1 Scope

This procedure describes the calibration of a temperature probe and transmitter by direct comparison against a calibrated standard in a temperature controlled block calibrator.

2 Applicability

This procedure is applicable to the calibration of temperature probes with transmitters, from 0 to 100°C, with an uncertainty of approximately ± 0.2°C.

It is suitable for probes and transmitters intended for use with the FCO510 or FCO560.

3 Definitions

PT100	A PRT with a resistance of 100 Ω at 0°C.
RS232	Recommended Standard 232. A digital communications standard for serial binary data signals (not to be confused with the RS identification numbers for laboratory equipment).
RS422	Recommended Standard 422.

4 Abbreviations

CS043	Company Software 043;
CS072	Company Software 072;
EUT	Equipment Under Test;
PRT	Platinum Resistance Thermometer
RTD	Resistance Temperature Detector (Resistance thermometer)

5 Documents Required

Euramet Calibration Guide No.13 V4.0 (09/2017)
EA-10/13 EA Guidelines on the Temperature Block Calibrations
Temperature Calibrations With Isotech Block Calibrators

6 Equipment Required

Standard temperature probe and transmitter (calibrated as a unit);
Validation temperature probe and transmitter (calibrated as a unit);

Either FCO560
Or 24V Supply;
FCO560;
Agilent DMM;
RS232 connector cables as required;
Computer running CS043.

7 General

7.1 Block Calibrator and Oven

The Block Calibrator consists of a temperature controlled chamber enclosing an aluminium block. The temperature changes in the block as the axial distance changes so care must be taken to ensure that the insertion depth of the probes does not exceeds 20 mm from the bottom to ensure that the temperature gradients within the block are minimised.

In general:

a) the reference probes and the EUT should be at the same depth,

b) the hole clearance should be about 0.2 mm.

c) The thermometer with a protective tube of outside diameter d ≤ 6 mm should be used.

Various inserts are available to suit different sized probes.

Stabilisation: In the temperature range 0 to 100 °C the stabilisation time for block calibrator is **30 minutes**.

The Oven works similarly, but allows for the calibration of remote sensors as well. If calibrating a temperature probe, an Aluminium block with bores of varying depths should be used.

Stabilisation: In the temperature range 0 to 50 °C the stabilisation time for block calibrator is **3 hours**.

7.2 Default Calibration Points

Block Calibrator:

- 0-50°C: 0°C, 10°C, 20°C, 35°C, 50°C, 20°C
- 0-100°C: 0°C, 20°C, 50°C, 100°C, 20°C

Oven:

- 5-50°C: 5°C, 10°C, 20°C, 35°C, 50°C, 20°C
- 10-30°C: 10°C. 20°C, 30°C, 20°C

Block Calibrator or Oven:

- Room Temperature Sensor: 10°C, 15°C, 20°C, 25°C, 30°C, 20°C

8 Calibrating PRTs+Xtmtr in Block Calibrator

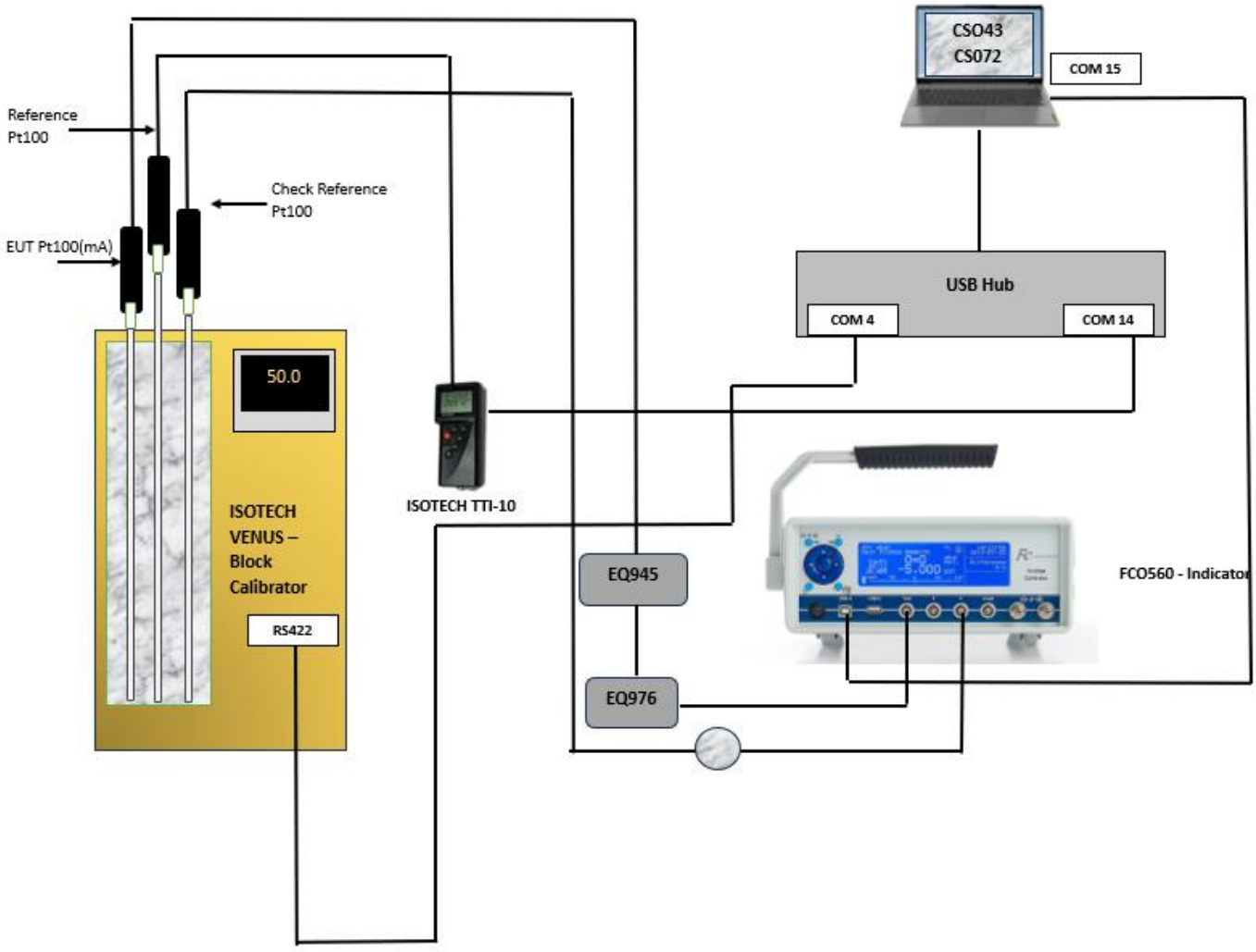


Figure 1: Calibrating a PRT+Xtmtr

8.1 Block Calibrator Diagrams

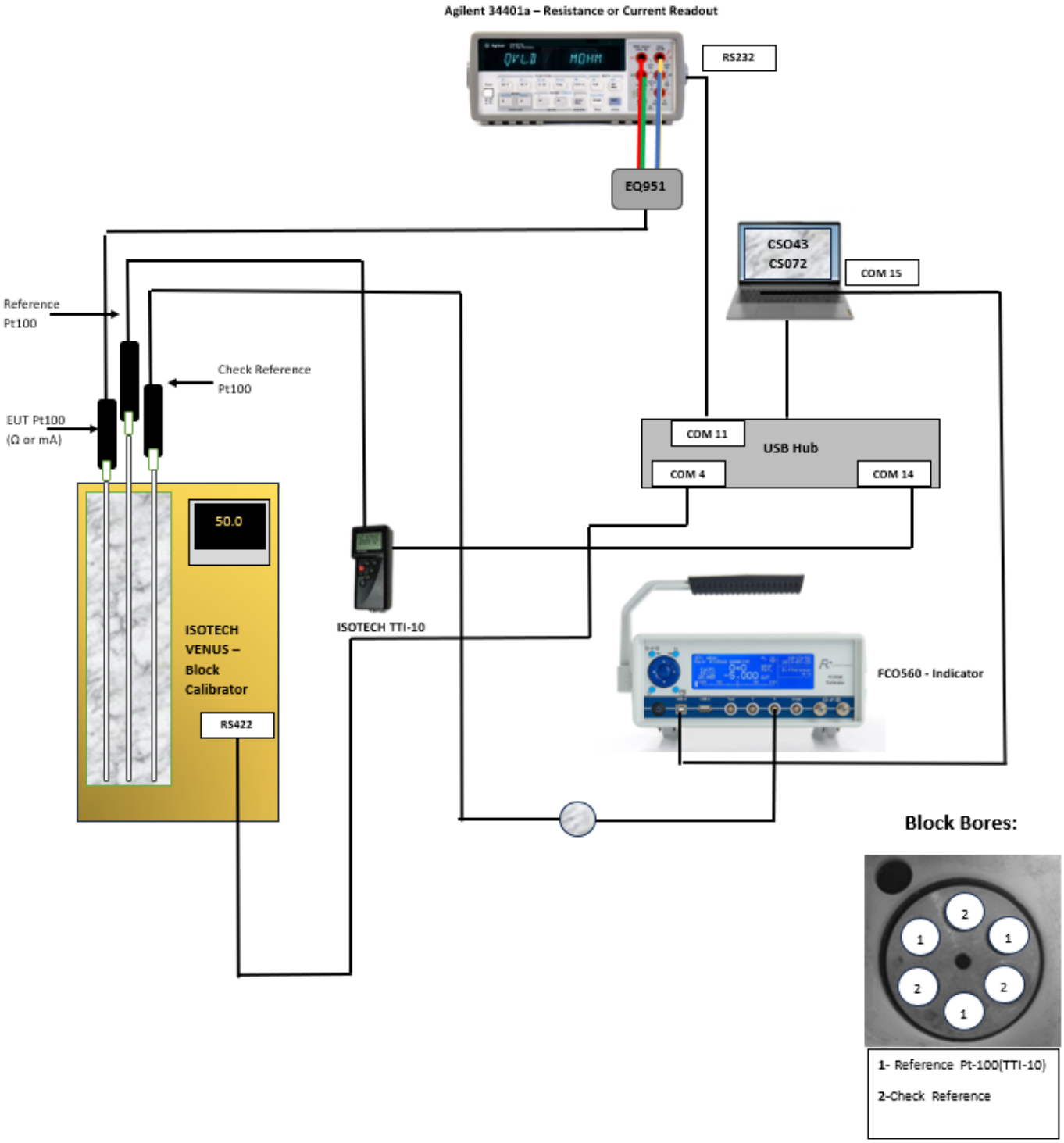


Figure 2: Calibrating a PRT/PRT+Xtmtr using an Agilent

8.2 Block Calibrator Setup

Setup:

- Connect RS80 PRT Reference probe via USB to the Datahub.
- Connect Check Reference PRT to the FCO560 Pressure Port and connect the **FCO560 via USB** to the laptop.
- On the FCO560, press the centre button to go to Main Menu/Pressure Sources. Select the Check PRT being used (add the PRT being used if this has not already been done so) and set the temperature values @4mA and @20 mA. Navigate to Main Menu/Aux. Signals, and set the Aux.Press to the Check PRT being used.
- Insert the EUT into the aluminium block so that the tip of the probe is at the same depth as the Reference probe.

If using an Agilent:

- Connect the Agilent via RS232 to the Datahub
- Connect EUT to the Agilent using EQ951 Adaptor.
- Connect the **Red** and **Green** wires to the 4W Sense/Ratio Ref HI and LO ports. Connect the **Yellow** and **Blue** wires to the Input V HI and LO ports on the Agilent.

9 Calibrating PRTs and PRT+Xtmtrs in Oven

9.1 Oven Diagrams

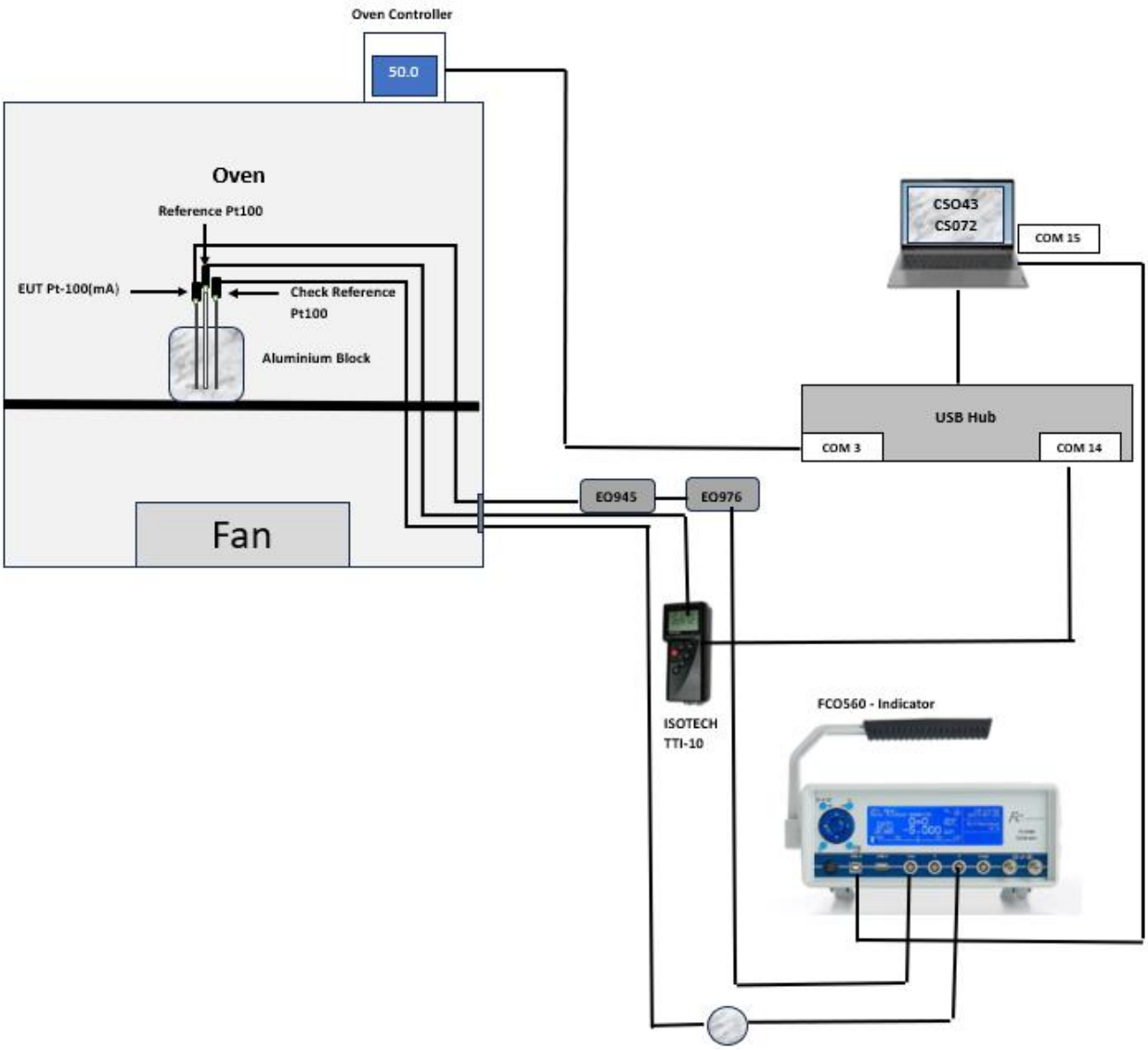


Figure 3: Calibrating a PRT+Xtmtr

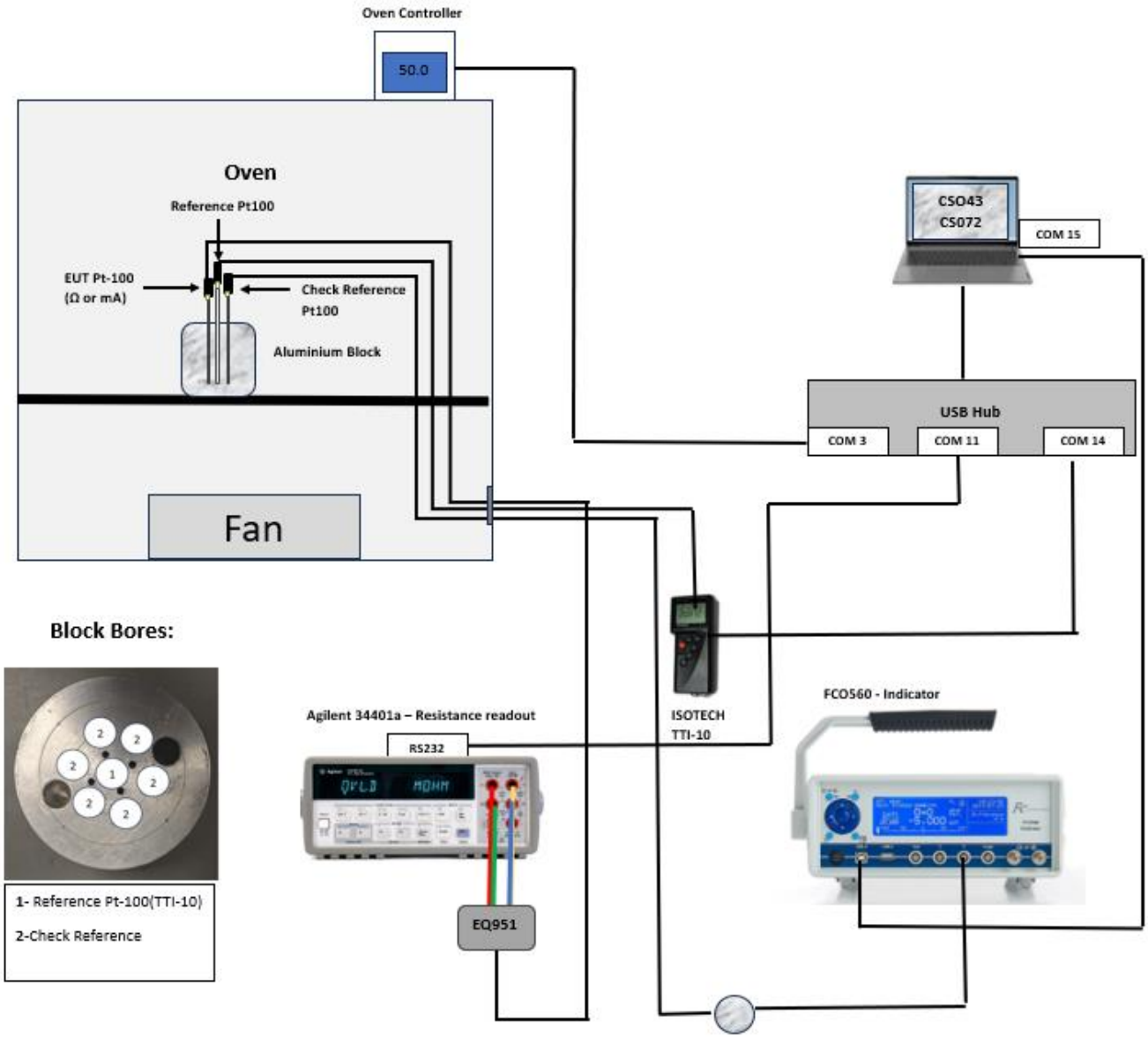


Figure 4: Calibrating a PRT/PRT+Xtmtr using an Agilent

9.2 Oven Setup

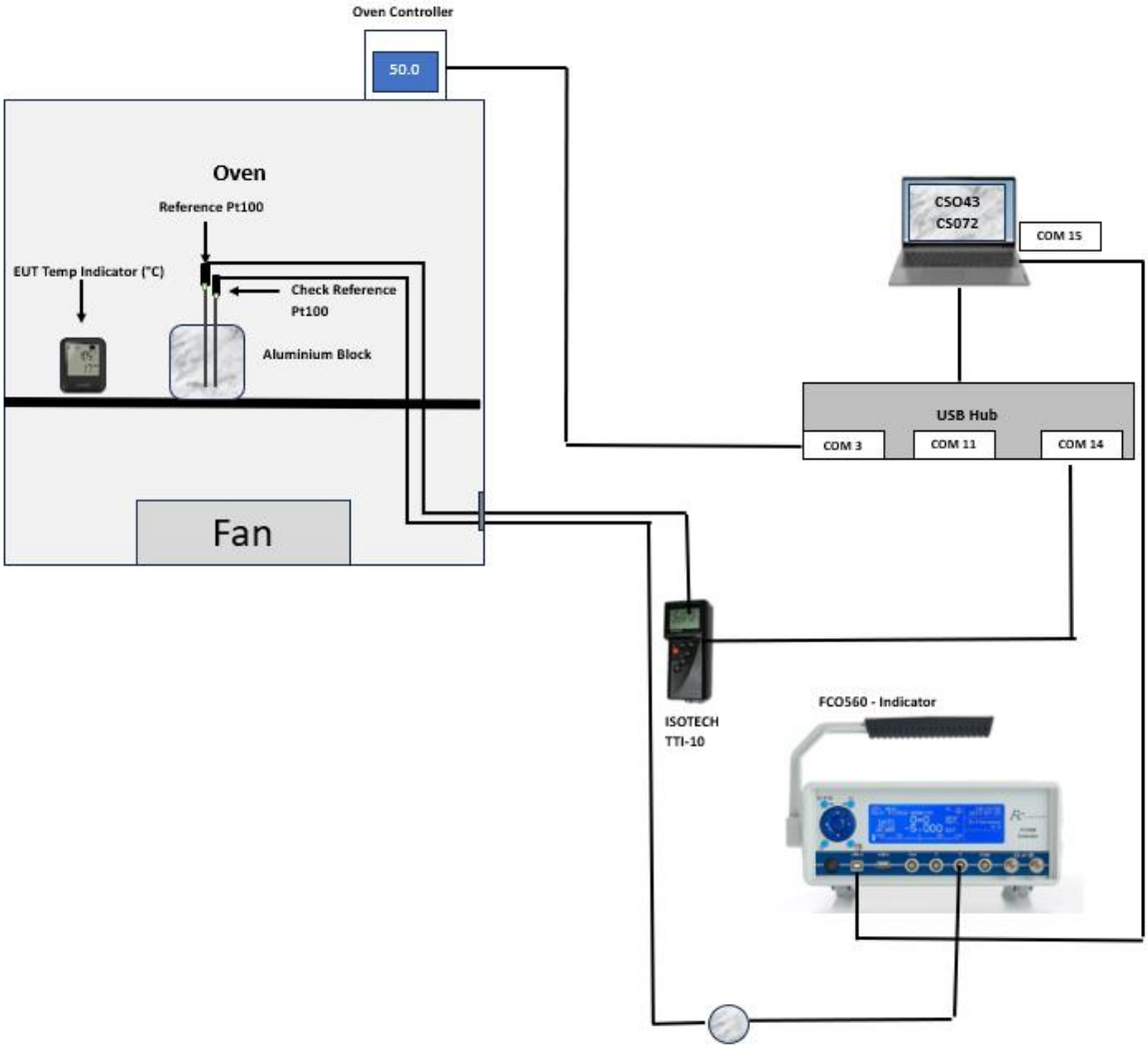
Setup:

- Connect RS80 PRT Reference probe via USB to the Datahub.
- Connect Check Reference PRT to the FCO560 Pressure Port and connect the **FCO560 via USB** to the laptop.
- On the FCO560, press the centre button to go to Main Menu/Pressure Sources. Select the Check PRT being used (add the PRT being used if this has not already been done so) and set the temperature values @4mA and @20 mA. Navigate to Main Menu/Aux. Signals, and set the Aux.Press to the Check PRT being used.
- Insert the EUT into the aluminium block so that the tip of the probe is at the same depth as the Reference probe. Pass the EUT leads through the oven access hole.

If using an Agilent:

- Connect the Agilent via RS232 to the Datahub
- Connect EUT to the Agilent using EQ951 Adaptor.
- Connect the **Red** and **Green** wires to the 4W Sense/Ratio Ref HI and LO ports. Connect the **Yellow** and **Blue** wires to the Input V HI and LO ports on the Agilent.

10 PRT Temperature Indicators/ Display + Output

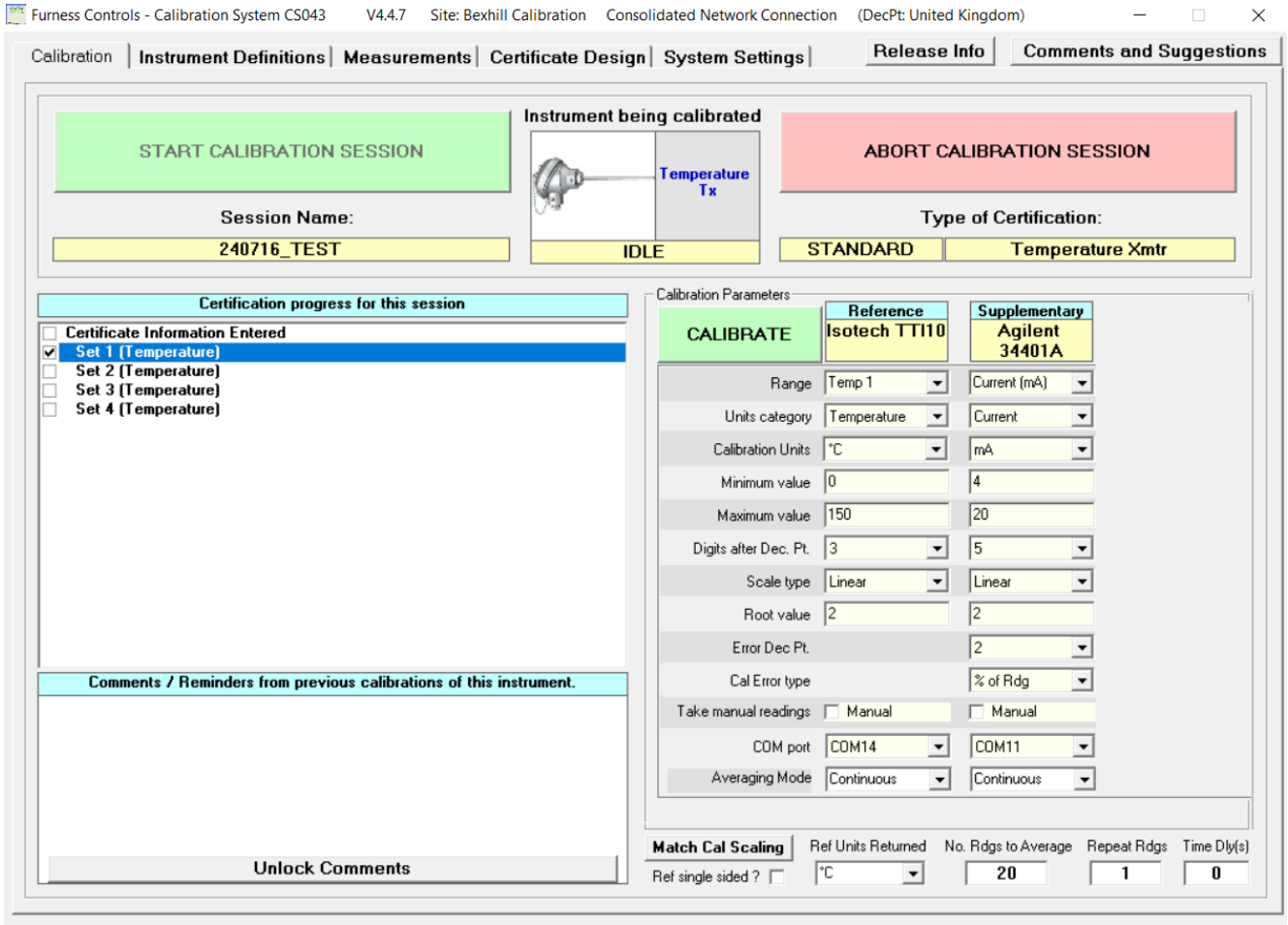


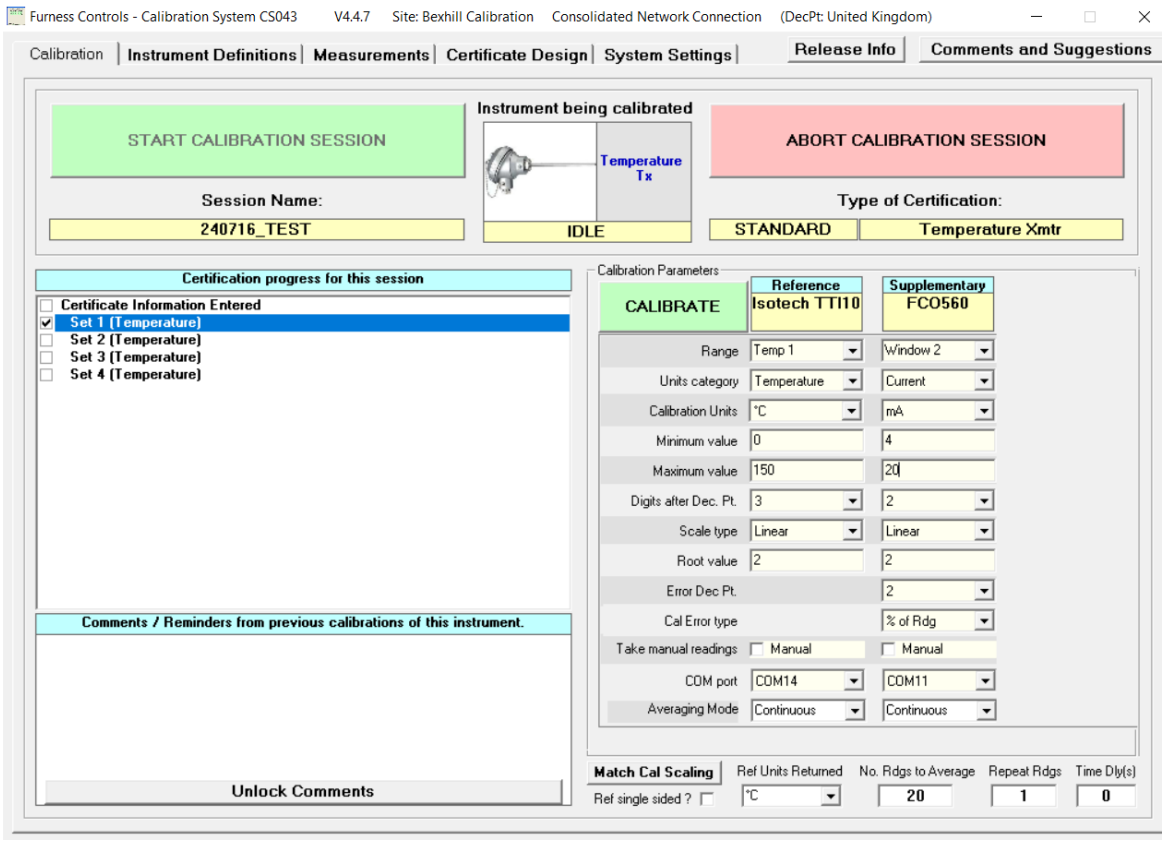
When calibrating temperature indicators, set up the equipment as above. The readings may be logged to a cloud server or have to be taken manually.

11 Measurement using CS072 and CS043

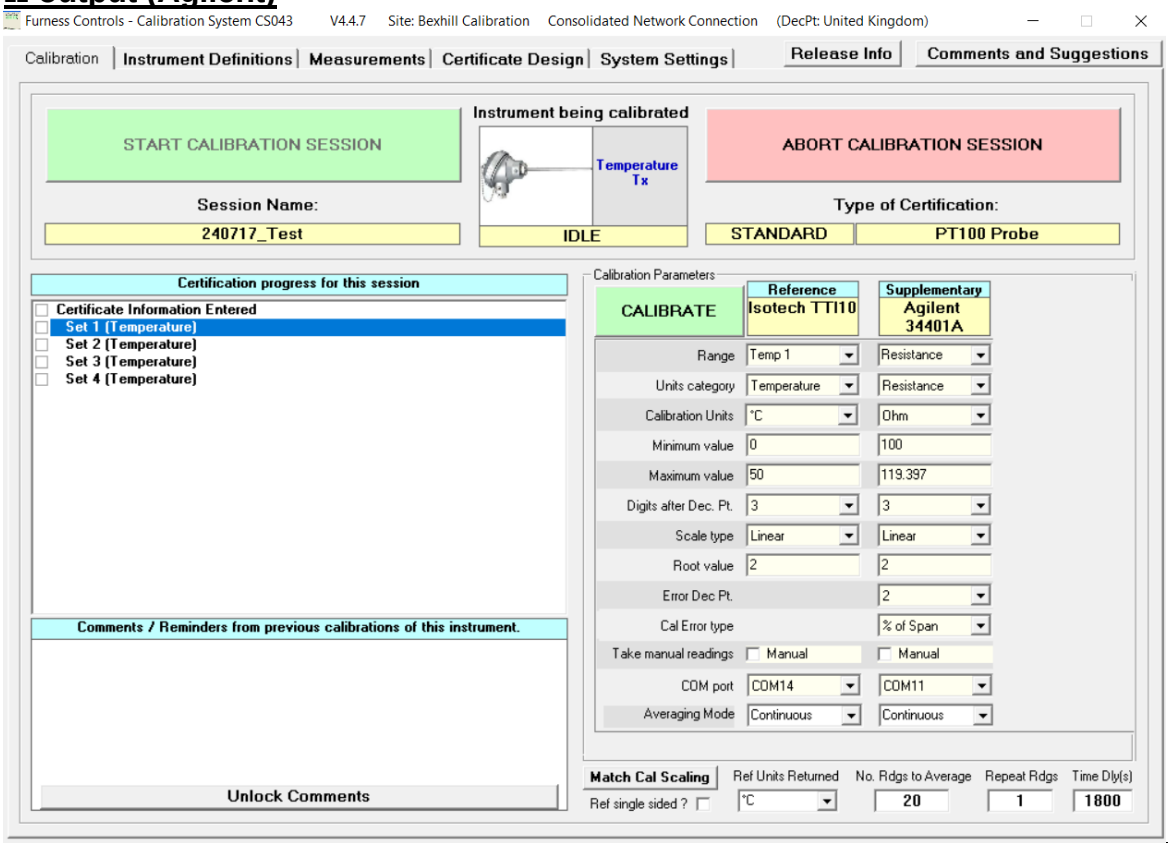
To begin the temperature calibration run, open CS043, fill in the serial number and use the settings below based on the setup used (**Note adjust the temperature min and max value based on the temperature range of the EUT)**:

mA ouput (Agilent or FCO560):

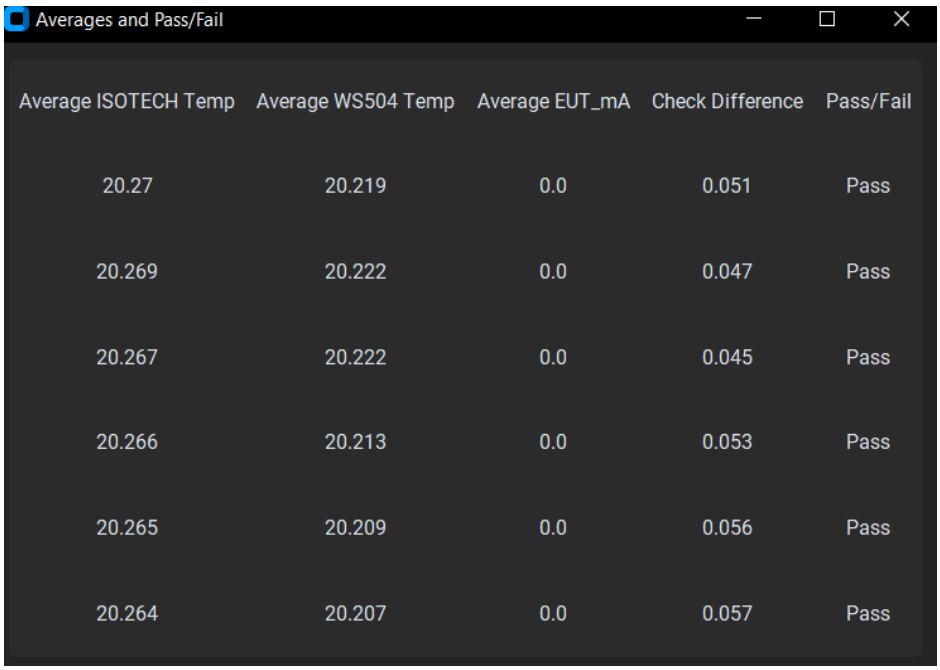




Ω output (Agilent)



- Select ‘Calibrate’ and ensure that the “Take Readings” button window is open.
- Open CS072 using the shortcut on the Desktop.
- Select the save location and name the CSV file as **yymmdd_serialno** and run the program. Choose the relevant setup and temperature profile.
- Click Run on CS072 and allow the program to cycle through all the temperatures. At the end of the run, the window below will appear:



- Ensure that all Check Differences have passed (the difference is calculated as Ref Temp – Check Ref Temp, which must be less than or equal to 0.1°C).
- Notify the cal lab manager if this is not the case.
- Generate the Excel Label.

If PRT + Xtmtr(mA):

- Opens CPS226. Go to the “Bestfit and Label” sheet, remove any hysteresis readings and type the output @4 and 20 mA into the next results sheet on CS043. Copy the results to this sheet.

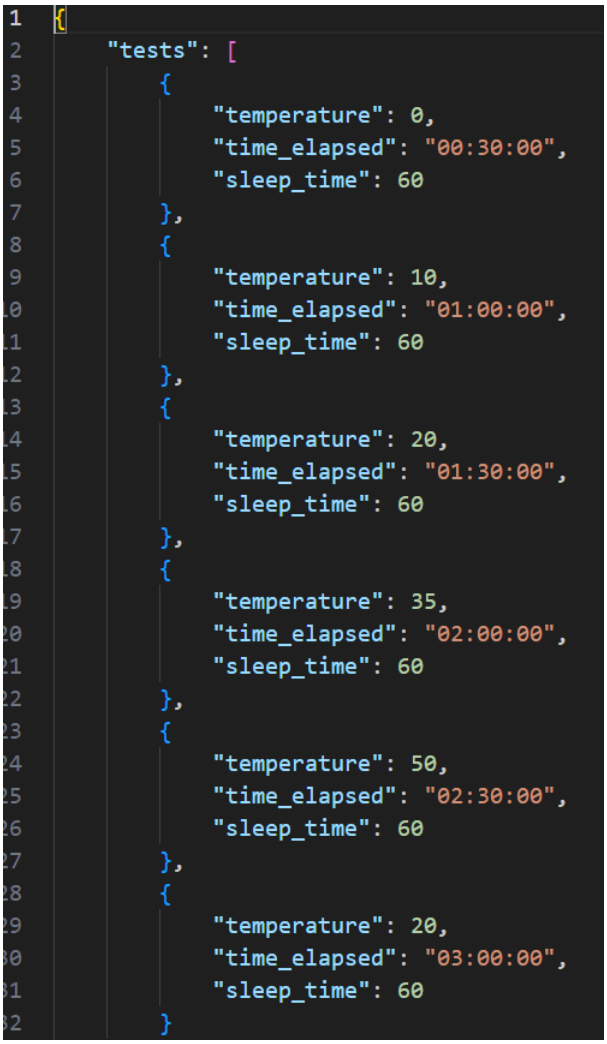
If PRT (Ω):

- Opens CPS224. Type the new R0 value into the next results sheet on CS043. Copy the results to this sheet.

12 Uncertainties
13 Appendix

13.1 Setting Temperatures and Time Intervals

The temperature values, interval times and delay times are taken from a .json file. Below is an example for the Block calibrator:



```
{
    "tests": [
        {
            "temperature": 0,
            "time_elapsed": "00:30:00",
            "sleep_time": 60
        },
        {
            "temperature": 10,
            "time_elapsed": "01:00:00",
            "sleep_time": 60
        },
        {
            "temperature": 20,
            "time_elapsed": "01:30:00",
            "sleep_time": 60
        },
        {
            "temperature": 35,
            "time_elapsed": "02:00:00",
            "sleep_time": 60
        },
        {
            "temperature": 50,
            "time_elapsed": "02:30:00",
            "sleep_time": 60
        },
        {
            "temperature": 20,
            "time_elapsed": "03:00:00",
            "sleep_time": 60
        }
```

Figure 5 Example of a Block Calibrator .json file

If using the Block Calibrator only 0°C, 10°C, 20°C, 35°C and 50°C can be set currently. However if using the Oven, any temperature value can be set.
N.B. Block Calibrator- If other temperatures are required, the relevant commands will need to be added to the code base.

If using the Oven, the permissible temperature range is **5-50°C.**

13.2 Block Calibrator Temperature Commands

All Venus Block Calibrator commands are stored in X:\Production Eng\TEST EQUIPMENT\CS - Inhouse Company Software\CS072 - Temperature Calibration\Block Calibrator Commands

AMENDMENT RECORD

Issue No	Date		Issued by
01	2024-07-17	First issue	R.Dabawala

DISTRIBUTION LIST

Head of Calibration
Service Manager
Service Manager
Service Manager

13.3 Adjusting Comports in Script

```
'serial_ports": {
    "1": {
        "port": "COM3",
        "baudrate": 9600
    },
    "2": {
        "port": "COM4",
        "baudrate": 9600
    },
    "3": {
        "port": "COM15",
        "baudrate": 9600
    },
    "7": {
        "port": "COM11",
        "baudrate": 9600
    },
    "14": {
        "port": "COM14",
        "baudrate": 2400
    }
```

In case comports need to be adjusted, open the .json file to be used and type in the relevant comport name in the same format as above.

```
38          WS504_T = fur_send_enquiry(3, 'Temp', '01L002')
39          print(WS504_T)
40
41          EUT_mA = agilent_send_enquiry()
42          if response is None:
```

If any device number needs to be changed, change the “key” number associated with the “port” and “baudrate” dictionary.

```
"14": {
    "port": "COM14",
    "baudrate": 2400
```