# Watlow Model 988 and EZ Zone PM Temperature Controller Calibration

## Tank Farm Maintenance Procedure

### MAINTENANCE

USQ # GCX-2

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1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides instructions for calibration of the Watlow Model 988 and EZ Zone PM Temperature Controller.

1.2 Scope

This procedure applies to field or bench calibration of a Watlow Model 988 and EZ Zone PM Temperature Controller.

2.0 INFORMATION

2.1 Terms and Definitions

- TC  Thermocouple
- RTD  Resistance Temperature Device.
3.0 PRECAUTIONS AND LIMITATIONS

3.1 Personnel Safety

3.1.1 Compliance with DOE–0359, Hanford Site Electrical Safety Program is required when working with this procedure.

3.1.2 If a lock and tag is required during the performance of this procedure, comply with the DOE-0336, Hanford Site Lockout/Tagout Procedure.

3.2 Equipment Safety

**CAUTION** - When performing calibrations, always do the Output 1 prompts first, then continue to the Output 2 prompts. Failure to comply may result in false or inaccurate indications.

3.3 Radiation and Contamination Control

Work in radiological areas will be performed using a radiological work permit following review by Radiological Control per ALARA Work Planning procedure TFC-ESHQ-RP_RWP-C-03.
4.0 PREREQUISITES

4.1 Special Tools, Equipment and Supplies

The following supplies may be needed to perform this procedure:
- Decade box, 1 K ohm precision, with .01 ohm resolution
- Current source, 4 - 20 mAmp, with 0.1 mAmp resolution
- 4½ digit, Digital Multimeter
- RTD Simulator
- TC Input source, (i.e., Transmation J type TC input or equivalent)
- Oscilloscope or Alternate Graphic Meter
- Load Resistor (400 to 800 Ohms, ½ Watt).

4.2 Performance Documents

The following documents may be needed to perform this procedure:

4.3 Field Preparation

4.3.1 IF connected to heater, DISCONNECT output wires to heater before performing calibration.
5.0 PROCEDURE

NOTE Section 5.1 RTD Input Calibration, 5.2 Thermocouple (TC) Input Calibration and/or Section 5.3 Current Input Calibration are to be performed type of signal.

- Sections may be performed concurrently to allow verification of expected output relay status with dual inputs, i.e. RTD and mA inputs.
- Contact closures may not be observed until unit is powered from external contactor/controller.

5.1 RTD Input Calibration

5.1.1 ENSURE proper Electrical Safety measures are taken, (i.e. shielding, PPE etc. per DOE–0359, Hanford Site Electrical Safety Program) before proceeding.

5.1.2 REFERENCE Figure 7 and Figure 8 for input wiring terminal connections and Figure 11 for rear view of Series 988 terminal connection screw location.

OR

REFERENCE Figure 12 for Model EZ-Zone PM input connections.

5.1.3 IF checking calibration in the field, DISCONNECT RTD from terminals for selected input (Figure 1 - Connection to Decade Box).

5.1.4 IF checking calibration in the shop, REMOVE internal module from field location to shop test set up, reference Figure 5 or Figure 12 as applicable.

5.1.5 USE 20 to 24 gauge copper wire (Figure 1 and Figure 7) for Model 988 or Figure 12 for EZ-ZONE PM, CONNECT decade box to input terminals.

5.1.6 IF calibrating model EZ Zone PM GO TO Step 5.1.29.

NOTE - Input 1 and input 2 will be calibrated separately.

5.1.7 REMOVE Model 988 controller from case AND

ENSURE input 1(2) DIP switches (Figure 3) are as follows:

- 1 OFF
- 2 OFF
- 3 ON.
5.1 RTD Input Calibration (Cont.)

5.1.8 **ADJUST** decade box to inputs specified on Data Sheet **AND**
**RECORD** As-Found readings.

5.1.9 **CHECK** the Outputs/Indications on Controller Display for dual inputs.

NOTE - Watlow Series 988 Users Manual (0600 0009 0001 Rev AA) or Watlow Model EZ-Zone (0600-0059-0000) may be referred to.

5.1.9.1 **CONFIRM** Watlow configuration per Data Sheet.

5.1.9.2 **IF** corrections are necessary, **NOTIFY** FLM prior to making corrections to configuration.

5.1.10 **IF** As-Found readings are not within specified tolerance per Data Sheet **GO TO** Step 5.1.12.

**OR**

**IF** As-Found values are within specified tolerance, but deemed marginal, and optimization is desired, **GO TO** Step 5.1.12.

**OR**

5.1.11 **IF** as-found readings are within tolerance as specified per Data Sheet, **RECORD** as-left readings, on Data Sheet **AND**
**GO TO** Restoration Section 5.7 or to the applicable Section as required.

Temperature (RTD) Input Calibration for Watlow Controller Model 998

5.1.12 **PRESS** “Up and Down” keys simultaneously for approximately three seconds to enter setup menu and an additional three seconds to enter Factory menu.

5.1.13 **PRESS** “Up” or “Down” at Factory prompt to advance upper display to CAL prompt.

5.1.14 **PRESS** “Up” or “Down” to advance to "A 15 (input 1) b 15 (input 2)" prompt.

5.1.15 **ADJUST** decade box to 15.00 ohm.

5.1.16 **ALLOW** approximately 10 seconds for stabilization.
5.1 RTD Input Calibration (Cont.)

5.1.17 PRESS “Up” key to change upper display to YES.

5.1.18 PRESS Mode key.

5.1.19 PRESS Down key to advance to "A380 (input 1) or b380 (input 2)" prompt.

5.1.20 ADJUST decade box to 380.00 ohm.

5.1.21 ALLOW approximately 10 seconds for stabilization.

5.1.22 PRESS “Up” key to change upper display to YES.

5.1.23 PRESS Mode key.

5.1.24 PRESS Display key.

5.1.25 CHECK the Outputs/Indications on Controller Display for dual inputs.

5.1.26 ADJUST decade box to inputs specified on Data Sheet AND CHECK output values for tolerance.

5.1.27 IF values are within tolerance per Data Sheet, RECORD As-Left values on Data Sheet AND GO TO Restoration, Section 5.7 or to the applicable Section.

5.1.28 IF values are not within tolerance per Data Sheet, REPEAT Steps 5.1.12 through 5.1.27 until values are within tolerance OR IF values cannot be brought into tolerance, NOTIFY FWS for resolution AND STOP WORK.

Temperature (RTD) Input Calibration for Watlow Controller, Model EZ Zone

NOTE - If necessary Electrical Offset can be set to 0 and Electrical Slope can be set to 1 to restore factory calibration.

5.1.29 MEASURE Low Source resistance to ensure it is accurate AND CONNECT Low Source resistance to the input.
5.1 RTD Input Calibration (Cont.)

5.1.30 READ value of Electrical Measurement “Mv” (Factory Page, Calibration Menu) for that input.

5.1.31 CALCULATE offset value by subtracting this value from the low source resistance.

5.1.32 SET Electrical Input Offset “Elio” (Factory Page, Calibration Menu) for this input to the offset value.

5.1.33 CHECK Electrical Measurement to see whether it now matches the resistance AND

IF it doesn’t match, ADJUST Electrical Offset again.

5.1.34 MEASURE high source resistance to ensure it is accurate AND

CONNECT high source resistance to the input.

5.1.35 READ value of Electrical Measurement for that input.

5.1.36 CALCULATE gain value by dividing the low source signal by this value.

5.1.37 SET Electrical Input Slope “EliS” (Factory Page, Calibration Menu) for this input to the calculated gain value.

5.1.38 CHECK Electrical Measurement to see whether it now matches the signal AND

IF it doesn’t match, ADJUST Electrical Slope again.

5.1.39 IF values are within tolerance per Data Sheet, RECORD As-Left values on Data Sheet AND

GO TO Restoration, Section 5.7 or to the applicable Section.

5.1.40 IF values are not within tolerance per Data Sheet, REPEAT Steps 5.1.12 through 5.1.27

OR

IF values cannot be brought into tolerance, NOTIFY FWS for resolution AND

STOP WORK.
5.2 Thermocouple (TC) Input Calibration

NOTE - The final milliamp output (4-20) is the resultant of the Δt (Differential Temperature) from Input one (1) and Input (2).

5.2.1 ENSURE proper Electrical Safety measures are taken, (i.e. shielding, PPE etc. per DOE–0359, Hanford Site Electrical Safety Program) before proceeding.

5.2.2 IF checking calibration in the field, DISCONNECT thermocouple leads from terminals for selected input.

5.2.3 IF checking calibration in the shop, REMOVE internal module from field location to shop test set up.

5.2.3.1 REMOVE controller from case by pressing the release tabs (see Figure 5).

5.2.3.2 ENSURE input dip switches (Figure 3) are configured for the thermocouple being used per Data Sheet.

5.2.3.3 REINSTALL controller into case as necessary.

NOTE - Input 1 and input 2 will be calibrated separately.

- Use same type of connection wire as the TC Type specified on Data Sheet.

5.2.4 CONNECT #1 thermocouple calibration instrument to Input #1, terminals 9 (+) and 10 (-) (see Figure 7, Figure 8, or Figure 12 for EZ-Zone controller).

5.2.5 CONNECT multimeter (mA) instrument to terminals 12(+) and 14(-) per Figure 7 or Figure 12 for EZ-Zone controller).

5.2.6 CONNECT power to unit as required.

5.2.7 ADJUST thermocouple calibration instruments to input values per Data Sheet AND

RECORD As-Found values and Alarms on Data Sheet.
5.2 Thermocouple (TC) Input Calibration (Cont.)

5.2.8 CONNECT #2 thermocouple calibration instrument to Input #2, terminals 19 (+) and 20 (-) per Figure 8 or Figure 12.

5.2.9 ADJUST thermocouple calibration instruments to input values per Data Sheet AND RECORD As-Found values and Alarms on Data Sheet.

5.2.10 CHECK the Outputs/Indications on Controller Display for dual inputs.

5.2.11 IF As-Found values are not within specified tolerance per Data Sheet, GO TO Step 5.2.15.

OR

5.2.12 IF As-Found values are within specified tolerance, but deemed marginal, and optimization is desired, GO TO Step 5.2.15.

OR

5.2.13 IF As-Found values are within specified tolerance, RECORD As-Found values in As-Left column of Data Sheet AND GO TO Restoration, Section 5.7 or to the applicable Section as required.

5.2.14 IF calibrating model EZ Zone PM, GO TO Step 5.2.34.

Temperature (Thermocouple) Input calibration for Watlow Controller Model 988

5.2.15 IF performing calibration in the field, POSITION the remote lock-out toggle switch to unlock calibration menu.

5.2.16 IF checking calibration in the shop, POSITION the on-board lock-out dip switch (Figure 4) to unlock calibration menu.

5.2.17 PRESS “Up and Down” keys simultaneously for approximately three seconds to enter setup menu and an additional three seconds to enter Factory menu.

5.2.18 PRESS “Up” or “Down” at Factory prompt to advance upper display to CAL prompt.

5.2.19 PRESS Mode to advance to "A 50 (input 1) B 50 (input 2)" prompt.
5.2 Thermocouple (TC) Input Calibration (Cont.)

5.2.20 ADJUST thermocouple calibration instruments to input SPAN value per Data Sheet.

5.2.21 ALLOW approximately 10 seconds for stabilization.

5.2.22 PRESS “Up” key to change upper display to YES.

5.2.23 PRESS Mode key A00 (input 1) and B00 (input 2).

5.2.24 ADJUST thermocouple calibration instruments to input ZERO value per Data Sheet.

5.2.25 ALLOW approximately 10 seconds for stabilization.

5.2.26 PRESS “Up” key to change upper display to YES.

5.2.27 PRESS Mode key A00 (input 1) and B00 (input 2).

5.2.28 PRESS Display key.

5.2.29 CHECK Outputs/Indications on Controller Display for dual inputs.

5.2.30 SETUP controller by referring to Steps 5.2.15 and 5.2.16.

5.2.31 ADJUST thermocouple calibration instruments to input values specified on Data Sheet AND CHECK output values for tolerance.

5.2.32 IF values are within tolerance per Data Sheet, RECORD As-Left values on Data Sheet AND GO TO Restoration, Section 5.7 or to the applicable Section.

5.2.33 IF values are not within tolerance per Data Sheet, REPEAT Steps 5.2.17 through 5.2.32

OR

IF values cannot be brought into tolerance, NOTIFY FWS for resolution AND STOP WORK.
5.2 Thermocouple (TC) Input Calibration (Cont.)

**Temperature (Thermocouple) or Process Input calibration for Watlow Controller Model EZ-Zone**

**NOTE** - If necessary Electrical Offset can be set to 0 and Electrical Slope can be set to 1 to restore factory calibration.

5.2.34 **APPLY** low source signal to the input that is being calibrated AND **MEASURE** signal to ensure it is accurate.

5.2.35 **READ** value of Electrical Measurement “Mu” (Factory Page, Calibration Menu) for that input.

5.2.36 **CALCULATE** offset value by subtracting this value from the low source signal.

5.2.37 **SET** Electrical Input Offset “Elio” (Factory Page, Calibration Menu) for this input to the offset value.

5.2.38 **CHECK** Electrical Measurement to see whether it now matches the signal AND **IF** it doesn’t match, **ADJUST** Electrical Offset again.

5.2.39 **APPLY** high source signal to the input AND **MEASURE** signal to ensure it is accurate.

5.2.40 **READ** value of Electrical Measurement for that input.

5.2.41 **CALCULATE** gain value by dividing the low source signal by this value.

5.2.42 **SET** Electrical Slope “EliS”, (Factory Page, Calibration Menu) for this input to the calculated gain value.

5.2.43 **CHECK** Electrical Measurement to see whether it now matches the signal AND **IF** it doesn’t match, **ADJUST** Electrical Slope again.

5.2.44 **IF** values are within tolerance per Data Sheet, **RECORD** As-Left values on Data Sheet **AND** **GO TO** Restoration, Section 5.7 or to the applicable Section as required.
5.2 Thermocouple (TC) Input Calibration (Cont.)

5.2.45 IF values are not within tolerance per Data Sheet, **REPEAT** Steps 5.2.17 through 5.2.32 until values are within tolerance.

**OR**

IF values cannot be brought into tolerance, **NOTIFY** FWS for resolution **AND** STOP WORK.
5.3 Current Input Calibration

5.3.1 **ENSURE** proper Electrical Safety measures are taken, (i.e. shielding, PPE etc. per DOE–0359, Hanford Site Electrical Safety Program) before proceeding.

5.3.2 **IF** checking calibration in the field, **DISCONNECT** wires from terminals for selected current input.

5.3.3 **IF** checking calibration in shop, **REMOVE** internal module from field location to shop test set up (ref Figure 5 or Figure 12).

5.3.4 **CONNECT** current source to input terminals using 20 to 24 gauge copper wire.
- Input 1: 10 (+), 8 (-) per Figure 7 (Model 988)
- Input 2: 20 (+), 18 (-) per Figure 8 (Model 988)
- Input 1: T1 (+), S1(-) per Figure 12 (Model EZ-Zone PM)
- Input 2: T2 (+), S2(-) per Figure 12 (Model EZ-Zone PM).

5.3.5 **REMOVE** Model 988 control from case.

5.3.5.1 **ENSURE** input 1 DIP switches (Figure 3 and Figure 7 ) are as follows:
- 1 ON – Down Position
- 2 ON – Down Position
- 3 ON – Down Position.

5.3.5.2 **ENSURE** input 2 DIP switches (Figure 3 and Figure 8) are as follows:
- 1 ON – Up Position
- 2 ON – Up Position
- 3 ON – Up Position.

5.3.6 **ADJUST** current source to inputs specified on Data Sheet **AND**

**RECORD** as-found readings.

5.3.7 **CHECK** the Outputs/Indications on Controller Display for dual inputs.
5.3 Current Input Calibration (Cont.)

5.3.8 IF As-Found values are not within specified tolerance per Data Sheet, GO TO Step 5.3.12.

OR

5.3.9 IF As-Found values are within specified tolerance, but deemed marginal, and optimization is desired, GO TO Step 5.3.12.

OR

5.3.10 IF as-found values are within tolerance as specified by Data Sheet, RECORD values in as-left column on Data Sheet.

5.3.11 GO TO Restoration Section 5.7 or to the applicable Section as required.

Current Input Calibration for Watlow Controller Model 988

5.3.12 PRESS “Up and Down” keys simultaneously for approximately three seconds to enter setup menu and an additional three seconds to enter Factory menu.

5.3.13 PRESS “Up or Down” at Factory prompt to advance upper display to CAL prompt.

5.3.14 PRESS Up or Down to advance to A 20A (input 1) b 20A (input 2)” prompt.

5.3.15 ADJUST current source to 20.00 mA.

5.3.16 ALLOW approximately 10 seconds for stabilization.

5.3.17 PRESS “Up” key to change upper display to YES.

5.3.18 PRESS Mode key.

5.3.19 PRESS “Down” key to advance to "A 4A (input 1) or b 4A (input 2)" prompt.

5.3.20 ADJUST current source to 4.00 mA.

5.3.21 ALLOW approximately 10 seconds for stabilization.

5.3.22 PRESS “Up” key to change upper display to YES.

5.3.23 PRESS Mode key.
5.3 Current Input Calibration (Cont.)

5.3.24 PRESS Display key.

5.3.25 CHECK Outputs/Indications on Controller Display for dual inputs.

5.3.26 ADJUST current source to inputs specified on Data Sheet AND
CHECK output values for tolerance.

5.3.27 IF values are within tolerance per Data Sheet, RECORD As-Left values on Data Sheet AND
GO TO Restoration, Section 5.7 or to the applicable Section.

5.3.28 IF values are not within tolerance per Data Sheet, REPEAT Steps 5.3.12 through 5.3.27
OR

IF values cannot be brought into tolerance, NOTIFY FWS for resolution AND
STOP WORK.
5.4 VDC Process Output 1 and 2 Calibration for Model 988

5.4.1 CONNECT AC voltage L1, L2 and ground to proper terminals on the series 988. (Refer to Chapter 2 in Temperature Controller User’s Manual.)

5.4.2 IF performing Output #1 calibration, CONNECT digital voltmeter to terminal #13 (+) and terminal #14 (-) per Figure 9.

5.4.3 IF performing Output #2 calibration, CONNECT digital voltmeter to terminal #16 (+) and terminal #17 (-) per Figure 10.

5.4.4 SET digital voltmeter to read a range of 0 to 10 VDC.

5.4.5 CONNECT leads of digital voltmeter to measure volts DC.

5.4.6 APPLY power to unit.

5.4.7 ALLOW unit to warm up for a minimum of 15 minutes.

5.4.8 AFTER unit is warmed up, PLACE unit in CAL menu.

5.4.8.1 PRESS “Up and Down” keys simultaneously for approximately three seconds to enter the setup menu and an additional three seconds to enter Factory menu.

5.4.8.2 PRESS “Up or Down” at Factory prompt to advance upper display to CAL prompt.

CAUTION
When performing calibrations, always do the Output 1 prompts first, then continue to the Output 2 prompts. Failure to comply may result in false or inaccurate indications.

NOTE - Any prompt beginning with a "1" applies to Output 1. Those beginning with a "2" apply to Output 2.

5.4.9 PRESS “Up or Down” to advance to "1 0" or "2 0" prompt.
5.4 VDC Process Output 1 and 2 Calibration for Model 988 (Cont.)

5.4.10 **ADJUST** reading on voltmeter to 0.0 VDC ±0.1 VDC, using “Up and Down” keys.

5.4.11 **ALLOW** control to stabilize for approximately 10 seconds.

5.4.12 **PRESS** Mode key to enter.

5.4.13 **ADVANCE** to next prompt.

5.4.14 **REPEAT** steps 5.4.10 through 5.4.13, until reaching "1 10" or "2 10" prompt.

5.4.15 **WHEN** at "1 10" or "2 10" prompt, **ADJUST** reading on voltmeter to 10.0 VDC ±0.1 VDC using “Up or Down keys”.

5.4.16 **ALLOW** control to stabilize for approximately 10 seconds.

5.4.17 **PRESS** Mode key to enter.

5.4.18 **ADVANCE** to next prompt.

5.4.19 **WHEN** VDC output calibrations are complete, **PRESS** Display key.
5.5 mA Process Output 1 and 2 Calibration for Model 988

5.5.1 CONNECT AC voltage L1, L2 and ground to proper terminals on series 988. (Refer to Chapter 2 in the Temperature Controller User's Manual.)

5.5.2 IF performing Output #1 calibration, CONNECT digital multimeter to terminal #12 (+) and terminal #14 (-) per Figure 9.

5.5.3 IF performing Output #2 calibration, CONNECT digital multimeter to terminal #15 (+) and terminal #17 (-) per Figure 10.

5.5.4 SET digital multimeter to read a range of 0 to 20 mA.

5.5.5 CONNECT leads of digital multimeter to measure current.

5.5.6 APPLY power to unit.

5.5.7 ALLOW unit to warm up for a minimum of 15 minutes.

5.5.8 AFTER unit is warmed up, PLACE unit in CAL menu.

5.5.8.1 PRESS “Up and Down” keys simultaneously for approximately three seconds to enter setup menu and an additional three seconds to enter Factory menu.

5.5.8.2 PRESS “Up or Down” at Factory prompt to advance upper display to CAL prompt.

CAUTION
When performing calibrations, always do the Output 1 prompts first, then continue to the Output 2 prompts. Failure to comply may result in false or inaccurate indications.

NOTE - Any prompt beginning with a "1" applies to Output 1. Those beginning with a "2" apply to Output 2.
- At the "1 4" or "2 4" prompt, the multimeter should read approximately 4.0 mA.

5.5.9 PRESS “Up or Down” to advance to "1 4" or "2 4" prompt.
5.5 mA Process Output 1 and 2 Calibration for Model 988 (Cont.)

5.5.10 **ADJUST** reading on multimeter to 3.85 mA ±0.05 mA using “Up and Down” key.

5.5.11 **ALLOW** control to stabilize for approximately 10 seconds.

5.5.12 **PRESS** Mode key to enter.

5.5.13 **ADVANCE** to next prompt.

5.5.14 **REPEAT** steps 5.5.10 through 5.5.13, until reaching "1 20" or "2 20" prompt.

5.5.15 **WHEN** at "1 20" or "2 20" prompt, using “Up or Down” keys, **ADJUST** reading on multimeter to 20.15 mA ±0.05 mA.

5.5.16 **ALLOW** control to stabilize for approximately 10 seconds.

5.5.17 **PRESS** Mode key to enter.

5.5.18 **ADVANCE** to next prompt.

5.5.19 **WHEN** mA output calibrations are complete, **PRESS** Display key.
5.6 Output Functional Check

NOTE - The purpose of this test is to functionally check the output of the controller that drives the DIN-A-MITE SCR Controller.

- The output of the Watlow controller is a 22 to 32 VDC Switched output that should be observed by connecting an Oscilloscope to the output.
- The output observed should be a Square Wave Pulsed DC waveform that varies with the setpoint input or process input.
- The output waveform can only be observed by connecting a load or resistor across the output.

5.6.1 CONNECT a resistance Decade Box to the input terminals per Figure 12.

5.6.2 CONNECT a Current Source to the input terminal per Figure 12.

5.6.3 CONNECT a load resistor (400 to 800 Ohms, ½ Watt) across Terminals Y1(+) & W1(-) per Figure 13.

5.6.4 CONNECT an Oscilloscope across Terminals Y1(+) & W1(-) per Figure 13.

NOTE - If resistance value is increased above setpoint value, output waveform should decrease or If resistance value is decreased below setpoint value, output waveform should increase.

5.6.5 VARY RTD (resistance) input around constant setpoint setting,

OR

VARY setpoint around RTD (resistance) constant value.

5.6.6 DOCUMENT results on Datasheet.
5.7 Restoration

5.7.1 IF any problems were encountered with calibration, INFORM FWS.

5.7.2 DISCONNECT AND REMOVE Test Equipment.

5.7.3 IF controller was removed for bench calibration, REINSTALL controller to its field location (ref Figure 3).

5.7.4 IF controller was calibrated in the field location, RECONNECT field wires to As-Found condition.

5.7.5 RECORD Test Equipment information and calibration status on Data Sheet

5.7.6 CHECK equipment system restoration by observing indications are consistent with expected conditions.

5.7.7 NOTIFY Operations that testing is complete and system may be returned to desired configuration.

5.8 Acceptance Criteria

Acceptance Criteria has been met when Steps in this procedure have been satisfactorily performed and As-Left values meet the specifications and tolerance(s) per the Data Sheet.

5.9 Review

5.9.1 INFORM FWS test is complete.

5.9.2 FWS REVIEW AND ENSURE the following:

- Completed Data Sheets meet acceptance criteria.
- Comments sections are filled out appropriately.
- Work requests needed as a result of this procedure are identified and generated.
- Work request number(s) of any work documents generated as a result of this procedure, are recorded in the Comments/Remarks section of the Data Sheet.
5.10 Records

The performance of this procedure generates no records. However, PM Data Sheets associated with the procedure, are records and are maintained in the work package as record material.

The record custodian identified in the Company-level Records Inventory and Disposition Schedule (RIDS) is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.
Figure 1 - Connection to Decade Box

Input 1 (or 2)
To 8 (or 18)
To 9 (or 19)
To 10 (or 20)

H
L
G

Input 1 (or 2)
To 8 (or 18)
To 9 (or 19)
To 10 (or 20)
### Figure 2 – Temperature to mV Conversion Chart, Type “J” TC

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<th>Deg F</th>
<th>Mv.</th>
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Figure 3 – Setting Input DIP Switches

Set the input DIP switches to match the sensors you are using in your application. Only controllers with model number 98__-2__-__-__ or 98__-2__-__-__ have an input DIP switch.

Input 1
(98__-2__-__-__)

RTD (100 Ω)

thermocouple: R, S or B

thermocouple: J, K, T, N, E, C, D, Pt2 or 0-50mV (high impedance)

0-20 or 4-20mA; 0-5, 1-5 or 0-10V
The lockout DIP switch hides the Setup Menus (Input, Output, Global and Communications) and the Factory Menus (Panel Lockout, Diagnostics and Calibration). All units have a lockout DIP switch.

- No hardware lockout (Switch 1 has no effect.)
- Lockout Setup and Factory menus (Switch 1 has no effect.)
Figure 5 – Controller Display, Layout and Release Tabs
Figure 6 – Keys and Display Descriptions

Upper Display
Indicates the actual process value, prompt parameter value or error code.

DEV LED
When lit, the lower display shows the most recent deviation unit from the set point.

% OUT LED
When lit, the lower display shows the current percent output.

Up-arrow Key
Increases the value or changes the parameter in the upper display (except for set point changes in the Display Loop, which occur in the lower display). Hold the key down to increase the value rapidly. New data takes effect in five seconds or when the Mode key or Display key is pressed.

Mode Key
Enters new data and steps to the next prompt in the current menu.

Mode + Up-arrow Keys
Hold the Mode key then press the Up-arrow key to move backwards through the current menu. Scrolling stops when you reach the top of the menu.

Lower Display
Indicates the set point, deviation, percent power, temperature unit, menu prompt name or alarm code.

L1, L2, L3, L4
These LED’s indicate when output 1, 2, 3 or 4 are active. Outputs can be configured as:
- Output 1: Control
- Output 2: Control or Alarm
- Output 3: Alarm or Retransmit
- Output 4: Alarm or Communications (flashes on transmit and receive)

Display Key
Pressing this key enters the Display Loop. Press the Display key at any time to return to this loop. The next page has more information on the Display Loop.

Auto/Man Key
In Manual mode the lower display shows percent output. Pressed once, it clears any latched alarm. If pressed again within five seconds it will toggle between Auto and Manual mode.

Auto/Man LED
Lit when the control is in Manual operation. Press the Auto/Man key twice to enter Automatic operation. When blinking, press the Auto/Man key to toggle between Auto and Manual. After five seconds without pressing the Auto/Man key, the LED stops blinking and returns to its previous state.
Input 1 Wiring

Figure 2.8a — Thermocouple or 0-50mV (high Impedance)

NOTE: Successful installation requires five steps:
• Model number and software choice (Appendix);
• DIP switch settings (Chapter 1);
• Sensor match (Chapter 2 and Appendix);
• Sensor installation (Chapter 2); and
• Wiring (Chapter 2).

Thermocouple only
98____1__________ (no DIP switches)

Universal signal conditioner
98____2__________

Input impedance: 20Ω

Figure 2.8b — RTD (2- or 3-wire) (100 Ω)

Universal signal conditioner
98____2__________

Jumper #9 to #10 for 2-wire RTD

Input impedance: 10KΩ

Figure 2.8c — 0-5V=, 1-5V= or 0-10V= (dc) Process

Universal signal conditioner
98____2__________

Input impedance: 10KΩ

Figure 2.8d — 0-20mA or 4-20mA Process

Universal signal conditioner
98____2__________

Input impedance: 7Ω

CAUTION: An external resistor may be required for 0-20mA and 4-20mA process wiring to prevent a high inrush current which could burn out the controller’s 7-ohm resistor. See page 2.5 for recommendations.
Figure 8 – Input 2 Wiring: TC’s, RTD, 0-10 Vdc, 4-20 mA

**Figure 2.9a — Thermocouple or 0-50mV (high impedance)**

Thermocouple only
98 _ _ _ _ 1 _ _ _ 
(no DIP switches)

Universal signal conditioner
98 _ _ _ _ 2 _ _ _ 

Input impedance: 20MΩ

**Figure 2.9b — RTD (2- or 3-wire) (100 Ω)**

Universal signal conditioner
98 _ _ _ _ 2 _ _ _ 

Jumper
#19 to #20 for 2-wire RTD

**Figure 2.9c — 0-5V=, 1-5V= or 0-10V= (dc) Process**

Universal signal conditioner
98 _ _ _ _ 2 _ _ _ 

Input impedance: 10KΩ

**Figure 2.9d — 0-20mA or 4-20mA Process**

Universal signal conditioner
98 _ _ _ _ 2 _ _ _ 

Input impedance: 7Ω

**CAUTION:**
An external resistor may be required for 0-20mA and 4-20mA process wiring to prevent a high inrush current which could burn out the controller’s 7-ohm resistor. See page 2.5 for recommendations.
Figure 9 – Output 1 Wiring: 0-10 Vdc and 4-20 mA

Output 1 Wiring

Figure 12c — 0-20mA and 4-20mA Process

98 _ _ _ _ F _ _ _ _

Maximum load impedance: 800Ω

---------

Figure 12d — 0-5V=, 1-5V= and 0-10V= (dc) Process

98 _ _ _ _ F _ _ _ _

Minimum load impedance: 1KΩ
Figure 10 – Output 2 Wiring: 0-10 Vdc and 4-20 mA

**Output 2 Wiring**

**Figure 13c – 0-20mA and 4-20mA Process**

98 _ _ _ _ F _ _ _

Maximum load impedance: 800Ω

**Figure 13d – 0-5V=, 1-5V= and 0-10V= (dc) Process**

98 _ _ _ _ F _ _ _

Minimum load impedance: 1KΩ
Figure 11 – Rear View of Series 988: Terminal Connections
Watlow Model 988 and EZ Zone PM Temperature Controller Calibration

Figure 12 – EZ-Zone PM Input Terminal Connections

### Input 1, 2 Thermocouple

- 2K Ω maximum source resistance
- >20 MΩ input impedance
- 3 microampere open-sensor detection
- Thermocouples are polarity sensitive. The negative lead (usually red) must be connected to S1.
- To reduce errors, the extension wire for thermocouples must be of the same alloy as the thermocouple.

Input 1: PM _ [C,R,B^*] _ _ _ _ _ _ _ (S1/R1)
Input 2: PM _ _ _ _ _ _ [C,R,L] _ _ _ _ _ (S2/R2)

*PM(4, 8 and 9) only

### Input 1, 2 RTD

- platinum, 100 and 1,000 Ω @ 0°C
- calibration to DIN curve (0.00385 Ω/°C)
- 20 Ω total lead resistance
- RTD excitation current of 0.09 mA typical. Each ohm of lead resistance may affect the reading by 0.03°C.
- For 3-wire RTDs, the S1 lead (usually white) must be connected to R1.
- For best accuracy use a 3-wire RTD to compensate for lead-length resistance. All three lead wires must have the same resistance.

Input 1: PM _ [C,R,B^*] _ _ _ _ _ _ (S1/R1),(T1/S1/R1)
Input 2: PM _ _ _ _ _ _ [C,R,L] _ _ _ _ (S2/R2),(T2/S2/R2)

*PM(4, 8 and 9) only

### Input 1, 2 Process

- 0 to 20 mA @ 100 Ω input impedance
- 0 to 10V= (dc) @ 20 kΩ input impedance
- 0 to 50 mV= (dc) @ 20 kΩ input impedance
- scalable

Input 1: PM _ [C,R,B^*] _ _ _ _ _ _ _ (-S1/+R1),(+T1/-S1)
Input 2: PM _ _ _ _ _ _ [C,R,L] _ _ _ _ (-S2/+R2),(+T2/-S2)

*PM(4, 8 and 9) only
**Output 1, 3 Switched DC/Open Collector**

**Switched DC**
- 30 mA dc maximum supply current
- Short circuit limited to <50 mA
- 22 to 32V= (dc) open circuit voltage
- Use dc- and dc+ to drive external solid-state relay.
- DIN-A-MITE compatible
- Single-pole: up to 4 in parallel or 4 in series
  - 2-pole: up to 2 in parallel or 2 in series
  - 3-pole: up to 2 in series

**Open Collector**
- 100 mA maximum output current sink
- 30V= (dc) maximum supply voltage
- Any switched dc output can use the common terminal.
- Use an external power supply to control a dc load, with the load positive to the positive of the power supply, the load negative to the open collector and common to the power supply negative.

Output 1: (X1, W1, Y1)
PM → [C] →
Output 3: (X3, W3, Y3)
PM → → → [C] →

**Figure 13 – EZ-Zone PM Output Terminal Connections**