**PURPOSE:**

Provide instruction on 9-point uniformity in Despatch ovens:

- Proper placement of thermocouples
- Proper thermocouple wire routing.
- Examples of typical test results
- Testing procedure
- Data analysis and offset input for the Protocol 3 controller

**DESPATCH - OVEN TEMPERATURE UNIFORMITY MEASUREMENT PROCEDURE**

An array of 9 thermocouples with special low limits of error* are placed at the distances indicated in Table 1 from each corner and the center of the oven. The temperature is checked with a calibrated temperature meter traceable to NIST standards at a minimum and maximum operating temperature specified by the customer. If the temperature is not specified by the customer, then the uniformity will be measured near its published maximum operating temperature.

Adjustments are made to bring the minimum and maximum chamber temperature within specified range about set-point after stabilization at set-point.

The temperature uniformity specifications for all Despatch oven models are available on the Despatch website at www.despatch.com

Table 1

| **Thermocouple Locations Based on Oven Model and Size** | |
|---|---|
| Bench Top Oven Models (up to 7 c.f.) | 3" from any surface |
| Bench Top Oven Models (7.1 c.f. to 18 c.f.) | 4" from any surface |
| Reach-In Oven Models (up to 35 c.f.) | 6" from any surface |
| Walk-In/Truck-In Oven Models (all sizes) | 6” from the walls and ceiling and 13" from the floor |

**ANSI standard for special limits of error thermocouples is +/-1.1C, or +/- .4%, whichever is greater.*

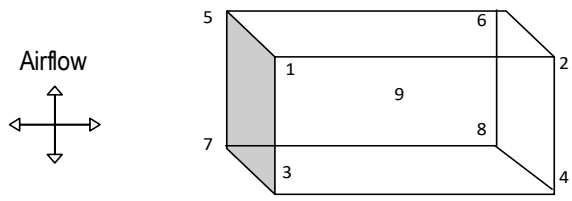
ITW EAE Electronic Assembly Equipment

F7.3-08 P 1of 1
Issue Date: 5/1/2005
Rev Date: 7/12/2019

# OVEN CHAMBER
# CERTIFICATE OF UNIFORMITY

| | | | |
|---|---|---|---|
| Oven Model | Model | Customer | Customer |
| Oven Serial | XXXXXX | Date | |
| Temperature Control Manufacturer and Model | | Temperature Control S/N | |

Ambient Conditions: Temperature _____ Humidity _____




Use Highest setpoint tested

| | | | |
|---|---|---|---|
| TC#1 | | TC#2 | |
| TC#3 | | TC#4 | |
| TC#5 | | TC#6 | |
| TC#7 | | TC#8 | |
| TC#9 | | TC#10* | |

Median Temperature { $(T_{HI} + T_{LO})/2$ } : 0

*TC#10 typically located at control instrument

Thermocouple Positions (Distance from walls, floor and ceiling): _____

Max. stabilization time: _____ (1 hour unless otherwise specified)
Max. allowable uniformity: _____ °F / °C @ _____ °F / °C ±10°F or ±2% of span if not otherwise specified.
Overshoot allowance: _____ °F / °C (if specified)
Other notes (Customer specifications such as AMS2750E, etc.) _____

TEST DATA:

| | | | |
|---|---|---|---|
| Control Setpoint # 1 | | Control Setpoint # 2 (If applicable) | |
| Cycle Time | | Cycle Time | |
| PID Settings P: ____ I: ____ D: | | PID Settings P: ____ I: ____ D: | |
| Temperature Control Readout | | Temperature Control Readout | |
| Actual Median Oven Temperature | | Actual Median Oven Temperature | |
| Deviation | | Deviation | |
| Control Offset #1 Setting | | Control Offset #2 Setting | |
| Fresh Air damper Setting | | Fresh Air damper Setting | |
| Exhaust Damper Setting | | Exhaust Damper Setting | |

TEST RESULTS:
Setpoint #1 ( ) In Tolerance ( ) Out of Tolerance Setpoint #2 ( ) In Tolerance ( ) Out of Tolerance

EQUIPMENT USED IN CALIBRATION:

| Instrument Manufacturer and Model Number | Serial No. | Date Calibrated | Calibration Due |
|---|---|---|---|
| | | | |

This uniformity test was controlled by the use of documented procedures and using equipment traceable to NIST.
This control calibration is based on the median oven temperature $(T_{HI} + T_{LO})/2$
compared to the readout of the temperature control. Typical specifications are +/- 1 degree C.

Certified By _____ Date _____



26-0110

MPM | Camalot | Electrovert | Vitronics Soltec | Despatch

The uniformity test thermocouples 1 thru 9 shown on the diagram above correspond to the following locations in the oven work chamber shown in Table 2 below, when viewed through the oven door.

Table 2

| Uniformity Test Thermocouple Key | | | |
|---|---|---|---|
| 1 | Front Upper Left Corner | 6 | Rear Upper Right Corner |
| 2 | Front Upper Right Corner | 7 | Rear Lower Left Corner |
| 3 | Front Lower Left Corner | 8 | Rear Lower Right Corner |
| 4 | Front Lower Right Corner | 9 | Center of Oven Chamber |
| 5 | Rear Upper Left Corner | | |

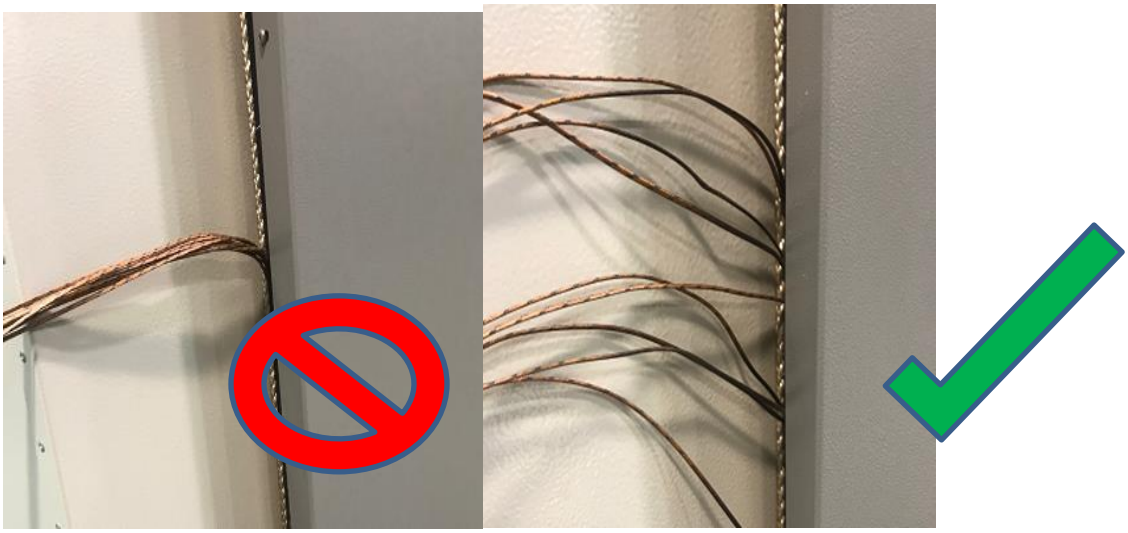
## GENERAL INSTRUCTIONS FOR MEASURING OVEN TEMPERATURE UNIFORMITY

### Thermocouple Installation and Placement

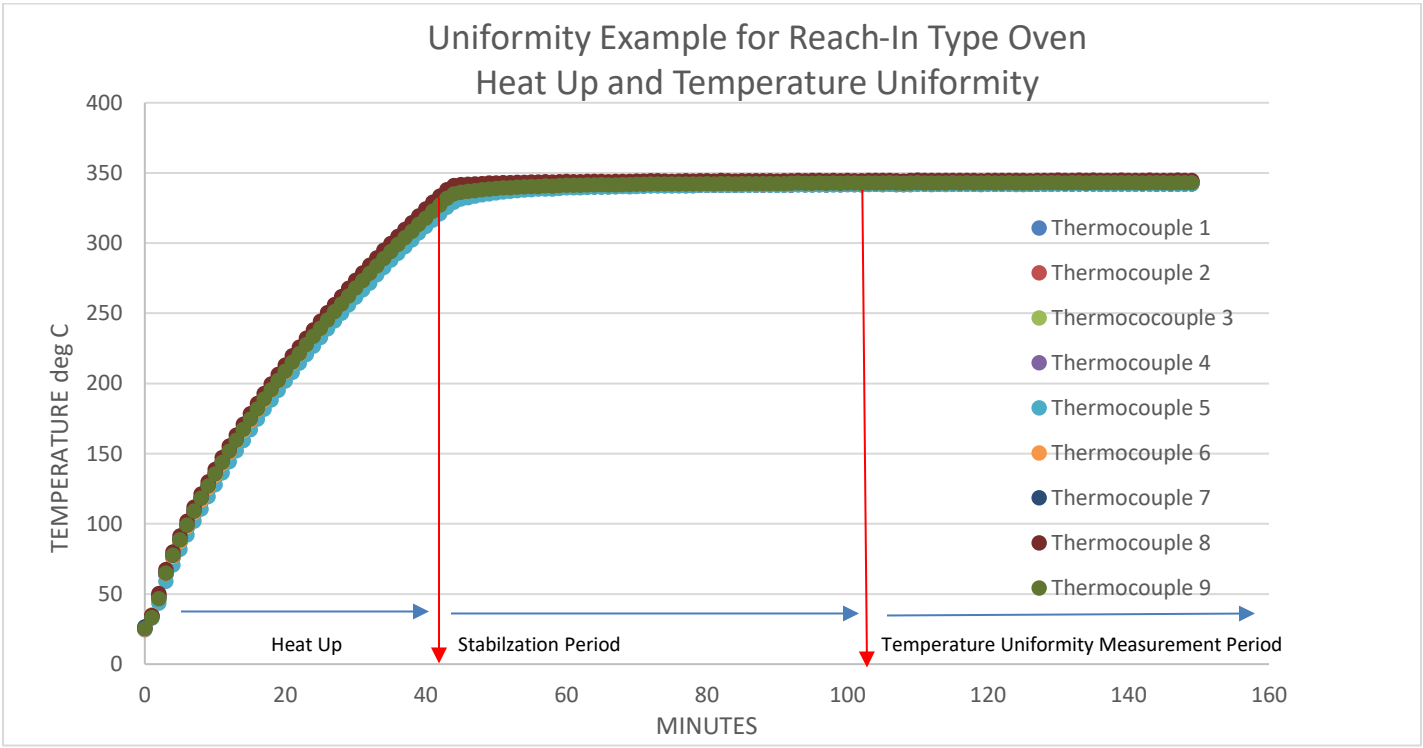
Depending on the oven model, the nine test thermocouples should be routed into the oven through an NPT type access port on the back of the oven whenever possible. An alternative method is to route the bundle of test thermocouple wires through the exhaust port on ovens not having a forced air exhaust fan or a direct-connected facility exhaust duct, typically seen on LBB and LAC series oven models shown below on the left hand photo.

If the thermocouples must be routed through the door opening, they should enter the oven on the airflow return plenum side (suction side) at mid-height on the oven. The thermocouples should not be bundled at the point where they pass between the door and seal on the oven

body. This will result in airflow leakage and impact the temperature uniformity measurement results. Instead, the thermocouples should be separated and laid flat.



The graph below shows the results of a temperature uniformity test run with an oven setpoint of 343°C.



### Oven Heat Up (see graph above)

After test thermocouples have been installed adjust the control instrument to the maximum operating temperature for the particular oven model, or to your desired process operating temperature. The oven should heat to setpoint within the amount of time listed in the specifications. This time to temperature is determined by the control instrument readout, or a test thermocouple placed next to the control thermocouple.

### Stabilization Period (see graph above)

The stabilization period begins when the first among the 9 test thermocouples reaches the minimum temperature allowable as defined by the temperature uniformity specifications.

For the example shown above, the TAD2-19 model oven has a temperature uniformity specification of +/- 3.7 deg C at an oven operating temperature of 343°C, so when the first test thermocouple reaches 339.3°C (343°C – 3.7°C) the 60 minute stabilization period begins.

If the test thermocouples stabilize above or below the setpoint temperature of the controller, an offset can be entered to calibrate the control instrument thermocouple to the test thermocouples (see Temperature Control Instrument Offset Parameter below).

### Temperature Uniformity Measurement Period (see graph above)

The temperature uniformity is measured beginning 60 minutes after the oven enters the stabilization period. In the example shown above, the temperature uniformity period would begin at 104 minutes as indicated by the arrow shown on the graph.

It is recommended that the test thermocouple measurements be logged at a minimum of 1 minute intervals for a period of 30 minutes. During this period the 9 thermocouples should remain within the specified limits for the oven (for the example above, 343°C +/- 3.7°C).

### Temperature Control Instrument - Offset Parameter

Note that when heating the oven to the desired temperature for verifying temperature uniformity, the minimum and maximum temperatures recorded on the test thermocouples may not be centered equally about the setpoint temperature. The control temperature of the oven can be adjusted using the “bias” or “offset” parameters within the control instrument.

Depending on the specific control instrument being used on the oven, it will typically have either a single point or dual point offset calibration that can be applied to correct and difference that exists between the control instrument thermocouple and the uniformity test thermocouples.

In general, entering a negative offset value will raise the temperature of the oven, while a positive offset value will decrease the temperature of the oven.

The offset value should be adjusted based on the values recorded among the 9 test thermocouples. The offset is calculated based on the temperature spread between the minimum and maximum temperatures measured on the test thermocouples.

Where:

Maximum Temperature – Minimum Temperature = Temperature Spread

Temperature Spread (divided by 2) is used to calculate the offset value

An example for determining offset value to be entered into the control instrument is shown below.

After the stabilization period has ended, the following temperatures are recorded on the 9 uniformity test thermocouples.

Table 3

| TC1 | TC2 | TC3 | TC4 | TC5 | TC6 | TC7 | TC8 | TC9 | Setpoint |
|---|---|---|---|---|---|---|---|---|---|
| 253.0 | 254.1 | 253.2 | 255.7 | 253.1 | 255.6 | 256.3 | 257.4 | 256.6 | 260.0°C |

1. From the 9 thermocouple test results shown in Table 3 above, take the maximum temperature reading and subtract the minimum temperature reading to determine the temperature spread, as follows:

   Maximum Temperature (257.4) - Minimum Temperature (253.0) = Temperature Spread (4.4)

2. Next, subtract half of the temperature spread from the oven setpoint temperature, as follows:

   Oven Setpoint (260.0) - Half of Temperature Spread (2.2) = Calculated Lowest Test Thermocouple Reading (257.8)

3. To determine the offset value that will be entered into the control instrument, subtract the **Actual** Lowest Test Thermocouple Reading from the **Calculated** Lowest Test Thermocouple Reading, as follows:

   Calculated (257.8) - Actual (253.0) = 4.8 offset

4. A value of 4.8 would be entered into the control instrument as the offset value so that the highest and lowest test thermocouple readings are centered about the oven controller setpoint.

5. In this example, since the test thermocouples are reading lower than the oven control setpoint of 260.0, the offset would be entered as a negative value (-4.8) so that the oven controller logic

increases the overall oven temperature.

6. After the offset value is entered into the control instrument, the following temperature uniformity results would be expected, where all of the test thermocouples should read 4.8 degrees higher, as shown in Table 4 below:

Table 4

| TC1 | TC2 | TC3 | TC4 | TC5 | TC6 | TC7 | TC8 | TC9 | Setpoint |
|---|---|---|---|---|---|---|---|---|---|
| 257.8 | 258.9 | 258.0 | 260.5 | 257.9 | 260.4 | 261.1 | 262.2 | 261.4 | 260°C |

**Note:** Please refer to the specific control instrument operating manual available on the Despatch website for additional information: https://www.despatch.com/manuals.html

For reference, we have included Calibration Offset instructions for the Protocol 3 Controller on the following pages (also available under Technical Bulletins on the Despatch website).

## Protocol 3 Calibration Offsets

Purpose: An introduction to using offsets on the Protocol 3 control.

**Accessing the Configuration Menu:**

To access the Configuration Menu, and all of its sub-menus, the control must be in its cycle complete or stopped state (not running), if it is not in that state press the  button to stop the control before proceeding.

1. Press  and  together from the Select a Mode screen. This should access the Main Menu.
2. From the Main Menu, use  or  to scroll to Configuration Menu. Press  when configuration menu is highlighted.
3. A prompt will appear to enter an unlock code. Enter the correct code with  and  (the default code is 0010), then press  . This should access the Configuration Menu.

**Working with the Input Configuration:**

With Input Configuration highlighted, press  . The Input Configuration menu allows you to configure items associated with the Control Input Setup, The Control Input Cal, The High Limit Input Setup, and the High limit Input Cal. The Control Calibration Offset parameters are in the Control Input Cal menu. The High Limit Calibration Offset parameters are in the High limit Input Cal menu. The two inputs are calibrated separately. Use  and  to scroll to Control Input Cal or High Limit Input Cal then press  . From this screen, you have the choice of three different Calibration types. They are Factory Calibration, Single Point calibration, and Two Point Calibration. Only one choice is active at any given time. The highlighted choice is the active choice. Use  or  to scroll and highlight the desired choice. Press  with your choice highlighted to configure the settings within that choice.

**Factory Calibration**

Factory means no calibration offset. Selecting this choice disables the Single Point and Two Point Calibration options. There is no settings to configure for this choice.

**Single Point Calibration**

The screen will show the value that the process input (PV) is offset. This offset will be the same through out the controller's input range.

Example: If the control was reading 100 degrees, and you measures 110 degrees inside the oven with the Calibration Offset set to Off, you would want to enter a Calibration Offset of 10 degrees. This would increase the displayed temperature by 10 degrees to match the actual temperature measured in the oven. Use  or  to set the value, then press  .

**Two Point Calibration**

The Two Point Calibration allows you to pick two temperature points with two different offsets. The actual offset at any given temperature will be interpolated between the chosen points and extrapolated above and below the chosen points.

Example: Given the following settings,
Calibration Low Temp = 100, Calibration Low Offset = 1,
Calibration High Temp = 200, Calibration High Offset = 2
The offset at 0 would be 0, the offset at 150 would be 1.5, and the offset at 300 would be 3.

Choosing Two Point Calibration, the screen will show Calibration Low Temp, the point that the low offset will occure. Use  and  to change the value, then press  . The Calibration Low Offset value, the amount of offset to apply will be shown. Use  and  to change the value, then press  . the screen will then show Calibration High Temp, the point that the High offset will occure. Use  and  to change the value, then press  . The Calibration High Offset value, the amount of offset to apply will be shown. Use  and  to change the value, then press  .

Example:

If with the calibration type set to Factory Calibration (no offset) the display on the control read 100 when the actual temperature measured 99, and if the display on the control read 200 when the actural temperature measured 195, you would want to enter the following Two Point Calibration settings.

Calibration Low Temp = 100, Calibration Low Offset = -1,
Calibration High Temp = 200, Calibration High Offset = -5.

**Retuning to the Main menu**

Pressing and holding  and pressing  several times will return the control to the Select a Mode Menu.

1. After the offset value is entered into the control instrument, the following temperature uniformity results would be expected, where all of the test thermocouples should read 4.8 degrees higher, as shown in Table 4 below: