maximum)
- Internal load switching (nominal): Switched dc (isolated) signal, 22 to $28\text{V}=(\text{dc})$, current limited @ 30mA
- Overload current and short circuit protection
- External load switching (maximum): Open collector up to $42\text{V}=(\text{dc})$ @ 1A with external power supply

Alarm Output:

- Output update rate 2 per second (2Hz)
- Electromechanical relay, Form A, 2A @ $30\text{V}=(\text{dc})$ or $240\text{V}\sim(\text{ac})$,
- Alarm output can be latching or non-latching, and process or deviation with separate high and low values. Alarm silencing (inhibit) on power-up

Electromagnetic Compatibility and Immunity

- Complies with EN 50081, EN 50082

Auto-Tuning PID Controllers

F.O.B.: Winona, Minnesota

MICRODIN

Specifications Cont.

Terminals

- Touch-safe set screw type, accepts 26-14 gauge wire

Power

- 24-28V \approx (ac/dc), -15 percent, +10 percent (20.4 to 30.8V \approx (ac/dc); 50/60Hz, \pm 5 percent for V \sim (ac)
- 5VA typical power consumption
- Data retention upon power failure via nonvolatile memory
- Sensor input isolation to switched dc output and communication circuitry 500V \sim (ac) dielectric

Operating Environment

- 0 to 65°C (32 to 149°F)
- 0 to 90 percent RH, non-condensing
- Storage temperature: -40 to 70°C (-40 to 158°F)

Ordering Information

To order, complete the code number on the right with the information below:

UD1A-1CES-

MICRODIN = DIN-rail mount temperature control. 1 sensor input, 1 control output, 1 alarm output, no operator interface and EIA-485 Modbus™ RTU serial communications with Quick Start Guide.

Hardware

1A = Single channel, low voltage[Ⓛ]

Input

1 = Type B, C, D, E, J, K, N, Pt 2, R, S, T, 1°RTD, 0.1°RTD (JIS and DIN)

Control Output

C = Switched dc, logic signal, non-isolated[Ⓛ]

Alarm Output

E = Electromechanical relay, Form A, 2A, w/o contact suppression[Ⓛ]

Communications

S = EIA/TIA-485 communications, opto-isolated, Modbus™ RTU protocol

Software

00 = Standard
XX = Custom setup parameters

Custom Options

00 = None
AA = No Watlow logo on front bezel
XX = Custom bezel or label

[Ⓛ] An IEC 742 rated power supply is required for CE compliance.

[Ⓛ] Electromechanical relays are warranted for 100,000 closures only.

Single-Loop
Auto-Tuning PID

Availability

Stock: Same day shipment on orders of 10 units or less; 10 working days on orders greater than 10 units.

Non-Stock: 10 working days

Stock List

Code Number	Input	Output 1	Output 2	Power	Front Bezel
UDIA-1CES-0000	T/C and RTD	Switched dc	Relay, 2A	24 to 28 V	English

Auto-Tuning PID Controllers

MICRODIN

Mounting a MICRODIN controller

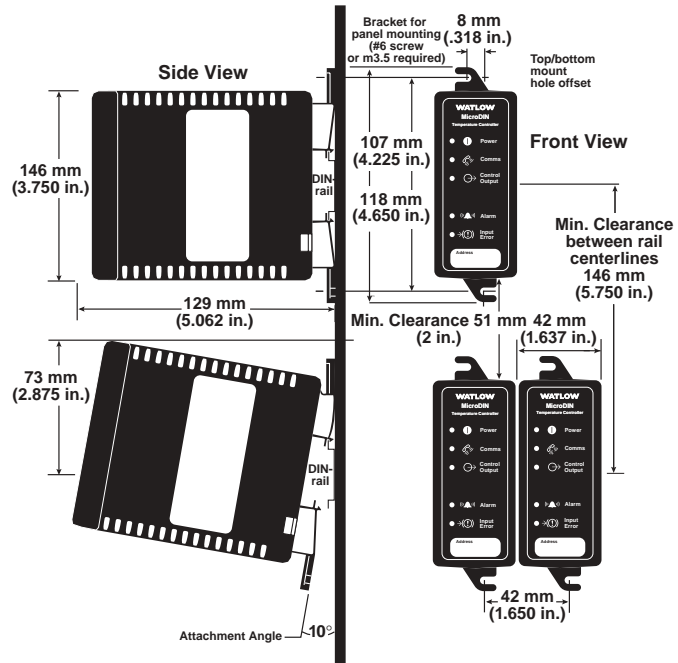
Dimensions

DIN-rail

Width:	42 mm	(1.64 in.)
Height:	118 mm	(4.65 in.)
Depth:	132 mm	(5.19 in.)

Chassis

Width:	42 mm	(1.64 in.)
Height:	118 mm	(4.65 in.)
Depth:	129 mm	(5.06 in.)



System Diagram

