Series 88 IR

Thermo - Ducer® / Controller Kit

User's Manual

WATLOW INFRARED

Watlow Infrared, One Richmond Square, Providence, RI 02906 PH: (401)521-7410, FAX: (401) 274-8905

August, 1988
GENERAL DESCRIPTION

The Watlow Infrared Series 88IR Thermo-ducer®/Controller Kit consists of a 1/4 DIN digital indicating temperature control and a Thermo-ducer® non-contact temperature sensor. The control mode is PID with user accessible adjustments to all parameters. Input to the control is a 0 - 50 mV signal from the Thermo-ducer® sensor. There are two output options to choose from: either a mechanical relay or 4 - 20 mA (1 - 5 Vdc). Front panel accessible adjustments include the push-to-set assembly for the main set point and a recessed pot for the proportional band adjustment. Emissivity adjustment can be made via a trimpot accessible through a 3/16 inch diameter hole located on the left side of the control. A process control electronics board is available as an accessory when temperature control is to be based on discrete products.

SPECIFICATIONS

88IR CONTROL SPECIFICATIONS

CONTROL MODE
* PID: Proportional with auto reset and rate (integral and derivative).
* Proportional band: 10 to 100°F/°C, front panel adjust
* Reset: 0.05 to 0.5 repeats per minute, internal adjust.
* Rate: 0 to 5 minutes, internal adjust.
* Cycle time: 2 to 30 seconds, internal adjust.

INPUT
* Thermo-ducer®: 0 to 50 mV DC non-linear input signal from one of four Thermo-ducer®'s (STD, MTD, ITD or WCJ).
* Sensor break protection: De-energizes output to protect the system.

                Upscale: EEE
                Downsacle: ---

OUTPUT
* Relay 10A, SPDT Plug in: 10A @ 120 VAC, 5A @ 240 VAC, 10A @ 28 VDC, 1/3 hp @ 120 or 240 VAC, 345 VA pilot duty @ 120 or 240 VAC.
* 4 - 20 mA / 1 - 5 VDC.
* Load impedance for voltage output; 5K minimum.
* Load impedance for current; 600 ohm maximum.

OPERATOR INTERFACE
* 1/2 " LEDs displaying process input value and, when setpot knob is depressed, set point value.
* LED indication of output energized (load light).

INDICATION
* Linearized mV output corresponding to input signal (5mV/digit).

OPERATING ENVIRONMENT
* 32 to 130°F/0 to 55°C.
* 0 to 90 % RH, non-condensing.
SPECIFICATIONS (CONT.)

ACCURACY
* Calibration accuracy: +/- 0.25% of span at 77°F +/- 5°F, ambient & rated line voltage +/- 1%.
* Linearization accuracy: +/- 0.25% of span, +/- 1 digit at 77°F +/- 5°F ambient & rated line voltage +/- 1%.
* MV signal I/O: +/- 0.25% of span.
* Accuracy span: 500°F or 260°C minimum.
* Temperature stability: +/- 2uV/°F ambient.
* Voltage stability: +/- 0.01% of span 1% of rated line.

TERMINALS
* #6 screws on barrier strips.

POWER
* 115/230 VAC +/- 10%, 50/60 Hz.
* 6 VA power consumption.

DIMENSIONS
* Height: 3.8 in.
* Width: 3.8 in.
* Behind panel depth: 4.9 in.
* Weight: 1.5 lb.

THERMO-DUCER® SPECIFICATIONS

INPUT
* +5 Vdc and -5 Vdc referenced to a common ground.

OUTPUT
* Non-linear signal, 0 to 50 mV full scale.

LENS SYSTEM
* An infrared pass, refractive fresnel lens.

WAVELENGTH RESPONSE BAND
* 7 to 15 microns nominal.

CALIBRATION
* Each sensor is zeroed and calibrated to blackbody sources at a minimum of four points along its full scale.

ACCURACY
* +/- 1% of full scale maximum value.

REACTION TIME
* 35 milliseconds

RESPONSE TIME
* 300 milliseconds to 95% of the target temperature.

CABLE LEAD TERMINATIONS
* Stripped/tinned leads

TEMPERATURE MEASUREMENT RANGE
* STD & MTD: 32 to 500°F/0 to 260°C
* ITD & W CJ: 32 to 500°F/0 to 260°C

THERMO-DUCER® AMBIENT OPERATING TEMPERATURE
* STD & MTD: 32 to 122°F/0 to 50°C
* ITD: 32 to 302°F/0 to 150°C
* W CJ: 32 to 550°F/0 to 288°C

PAGE 3
SPECIFICATIONS (CONT.)

AMBIENT TEMPERATURE COMPENSATION
* STD & MTD: Sensor self-compensates for ambient variations up to 122°F/50°C. Ambient temperatures beyond require cooling.
* ITD & WCJ: Same as STD & MTD, except cooling jacket functions to keep sensor below 122°F/50°C in a heated environment.

COOLANT LINES
* ITD: 3/16 inch O.D. plastic tubing. Sensor is equipped with a quick disconnect fitting.
* WCJ: 1/4 inch soft copper tubing. Sensor is equipped with a ferrule fitting.

COOLANT FLOW
* ITD: 5 psig air pressure at the Thermo-ducer®.
* WCJ: 0.25 gpm cooling water flow at the Thermo-ducer®. Air flow as specified for the ITD.

DISTANCE TO TARGET TO TARGET DIAMETER RATIO
* STD & MTD: 6:1 Distance to target(in.) Target diameter(in.)

<table>
<thead>
<tr>
<th>Distance to Target (in.)</th>
<th>Target Diameter (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1/2 (minimum)</td>
</tr>
<tr>
<td>3</td>
<td>3/4</td>
</tr>
<tr>
<td>6</td>
<td>1-1/4</td>
</tr>
<tr>
<td>12</td>
<td>2-1/4</td>
</tr>
</tbody>
</table>

* ITD & WCJ: 10:1

<table>
<thead>
<tr>
<th>Distance to Target (in.)</th>
<th>Target Diameter (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3/8 (minimum)</td>
</tr>
<tr>
<td>3</td>
<td>1/2</td>
</tr>
<tr>
<td>6</td>
<td>3/4</td>
</tr>
<tr>
<td>12</td>
<td>1-3/8</td>
</tr>
</tbody>
</table>

SPECIAL APPLICATION BOARDS
* Model PCE process control electronics: Works in conjunction with the controller in applications where temperature control is based on discrete parts/products. Requires dry contact closure input typically from a 10 to 30 Vdc optical sensor supplying a 15 Vdc source output.
* Model PAB remote pre-amp board: Contains the second, third and fourth stages of the Thermo-ducer® signal amplification circuit and the calibration trimpots. Used in applications where the Thermo-ducer® is no longer accessible after installation.

THERMO-DUCER® ACCESSORY ITEMS
* Add-on lens protection for the Model STD and MTD.
* Air pressure switch for use with the Model ITD.
* Mounting hardware.
* Additional shielded cable and stainless steel conduit.

PAGE 4
INSTALLATION AND DIMENSIONAL INFORMATION

FIGURE 1 - STANDARD CONTROLLER CASE

FIGURE 2 - CONTROLLER MOUNTING REQUIREMENTS

NOTE: The Thermo-ducer sensor must be mounted at a distance which assures that the desired target area fills the entire target diameter. Reference the distance to target to target diameter ratio information found on page 4 under "Specifications".
INSTALLATION AND DIMENSIONAL INFORMATION (CONT.)

FIGURE 3 - STD AND MTD THERMO-DUCER®

FIGURE 4 - ITD AND WCJ THERMO-DUCER®
INSTALLATION AND DIMENSIONAL INFORMATION (CONT.)

3.25 in.
(82.6 mm)

1.50 in.
(38.1 mm)

FIGURE 5 - PCE AND FAB BOARD

WIRING

Wire your kit according to the figures showing the correct input and output.

1. mV(+) (white) 1
2. +5Vdc (red) 2
3. mV(-) (black) 3 (J1)
4. -5Vdc (green) 4

FIGURE 6 - INPUT CONNECTIONS
THERMO-DUCER® TO BREAK PROTECTION BOARD

9. mV (+) (White) 9 10 11 12 13 14 15 16
10. +5Vdc (Red) 
11. mV (-) (Black)
12. -5Vdc (Green)
13. Set point (+) out
14. Not used
15. Signal conditioner (+) out
16. Circuit Common

FIGURE 7 - INPUT CONNECTIONS
BREAK PROTECTION BOARD TO CONTROLLER

PAGE 7
FIGURE 7 - 88IR RELAY OUTPUT

NOTE: YOU MUST JUMPER CURRENT OUTPUT TERMINAL 3 TO 4 IF USING VOLTAGE OUTPUT ONLY.

FIGURE 8 - 88IR 4 - 20 mA OUTPUT

CALIBRATION

CONTROLLER
Equipment Required:
1. Precision voltage source
2. Digital voltmeter (DVM)
3. Extender board Watlow P/N Z100-0421-0000 (optional)
CALIBRATION (CONT.)

Procedure:
1. Disconnect the Thermo-ducer® input leads (white & black) and connect the voltage source to the input terminals (+ to 1, - to 3, see page 7 figure 6). Connect power to the controller and allow to stabilize for approximately five minutes.
2. Set the voltage source to 0.00 volts. Use the DVM to measure the voltage at the input leads.
3. Adjust the ZERO pot to read 32°F (0°C if it is a centigrade control).
4. Increase the voltage source to 50 millivolts. Adjust FS to read 500°F (260°C if it is a centigrade control).
5. Repeat steps 2 through 4.

THERMO-ducer®
Equipment Required:
1. Low temperature blackbody (Aprox. 90°F).
2. High temperature blackbody (Aprox. 400°F).

Procedure: Thermo-ducer® without a remote PAB board
1. Remove the plastic cap (threaded plug on the ITD and WCJ) from the Thermo-ducer® end cap.
2. With the Thermo-ducer® wired to the controller, energize the control and point the Thermo-ducer® at a low temperature blackbody.
3. With the end cap hole in the twelve o'clock position, adjust the LH (offset) trimpot until the controller reads correctly.
4. Point the Thermo-ducer® at a high temperature blackbody from the same distance as used for step 3.
5. With the end cap still in the twelve o'clock position, adjust the RH (gain) trimpot until the controller reads correctly.
6. Repeat steps 2 through 5 until the temperature span is properly set.

Procedure: Thermo-ducer® with a remote PAB board
1. With the Thermo-ducer® connected to the controller, energize the control and point the Thermo-ducer® at a low temperature blackbody.
2. Adjust trimpot R4 (offset) on the PAB board until the controller reads correctly.
3. Point the Thermo-ducer® at a high temperature blackbody from the same distance as used for step 1.
4. Adjust trimpot R5 (gain) until the controller reads correctly.
5. Repeat steps 1 through 4 until the temperature span is properly set.
**FIGURE 9 - ADJUSTMENT GRAPH**

**Tuning Procedure for Time Proportioning Controls**

**Initial Settings:**
1. Proportional band: Turn maximum clockwise; CW (widest setting).
2. Reset: 0.05 repeats/minutes; turn maximum CW.
3. Rate: 0; turn maximum counter-clockwise, CCW
4. Cycle time: 2 seconds; turn maximum CCW.

Energize the system and allow the process temperature to stabilize. When the system is stable, the load light will cycle at a constant rate.

**Proportional Band Adjustment:**
Rotate the proportional band pot CCW 1/4 turn and observe system stability. Repeat until the process temperature begins to hunt (becomes unstable). When hunting is observed, rotate pot slowly CW until the system becomes stable. Some systems may be stable enough to allow minimum proportional band setting (maximum CCW).

**Reset Adjustment:**
The reset adjustment controls the time required to drive the error signal to zero. A slow setting (0.05 repeats/minute) requires long periods of time for the load temperature to reach set point. If the reset time is set too fast (0.5 repeats/minute) the system may become unstable and oscillate about set point temperature.

To adjust reset time, rotate the reset pot 1/4 turn CCW and observe stability. Continue adjusting CCW until the system becomes unstable. Rotate CW very slowly to regain stability.

**Rate Adjustment:**
The rate adjustment controls overshoot as load temperature approaches set point temperature by limiting the rate of change of load temperature. Rotate the rate pot 1/4 turn CW. Change the set point temperature 20 to 30°F/°C and observe the approach to set point.
TUNING (CONT.)

If the load temperature overshoots, repeat the procedure until optimum approach to set point is achieved. If the rate pot is advanced too far, the system will be overdamped and approach to set point will be very sluggish.

**Cycle Time:**
Cycle time is the time base used in proportioning power to the load. At a setting of 2 seconds, if 25% power is required to maintain load temperature at set point, power will be applied for 0.5 second every 2 seconds. At 10 second cycle time, power would be applied for 2.5 seconds every 10 seconds.

Best control is always achieved with faster cycle times. However, if a mechanical contactor or solenoid is used to switch power to the load, slower cycle times may be desirable to minimize the wear on the mechanical components.

**NOTE:** All pots are located on the bottom board.

TROUBLESHOOTING

If your Series 88IR Thermo-ducer/Controller Kit displays an error message or erroneous temperature reading, review the wiring, calibration and tuning sections of this manual to assure that all steps were properly performed. If no discrepancies were disclosed, perform the following test.

With the Thermo-ducer properly wired, energize the controller and make the following voltage measurements noting the result for each step in the space provided.

1. Measure the voltage (V) across terminals 2 and 3 on the break protection board.
2. Measure the voltage (V) across terminals 3 and 4 on the break protection board.
3. With the Thermo-ducer pointed at an object at ambient (70°F), measure the voltage (mV) across terminals 1 and 3.
4. With the Thermo-ducer pointed at an object above ambient (100°F), measure the voltage (mV) across terminals 1 and 3.

Once this information is obtained, consult the factory for assistance.

**NOTE:** THE COMMON PROBE OF THE DVM MUST BE PLACED ON TERMINAL THREE FOR ALL MEASUREMENTS.
GLOSSARY

1. **Anti Reset** - Inhibits reset action when the actual process temperature is outside the proportional band.

2. **Automatic Reset (integral)** - Used in proportioning control systems to automatically pick up any system droop. Normally this action is adjustable and adjusts the time for reset to obtain agreement between actual process temperature and set point.

3. **Cycle Time** - Time interval between consecutive turn ons.

4. **Emissivity** - The opposite of reflectivity. A perfect "black body" has an emissivity of 1.0, while a perfect reflector has an emissivity of 0.0. Substances in the real world have emissivities in between.

5. **Proportional Band** - In a straight time proportional control system when the actual process temperature is below set point and outside the proportional band limit, 100% power is applied to the load.

When the actual process temperature is above set point and outside the proportional band limit, 0% power is applied to the load.

When the actual process temperature is within the proportional band, the controller will proportion the amount of power applied to the load, 0 to 100%.

6. **Rate (derivative)** - Action that anticipates the rate of actual process temperature rise and automatically widens the proportional band to prevent overshoot. Returns the proportional band to the static adjustment when the set point temperature is stable within the static band boundaries.

7. **Temperature Droop** - Phenomenon that occurs in a proportional control system without reset. As the proportional band is increased, the average process temperature may drop to a point that is not the set point temperature. This action takes place even though the load has stabilized.

8. **Temperature Oscillation or Hunting** - Occurs when the proportional band is too narrow or the system is upset by some outside source. The actual process temperature is not controlled within the proportional band on its extreme temperature excursions.

9. **Thermo-ducer** - A trademark registered to Watlow Infrared for a product line of non-contact temperature sensors. The basic models are the STD, MTD, ITD and WCJ.
Series 88IR = Digital indicating closed loop temperature control with PID; Thermo-ducer® input; 1/4 DIN; SPDT relay, 10A or 4 - 20 mA output.

**THermo-Ducer®**
A = STD-AOC-BOO  
B = MTD-AOC-BOO  
C = ITD-AAC-BOO  
D = ITD-ABC-BOO  
E = WCJ-AAC-BOO  
F = WCJ-ABC-BOO

**Temperature Scale**
A = Celsius or Centigrade  
B = Fahrenheit

**Output**
A = Relay, 10A SPDT  
B = 4 - 20 mA / 1 - 5 VDC

**Output Control Mode**
A = Heat  
B = Cool

**Specials**
00' - ZZ

**Note Thermo-Ducer® Coding:**  _ _ _ _ (1) (2) (3) (4) 0 0

(1) A = 32 to 500 °F/0 to 260 °C  
(2) A = Internal pre-amp board  
   (Standard on STD)  
   B = Remote pre-amp board  
   (Standard on MTD)  
(3) C = Spade lug terminals  
(4) B = 0 to 50 mV output

PAGE 13