Sigma Systems Corporation  
Model C Controller  
Calibration Procedure

Modified: 6.13.01

Test Equipment Required:

Item 1.  (1) Oscilloscope (+ / - 2% accuracy @ 15° - 35°C)
Item 2.  (1) Voltmeter (+ / - 2% accuracy @ 15° - 35°C)
Item 3.  (1) Decade Resistance Box (0-1k ohm within 1% accuracy @ 15° to 35°C)

(For this procedure we used a Tektronix TDS 360 for the Oscilloscope, a Fluke 87 Digital Volt Meter (DVM) for the voltmeter, and an IET RS-200W Resistance Substituter for the decade resistance box.)

Note: This procedure will align the controller to within + / - 1°C of accuracy. Because this calibration procedure requires a decade resistance box as a Resistive Thermal Device (RTD) substitute, only the Controller is being calibrated.

WARNING: This calibration procedure requires this equipment to be open and energized. Not observing safe practices while calibrating the controller could result in personal injury or loss of life.

CAUTION: This calibration procedure requires this equipment to be open and energized. Not observing safe practices while calibrating the controller could result in damage to the equipment or to other property.
Figure 1. Model C Back panel

CAUTION!

WARNING!

- Power to host thermal platform (TP) or Chamber must be completely removed before removing controller from housing.

- Remove controller from enclosure, leave controller power plug hooked to chamber or TP.

- Disconnect existing wires to probe and connect decade resistance box to controller between TB1 P1 and P2 in place of probe wires. Connect ground wire from decade box to controller. (See Figure 1)
• Set decade resistance box to 500.0 ohms.

• Connect ground of decade resistance box probe wire and oscilloscope probe ground wire to Model C chassis ground.

• Turn bi-metal failsafe fully counter clock-wise to prevent heating during the calibration process.

I. **Inspect Controller Physical Properties**

   A. Look for discoloration on wires.
   B. Look for wires pulling away from solder joints.

• Restore line voltage to host system.

• Turn controller on.

II. **Test Point verification with DVM** (All Test Points are labeled on the trace side of the Printed Circuit Board Assembly.)

   A. TP1 = 15 Volts Direct Current (VDC) + / - 1VDC
      1. DC level does not vary more than + / - 250 milli Volts Direct Current (mVDC)

   B. TP2 = half of TP1 = + / - 250 mVDC
      1. DC level does not vary more than + / - 250 mVDC

   **Test Point verification with Oscilloscope**

   C. TP3 = 1 KHz Square Wave + / - 300 Hz (see Figure 2.1)
      1. Waveform is stable.

   D. Verification of digit switch integrity.

• Set Decade Resistance Box per below and check each of the digit switch settings and with the corresponding decade box setting.

Note: Verifying that the switch contacts of the digit switch are not causing random readings. The signal should be a steady sine wave signal approaching null, however until calibration is complete, the scope display may indicate a signal that is not completely null (null is less that 0.25v P-P ac signal)
Note: Wiggling the digit switches side to side will help pinpoint if there is a faulty connection in the digit switch. The waveform should not change more than 1 volt when wiggling the digit switches.

1. Test digit switches at -11°C 478.2 ohms at Decade box
2. Test digit switches at +22°C 543.4 ohms at Decade box
3. Test digit switches at +33°C 565.0 ohms at Decade box
4. Test digit switches at +44°C 586.5 ohms at Decade box
5. Test digit switches at +55°C 608.0 ohms at Decade box
6. Test digit switches at +66°C 629.4 ohms at Decade box
7. Test digit switches at +77°C 650.7 ohms at Decade box
8. Test digit switches at +88°C 671.9 ohms at Decade box
9. Test digit switches at +99°C 693.1 ohms at Decade box
10. Test digit switches at +100°C 695.0 ohms at Decade box

Figure 2.1 1 KHz Square wave

Figure 2.2 Correct Waveform of how digit switch noise test should look (Oscilloscope set to 2 volts per division).
III. Zero and Slope Null Verification – Set point calibration (See Figure 3. for Potentiometer Location & Figure 4. for how to adjust wave form to null.)

Note: On Decade Resistance Box

500.0 ohms = 0°C
695.0 ohms = 100°C

Note: Connect Oscilloscope Probe to TP4

A. Adjust specified potentiometers referenced in Table 1 to less than 250 mVAC peak to peak (null).
Table 1. Null Adjust

<table>
<thead>
<tr>
<th>Set Digit Switch to:</th>
<th>Set Decade Resistance Box to:</th>
<th>Adjust Potentiometer for null</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 000</td>
<td>500.0 ohms</td>
<td>P2</td>
</tr>
<tr>
<td>+ 000</td>
<td>500.0 ohms</td>
<td>MBX1</td>
</tr>
<tr>
<td>+ 099</td>
<td>693.0 ohms</td>
<td>P1</td>
</tr>
<tr>
<td>+ 100</td>
<td>695.0 ohms</td>
<td>MBX2</td>
</tr>
</tbody>
</table>

Repeat the next 2 steps until a null is found at both of the settings on the digit switch and the decade resistance box at the same time.

| + 000               | 500 ohms                      | P2                            |
| + 100               | 695 ohms                      | P1                            |
Figure 4.0 How to adjust Potentiometers for null (Oscilloscope set to 2 Volts per division) initial scope screen.

Figure 4.1 How to adjust Potentiometers for null (In progress: Adjusted down to within 5 VAC of zero [null]).
Figure 4.2 How to adjust Potentiometers for null (In progress, Adjusted down to within 0.5 volt peak to peak).

![Graph showing voltage measurements](image)

Figure 4.3 How to adjust Potentiometers for null – in progress (Set oscilloscope to 500 mV per division).

![Graph showing voltage measurements](image)
Figure 4.4  How to adjust Potentiometers for null (Adjust to less than 250mVAC)
Set point calibration is complete when calibration at 0°C and 100°C matches the below scope screen capture.

- Disconnect Oscilloscope.

IV. Gain adjustment
Note: Connect DVM between TP2 and TP5.
Set to DCV and range near 2VDC full scale.

A. Turn Gain Potentiometer P5 fully counter clock wise.
B. Adjust P4 for null on the meter, 0 + / - 150 mVDC (This step takes a few minutes to settle).
C. Adjust P5 for host system as stated in Table 2:

Table 2. Gain adjustment for Host System

<table>
<thead>
<tr>
<th>Adjust Gain pot P5 X turns:</th>
<th>Host System</th>
</tr>
</thead>
<tbody>
<tr>
<td>X = 8</td>
<td>Chamber</td>
</tr>
<tr>
<td>X = 13</td>
<td>TP larger than a TP 294</td>
</tr>
<tr>
<td>X = 20</td>
<td>TP 294</td>
</tr>
<tr>
<td>X = 25</td>
<td>TP smaller than a TP 294</td>
</tr>
</tbody>
</table>
• Turn the controller off.
• Turn bi-metal failsafe fully clockwise and then back off counter clockwise approximately ¼ of full range of motion to allow system to operate.
• Disconnect the decade resistance box, reconnect the system temperature probe and then turn the controller power back on.

Note: The probe is a resistance sensor without polarity, however, for consistency the black wire goes on the lower lug, the white or Red wire goes to the second lug from the bottom and the ground wire must be securely tightened to the stud below the terminal strip. It is important that this lug is secure, remove power and use a Phillips head screwdriver on the inside of the controller if necessary to make certain connection is secure.

Note: If the current temperature of the platform or chamber is not currently exceeding the failsafe setting, then cycling the power off and then on after the two previous steps resets the failsafe condition in the host system.

V. Gain Verification, final adjustment

A. Set temperature on Model C to 50°C.
B. Allow system to stabilize.
C. Observe the heat lamp, it should pulse on briefly and is directly proportional to the duty cycle.

Note: When the correct approximate duty cycle is set by the gain adjustment in section IV, the duty cycle is relatively even.

Note: If the duty cycle has a large variation (termed hunting) then adjust the gain P5 clockwise 1 more turn (that would be lower gain). If the controller seems to not be calling for enough heat to achieve the setpoint the gain needs to be increased by turning P5 counter clockwise, again making changes in increments of one turn. The best setting will be the highest gain setting that does not induce hunting.

Note: P4 (offset) rarely needs adjustment beyond the initial setting, its function is to offset the ratio of the controller’s response for cooling as opposed to heating.
CAUTION!
WARNING!

- Power to host thermal platform (TP) or Chamber must be completely removed before installing controller into housing
- Remove all test equipment
- Re-install controller into host enclosure
- Restore Power to Host System and Controller
- Reset system failsafe to desired maximum operating temperature

Calibration of the Sigma Systems Model C temperature Controller is complete