CC-1

Calibration Checker

User Manual

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Before You Start

NOTE	Contains important information for the user
⚠	Identifies conditions that may cause damage to the instrument or large errors in measurement
	Identifies conditions which may cause damage to the user
Software Version	V-2

NOTE

This user manual contains important operating and safety information. The user must carefully read and understand the contents of this manual prior to the use of this equipment. The user manual cannot cover all possible cases of installation, operation and maintenance.

Introduction

The SYSCON Sensors CC-1 calibration checker provides instant validation of calibration for handheld digital pyrometers, wall mounted digital pyrometers and metallurgical analyzers. The device can be configured and calibrated for two sets of temperatures depending on which temperature scale (Celsius or Fahrenheit) the user needs. Temperatures for each of these modes are listed in Table 3.

- Validation is provided for instruments that use S and K type thermocouples to measure temperature in either Celsius or Fahrenheit mode.
- Instrument has an accuracy of ±1° F
- Provides output that corresponds to three standard temperature points for S/K type thermocouples
- Provides a mock cooling curve for metallurgical analyzer type instruments.
- Long battery life with over 125 hours of runtime on full charge.
  (Approximates to over 1000 runs of the device)
- Automatic shutoff after 300 seconds (5 minutes) for low power consumption
- Smart charging circuit with overload/temperature protection
- Designed for use with type S or K thermocouple for IPTS 48, 68 and 90 calibration tables
- Rugged dust-proof IP 65 box for foundry and steel mill environments

Specifications

Measurement Input	Single Thermocouple Input (S, R, B, or K)
Instrument Accuracy	±1° F
Operating Temperature	32˚F -140 (0°C -60˚C)
Storage Temperature	0˚F -180˚F (-17°C -85˚C)
Battery	3.7 V 2500mAh, Lithium-Ion Polymer battery
Battery Life	125 hours on full charge
Battery Charger	100 - 240 V 60 Hz AC Input 5 V 1A DC Output
Housing	IP 65 rated instrument box
Ambient Humidity	0 to 90% non-condensing

Application

The CC-1 Calibration Checker is used to validate the calibration of handheld digital pyrometers, wall mounted pyrometers and metallurgical analyzers that use S or K type thermocouples. The CC-1 outputs a compensated voltage that corresponds to standard temperatures for S and K type thermocouples. There is a provision to output a curve that approximates a real cooling curve which can be used with metallurgical analyzer type instruments. The insulation integrity on the lances for handheld and wall mounted instruments can also be checked by using this device. The instrument can be configured and calibrated to specific set of temperatures listed in Table 3.

The color codes and operating temperature limits (ANSI 96.1 Standard) for types S, and K are listed in Table 1. The temperature limits are for the thermocouple wire diameter of 24-gauge wire for type S and 8-gauge for type K.

Table 1: Thermocouple comparison (types S and K)[1].

Thermocouple Type	**Common Name**	**Alloy Type** $\frac{Positive\ end}{Negative\ end}$	**Plug and Jack color**	**Wire color** $\frac{Positive\ end}{Negative\ end}$	**Maximum Temp °F (°C)**	**Recommended Operating Temperature °F (°C)**
S	**10%**	**Platinum Rhodium – 10%**	**Green**	**Black**	3214 (1600)	2640 (1450)
		Platinum		**Red**		
K	**Chromel - Alumel**	**Nickel - Chromium**	**Yellow**	**Yellow**	2460 (1350)	2300 (1260)

[1] Preston-Thomas, H. "The International Temperature Scale of 1990 (ITS-90)." Metrologia 27.1 (1990): 3

Setup

The CC-1 is easy to use and includes to following parts and accessories:

- Calibration Checker test instrument

  The Calibration Checker's front panel includes a set of buttons and LEDs that show the test device's state. It has a multi-plug socket that can be used to connect the CC-1 to the instrument to be tested. The front panel in Figure 1 corresponds to a device that is configured for temperatures corresponding to Fahrenheit scale Table 3, shows temperatures applicable for each mode.

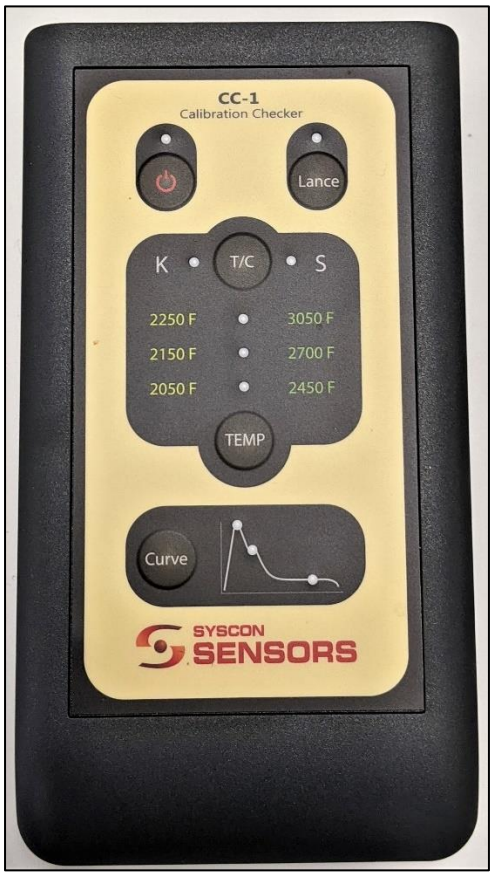


Figure 1: CC-1 Calibration Checker

- Micro-USB charger

  A micro-USB charger is provided to charge the instrument. The charging circuit on the PCB is set to charge the battery at 500 mA max current. This makes the instrument safe to be charged via a PC/laptop. Since the battery is 2500 mAH, it takes 2.5 hours to charge the battery fully. The instrument can be used while being charged. The charger provided is rated at 5V and 1A.

- Cables to connect to the instruments of S/K type

  The following sets of cables are provided with the instrument. The green color cables are to be used for instruments that use S-type thermocouples and the yellow color cable is to be used with instruments that use K-type thermocouples.

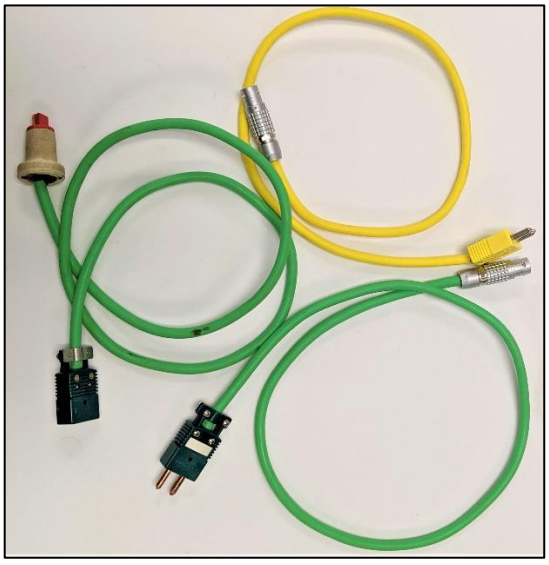


Figure 2: S- and K-type connector cables

- Case for instrument and cable

A hard-shell case is provided for conveniently storing the Calibration Checker, test leads, and micro-USB charger.

Instrument operation

Operating Controls and Indicators

Figure 3 and Figure 4 show the configurations available for the device. Table 2 shows and explains the various LED and buttons on the instrument panel.

Figure 3: Instrument Panel and LEDs for Fahrenheit mode

Figure 4: Instrument Panel and LEDs for Celsius mode

Table 2: Button and LED description

Button	Button Function	LED Color	Description
Power	Switches the device on/off	Green	Unit is powered on
		Yellow	Charger is connected and the battery is charging
Lance	Checks the insulation in the lance assembly	Green	Lance connected has good insulation
		Red	Lance connected has a shorted insulation.
T/C	Selects the thermocouple output mode	Green	S type thermocouple output is selected
		Yellow	K type thermocouple output is selected
TEMP	Selects temperature	Green	When S type thermocouple output is selected, the LED indicates the calibration temperature value on the left
		Yellow	When K type thermocouple output is selected, the LED indicates the calibration temperature value on the right
Curve	Starts a cooling curve for K type thermocouple	Yellow	When in curve mode, the LED indicates the status of the cooling curve

Table 3: Instrument configurations available

Instrument Mode	Thermocouple type	Temperature 1	Temperature 2	Temperature 3
Fahrenheit	S Type	3050 °F	2700 °F	2450 °F
	K Type	2250 °F	2150 °F	2050 °F
Celsius	S Type	1300 °C	1500 °C	1700 °C
	K Type	1100 °C	1200 °C	1300 °C

Instrument startup cycle

Pressing the **POWER** button turns the CC-1 ON, and a green LED is lit on top of the power button to indicate that the instrument is switched on. The instrument then shows the calibration standard [IPTS 48, 68, 90], which can be different for S type vs K type. The following figures Figure 5, Figure 6 and Figure 7 show how the calibration settings are indicated at the startup cycle. The LEDs on the curve graphic indicate which ITPS calibration setting is configured for each thermocouple type. These settings can be changed by the user (refer to settings mode). Each of the settings are shown for 2 seconds.

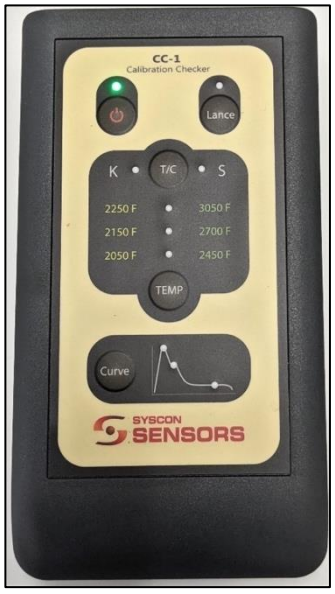


Figure 5: Instrument power on

Figure 6: S-type IPTS calibration settings (S-68)

Figure 7: K-type IPTS calibration settings (K-68)

All the green LEDs are displayed after this to show that the device is configured for Celsius mode Figure 9. All the yellow LEDs are displayed instead if the device is configured for Fahrenheit mode Figure 8. After the settings are shown, the instrument moves to an idle state.

Figure 8: Startup showing device is in Fahrenheit mode

Figure 9: Startup showing device is in Celsius mode

Pressing the power button once again will power down the instrument.

Idle mode

After instrument startup or when an operation is completed, the CC-1 moves to Idle mode. In this mode, the T/C type LED shows the thermocouple selected and shorts the output of the CC-1. Refer to Figure 10 which shows the instrument in idle mode with an S-type thermocouple output selected. Shorting the output of the CC-1 will cause the instrument being tested [TS-1, WM-1 or FL-1] to move to a ready status.

Figure 10: Instrument in Idle mode

T/C mode

Pressing T/C button switches the CC-1's output between S- and K-type thermocouple. Pressing this button will stop the current action being performed by the unit and shorts the output of the CC-1. This will cause handheld and wall mounted instruments to go to ready status.

Temperature mode

The operation in this mode differs based on what thermocouple was selected. Each of the operations is explained in the following sections.

S-Type:

When the S-type thermocouple output is selected using the **T/C** button and then the **TEMP** button is pressed, the instrument goes into S Temperature mode. This mode is used to validate the temperature calibration of handheld and wall mounted pyrometers. For analyzer type instruments, this mode can validate the **bath temperature** on the corresponding channel.

When the TEMP button is pressed, the instrument cycles through the three temperatures for S-type starting at 3050°F (1700°C) followed by 2700°F (1500°C) followed by 2450°F (1300°C) if the device is configured for Fahrenheit mode (Celsius mode). Green LEDs are shown next to the current temperature. Each of the temperature is held for 7 seconds which gives enough time for the test instruments [TS-1, WM-1, FL-1] to go from **READY** to **MEASURE** and **COMPLETE**. Between each temperature, the output is shorted for 2.5 seconds to simulate a new measurement on the test instruments. After 2450°F (1300°C) is output, the instrument goes back to the idle state.

If a specific temperature is desired, the **TEMP** button can be pressed to browse to that temperature in S mode. Refer to Figure 11 for one of the S-type temperature checks.

The results seen for these measurements on the TS-1/WM-1 or FL-1 should be logged in the "As Found Reading" column on the calibration verification sheet. An example for a TS-1/WM-1 is provided in Figure 23. For the FL-1, the data should be logged for the channels that are marked as S-type. A sample calibration verification sheet is provided in Figure 24.

Figure 11: S-type temperature check

K-Type:

When K-type thermocouple output is selected using the **T/C** button and then the **TEMP** button is pressed, the instrument goes into K Temperature mode. This mode outputs a step curve corresponding to the three K-type temperatures. This mode can be used to validate the analyzer type instruments.

When the **TEMP** button is pressed, the instrument starts a step curve starting at 2250°F followed by 2150°F followed by 2050°F. In-between these temperatures, CC-1 output will **NOT** be shorted. The length of time these outputs are held is not the same. Refer to Figure 12 for a sample of the square curve.

Pressing the **TEMP** button will not cycle through the temperature in K mode.

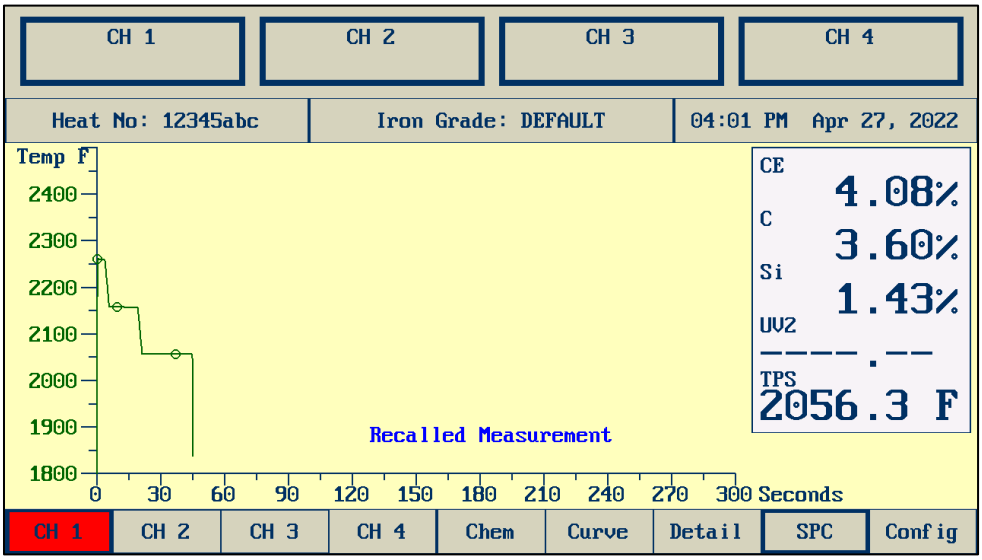


Figure 12: K-type temperature check on an FL-1.

The user should run the tests on all the channels marked as K-type on the FL-1 and should log the data in the "As Found Reading" column on the calibration verification sheet. An example is provided in Figure 24.

Lance Check

This mode is activated by pressing the **Lance** button.

Lance mode is used to check if the insulation resistance is greater than 1MΩ, which indicates that the lance wiring and contact block is functioning correctly. When the insulation resistance is greater than 1MΩ, the green LED on the Lance button is lit. If the insulation resistance is lower than 1MΩ, the red LED is on the Lance button [Figure 13]. This is indicative that the wiring in the lance/contact block has failed.

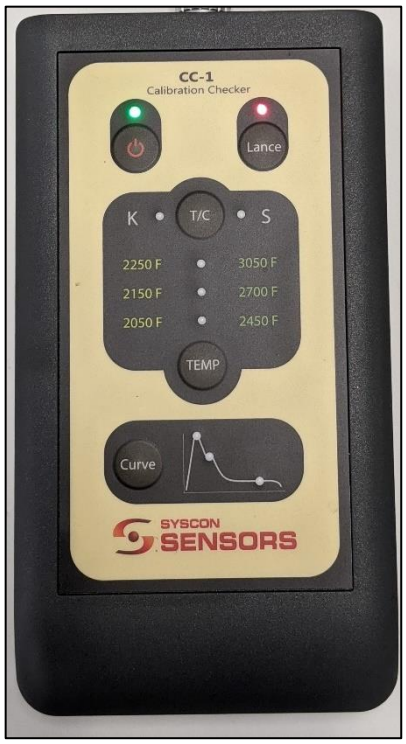


Figure 13: Lance check when insulation is less than 1MΩ

Curve mode

When the **Curve** button is pressed, a cooling curve [Figure 14] that is simulated to a real cooling curve is output from the CC-1. Pressing the **Curve** button automatically sets the T/C output to K-type, and the simulated curve is run for approximately 300 seconds. To make sure that the whole curve is plotted correctly, check the max runtime for the curve on the FL-1 or other analyzer instrument.

Initially the three LEDs on the curve graphic are switched on as the CC-1 simulates a cup removal [Figure 15]. When all the three LED's switch off, the device simulates a new cup and the FL-1 should move to ready status. The CC-1 then starts outputting the cooling curve simulation. The three LEDs on the graphic are indicative of three temperature points of interest from the cooling curve. They are TPK (Peak Temperature), TPL (Liquidous Temperature) and TEU (Eutectic Temperature). When each of these points are reached, the corresponding LED will light up.

To interrupt a run and simulate a cup removal, press the **Lance** button. When the instrument is in curve mode and is plotting a cooling curve, pressing the **Lance** button will stop plotting the curve and simulate a cup removal. The three LEDs on the curve graphic will light up to show this. The CC-1 instrument will then move to idle mode. The Lance LEDs will not light up for this operation.

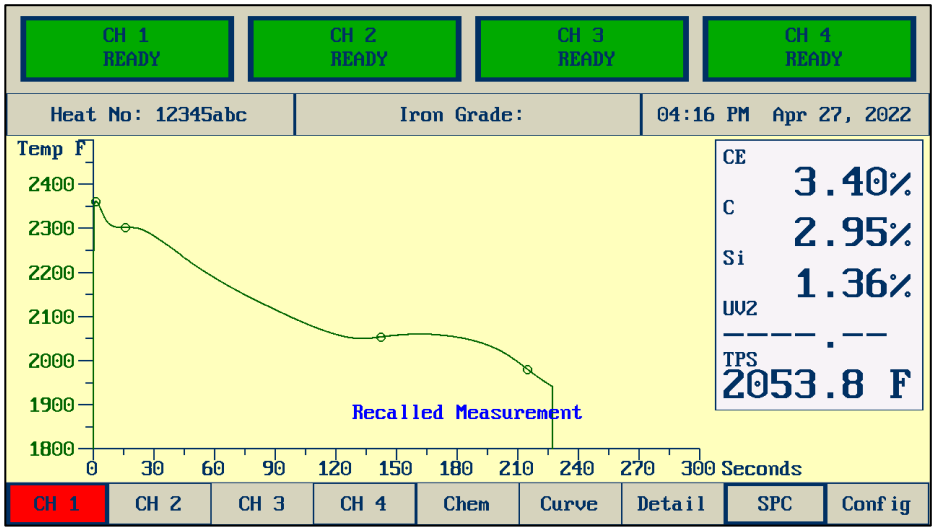


Figure 14: Sample cooling curve plotted on an FL-1

Figure 15: CC-1 panel showing the progression of the cooling curve test

Settings mode

This mode is used to change the IPTS settings for S- and K-type. Pressing the **TEMP** and **Curve** buttons at the same time will put the device in this mode Figure 16. Pressing the **T/C** button allows the user to move between S- and K-type thermocouples. Pressing the **TEMP** button cycles thru the three calibration standards [IPTS 48, 68, 90]. **Lance** and **Curve** button are inactive in this mode. The instrument can be powered off or will automatically switch off after 1 minute. When the unit is powered back on, the new settings should be displayed in the startup sequence.

Figure 16: CC-1 in Settings mode (K-90)

Figure 17: CC-1 in Settings mode (S-68)

Figure 18: CC-1 in Settings mode (K-48)

Calibration Mode

This mode is used in the factory to calibrate the CC-1. If the user goes into this mode, it does not affect the CC-1's calibration. Pressing the **T/C** and **TEMP** buttons will put the device in this mode [Figure 19]. All buttons except **POWER** button are inactive in this mode and the device will go to idle mode after 5 minutes. **If activated inadvertently, the user should power cycle the instrument to exit this mode.**

Figure 19: LEDs on the panel showing the device is in calibration mode

Technical Circuit Information

CC-1 consists of the following major components plus miscellaneous support components:

- **USB AC Battery Charger**

  This battery charger circuit charges the LiPO battery at 500mA. The current draw is hard limited to ensure that the device can be safely charged using a PC. This chip also enables switching between power supply and battery if CC-1 needs to be used while charging. The yellow LED on the power button is lit to show that the device is charging. When charging is complete the LED will switch off.

- **Precision Digital to Analog converter**

  This precision DAC will convert code to precise voltage up to 1 LSB. This device is used in such a way to achieve accuracies of up to 2uV.

- **Microcontroller**

  The microcontroller interfaces with the buttons, LEDs and the DAC to perform all desired user actions.

- **Precision internal temperature sensor**

  This device helps the microcontroller to perform cold-end compensation so that the DAC can output a compensated voltage.

- **Resistance check circuitry**

  A couple of comparators and a Wheatstone bridge help verify if the Insulation resistance is more than 1MΩ.

Instrument Returns

The CC-1 Calibration Checker must itself be returned to the factory once per year so that its own calibration can be set and verified. Upon annual calibration of the CC-1, a new NIST referenced calibration certificate will be issued (see Figure 20 thru Figure 21) for the Calibration Checker itself, allowing it to be used for the subsequent 12 months to issue valid calibration certificates for field instruments.

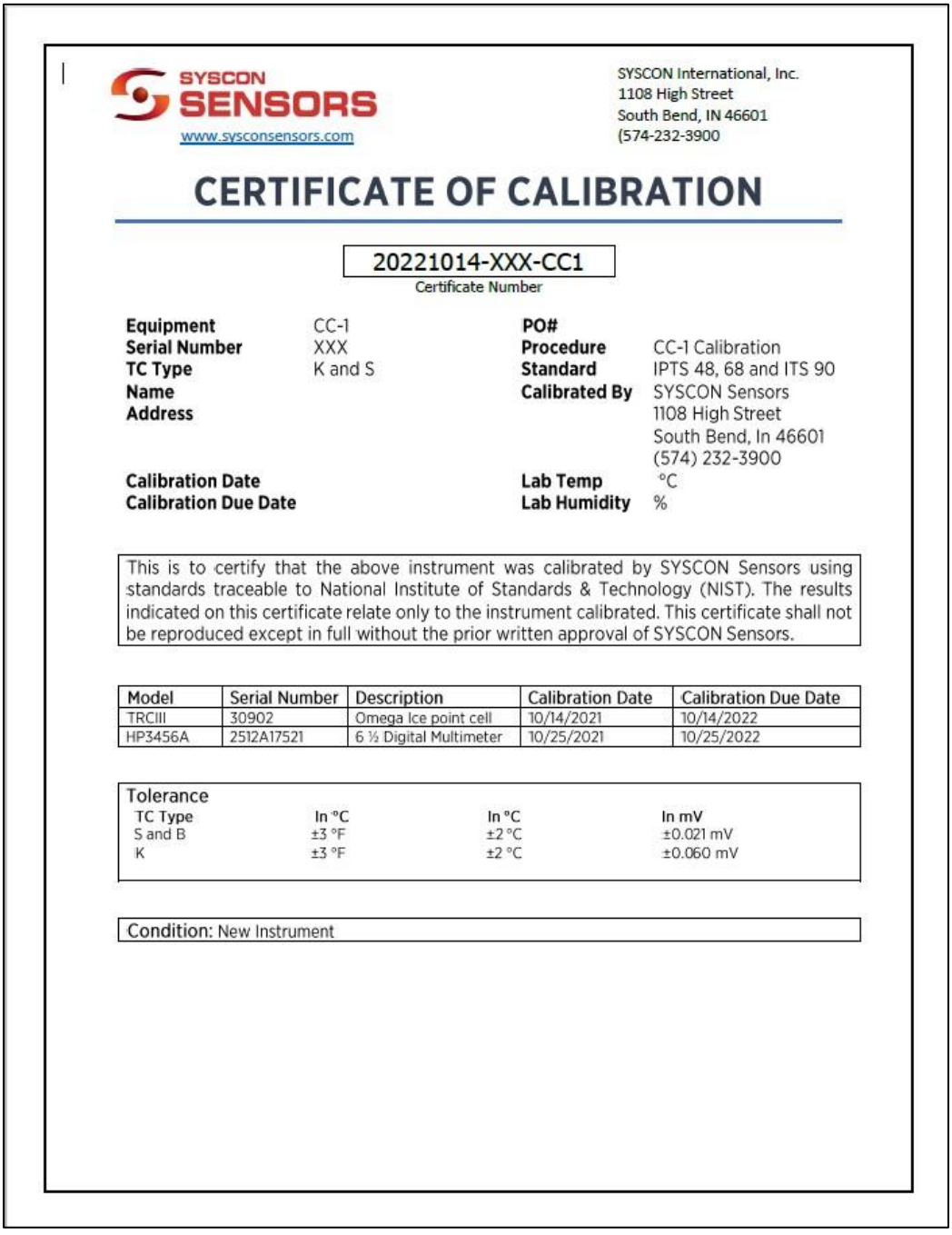
To return your CC-1 for calibration service, fill out the calibration service form at

https://www.syscon-intl.com/sensors/instrument-repair

Pack your CC-1 securely in its protective case and send it back to the address provided within the RMA process for prompt, courteous service

Calibration Certificate

A sample Calibration Certificate followed by report of calibration in both Celsius and Fahrenheit mode are shown through Figure 20 to Figure 22.



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CERTIFICATE OF CALIBRATION

20221014-XXX-CC1
Certificate Number

Equipment	CC-1	**PO#**	
Serial Number	XXX	**Procedure**	CC-1 Calibration
TC Type	K and S	**Standard**	IPTS 48, 68 and ITS 90
Name		**Calibrated By**	SYSCON Sensors
Address			1108 High Street South Bend, In 46601 (574) 232-3900
Calibration Date		**Lab Temp**	°C
Calibration Due Date		**Lab Humidity**	%

This is to certify that the above instrument was calibrated by SYSCON Sensors using standards traceable to National Institute of Standards & Technology (NIST). The results indicated on this certificate relate only to the instrument calibrated. This certificate shall not be reproduced except in full without the prior written approval of SYSCON Sensors.

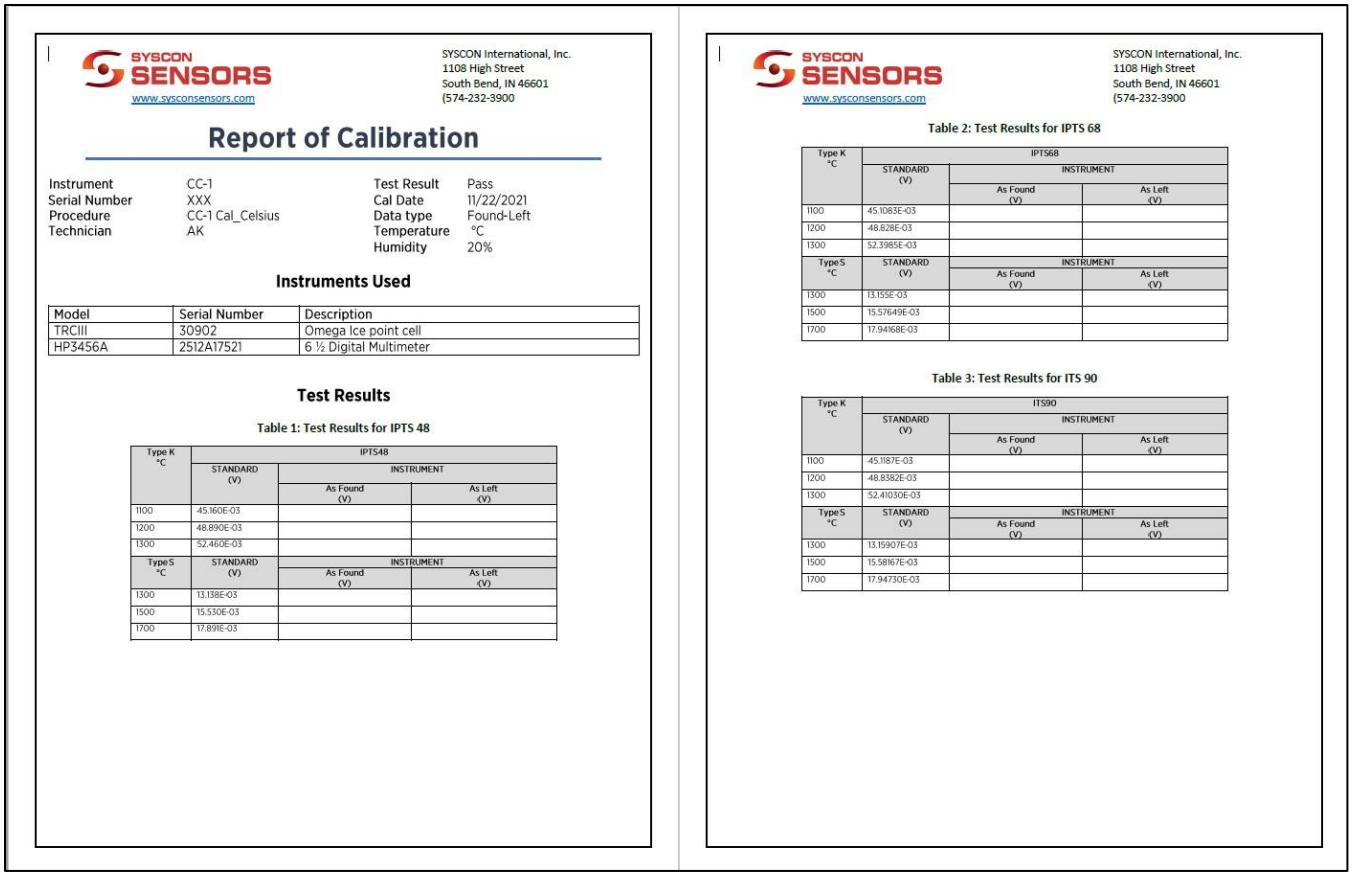
Model	Serial Number	Description	Calibration Date	Calibration Due Date
TRCIII	30902	Omega Ice point cell	10/14/2021	10/14/2022
HP3456A	2512A17521	6 ½ Digital Multimeter	10/25/2021	10/25/2022

Tolerance

TC Type	In °C	In °C	In mV
S and B	±3 °F	±2 °C	±0.021 mV
K	±3 °F	±2 °C	±0.060 mV

Condition: New Instrument

Figure 20: Certificate of Calibration for CC-1



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Report of Calibration

Instrument	CC-1	Test Result	Pass
Serial Number	XXX	Cal Date	11/22/2021
Procedure	CC-1 Cal_Celsius	Data type	Found-Left
Technician	AK	Temperature	°C
		Humidity	20%

Instruments Used

Model	Serial Number	Description
TRCIII	30902	Omega Ice point cell
HP3456A	2512A17521	6 ½ Digital Multimeter

Test Results

Table 1: Test Results for IPTS 48

Type K °C	IPTS48		
	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
1100	-45.160E-03		
1200	-48.890E-03		
1300	-52.460E-03		
Type S °C	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
1300	13.138E-03		
1500	15.530E-03		
1700	17.891E-03		

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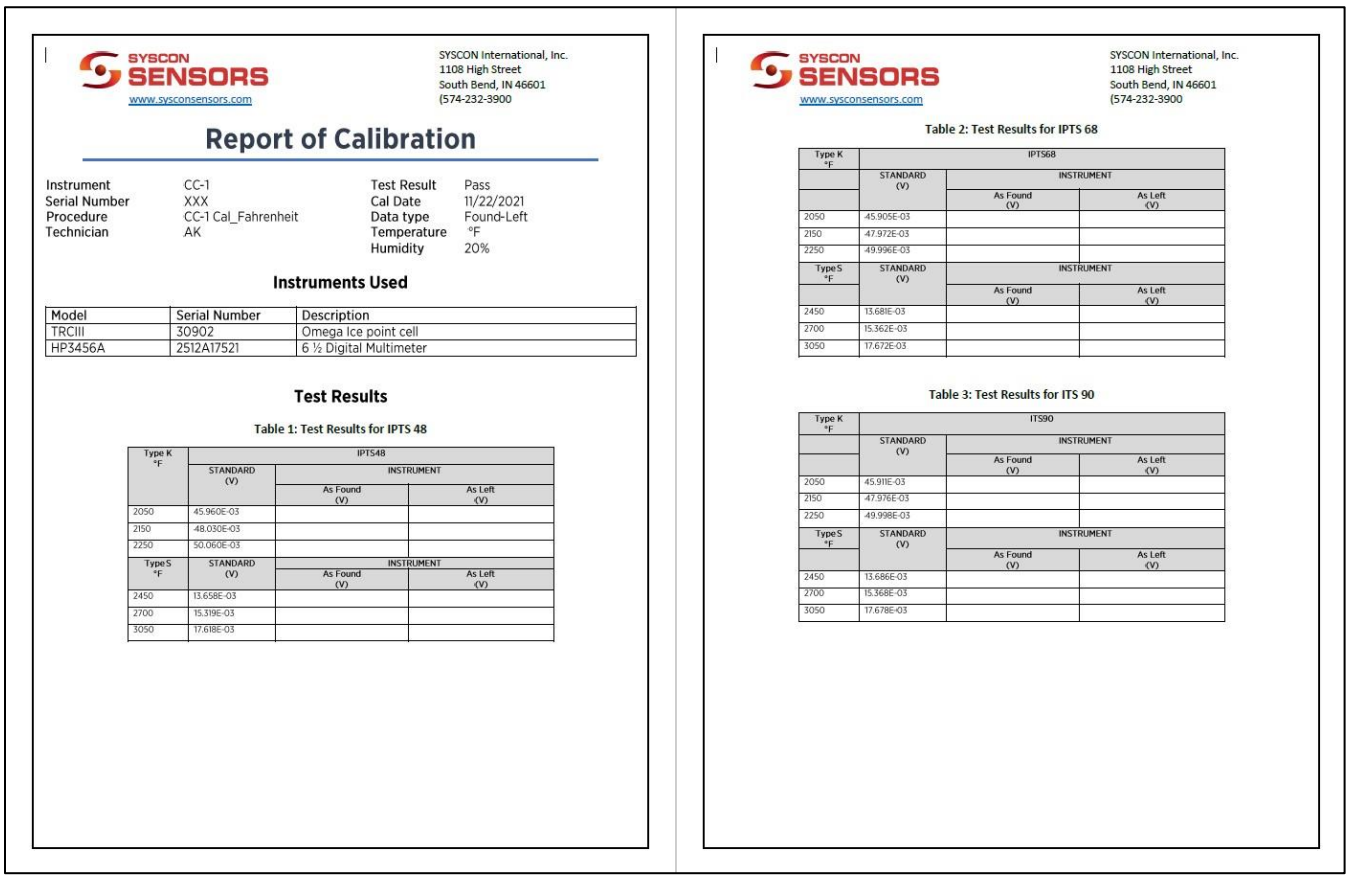
Table 2: Test Results for IPTS 68

Type K °C	IPTS68		
	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
1100	-45.1083E-03		
1200	-48.828E-03		
1300	-52.3985E-03		
Type S °C	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
1300	13.155E-03		
1500	15.57649E-03		
1700	17.94168E-03		

Table 3: Test Results for ITS 90

Type K °C	ITS90		
	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
1100	-45.1187E-03		
1200	-48.8382E-03		
1300	-52.41030E-03		
Type S °C	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
1300	13.15907E-03		
1500	15.58167E-03		
1700	17.94730E-03		

Figure 21: Report of Calibration for Celsius mode



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Report of Calibration

Instrument	CC-1	Test Result	Pass
Serial Number	XXX	Cal Date	11/22/2021
Procedure	CC-1 Cal_Fahrenheit	Data type	Found-Left
Technician	AK	Temperature	°F
		Humidity	20%

Instruments Used

Model	Serial Number	Description
TRCIII	30902	Omega Ice point cell
HP3456A	2512A17521	6 ½ Digital Multimeter

Test Results

Table 1: Test Results for IPTS 48

Type K °F	IPTS48		
	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
2050	45.960E-03		
2150	48.030E-03		
2250	50.060E-03		
Type S °F	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
2450	13.658E-03		
2700	15.319E-03		
3050	17.618E-03		

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Table 2: Test Results for IPTS 68

Type K °F	IPTS68		
	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
2050	45.905E-03		
2150	47.972E-03		
2250	49.996E-03		
Type S °F	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
2450	13.681E-03		
2700	15.362E-03		
3050	17.672E-03		

Table 3: Test Results for ITS 90

Type K °F	ITS90		
	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
2050	45.911E-03		
2150	47.976E-03		
2250	49.998E-03		
Type S °F	STANDARD (V)	INSTRUMENT	
		As Found (V)	As Left (V)
2450	13.686E-03		
2700	15.368E-03		
3050	17.678E-03		

Figure 22: Report of Calibration for Fahrenheit mode

Verification of Calibration

Instructions on performing Verification of Calibration

The following instructions should be used to verify the calibration for the Device Under Test (DUT).

- Check the IPTS settings for the DUT
  - If the DUT is a TS-1/WM-1, the instrument startup will show the settings for example: S-68-F (S-type, IPTS 68, Fahrenheit scale)
  - If the DUT is a FL-1, check the settings for each individual channel by going to Config -> enter password -> chan. TC type and TC Calib rows will show the settings.
- Set the CC-1 to the right IPTS setting [48,68,90] and TC type for the DUT (refer to the section on TC mode, settings mode).
- Connect cables corresponding to the TC type to the CC-1 refer to Figure 2.
- If testing TS-1/WM-1 along with the lance, connect the lance cable to the S-type cable.
- Connect the cables to the DUT and wait for it to go to Ready.
- To start the verification of calibration, move the CC-1 to Temperature mode to start making measurements.
- Using the Verification of Calibration template, make a note of the temperatures read on the DUT and enter them in the Verification of Calibration.
- Print and/or save the completed Verification of Calibration certificate and store it together with your compliance documents.
- If desired, initial and date a calibration check sticker and apply it to your instrument, noting the next calibration check due date.

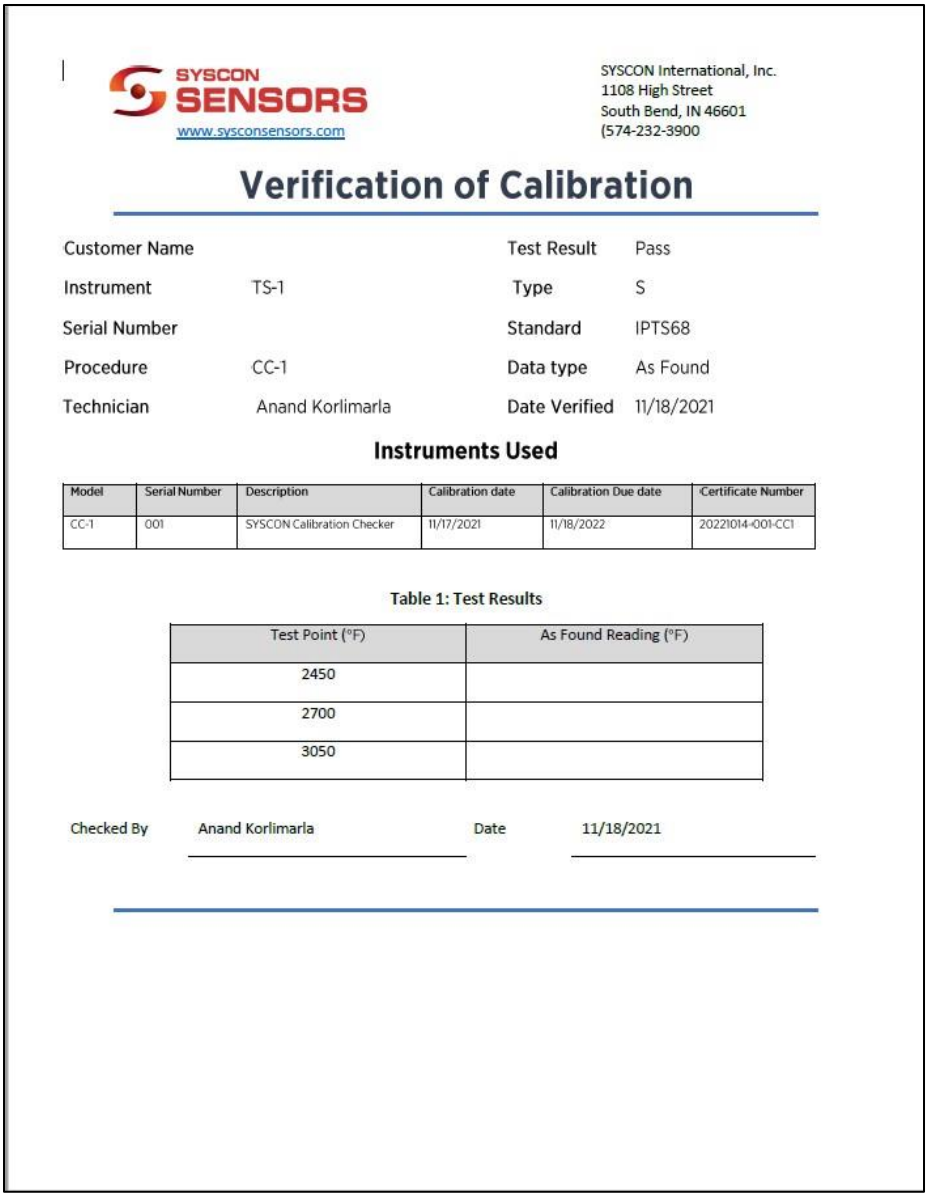
Instructions on using the Verification of Calibration Template

Templates for Verification of Calibration are provided on request to customers. The customers should replace the SYSCON logo with their own and fill in the instrument and other details. As and when a measurement is made using the device, the user should enter those details in the appropriate “As Found Reading”. Figure 23 and Figure 24 show templates for TS-1/WM-1 and the FL-1 instruments.

Details to be filled in the Verification of Calibration:

- Customer Name: Customer’s company name
- Test Result: Pass or Fail depending on the run
- Instrument: DUT’s type (TS-1/WM-1/FL-1)
- Type: TC type
- Serial number: DUT’s serial number

- Technician: Name of technician running the test
- Date Verified: Date when the test is run
- Instrument Used table: Data from the calibration certificate of the CC-1 being used
- Test results table:
    - For TS-1/WM-1 template [Figure 23], results observed on the test run corresponding to the Test point. Data to be entered in the As Found column
    - For the FL-1 template [Figure 24]:
    - For each Channel modify the TC Type and Calibration based on the DUT settings
    - For each Channel, enter the results observed corresponding to the test points.
- Checked By: Sign the technician's name
- Date: Enter the date the test was performed



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Verification of Calibration

Customer Name		Test Result	Pass
Instrument	TS-1	Type	S
Serial Number		Standard	IPTS68
Procedure	CC-1	Data type	As Found
Technician	Anand Korlimarla	Date Verified	11/18/2021

Instruments Used

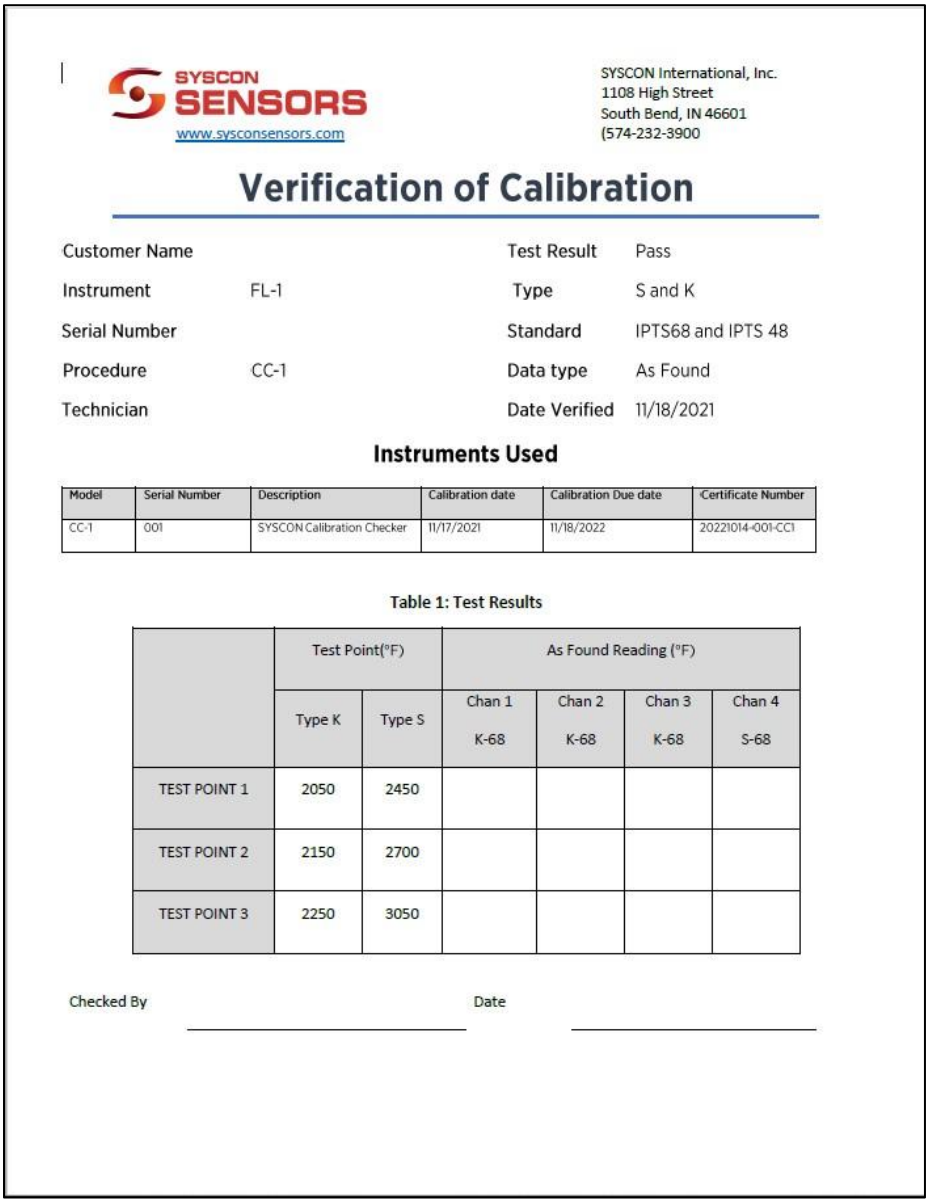
Model	Serial Number	Description	Calibration date	Calibration Due date	Certificate Number
CC-1	001	SYSCON Calibration Checker	11/17/2021	11/18/2022	20221014-001-CC1

Table 1: Test Results

Test Point (°F)	As Found Reading (°F)
2450	
2700	
3050	

Checked By Anand Korlimarla Date 11/18/2021

Figure 23: Verification of Calibration TS-1/WM-1 in Fahrenheit mode



SYSCON SENSORS
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SYSCON International, Inc.
1108 High Street
South Bend, IN 46601
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Verification of Calibration

Customer Name		Test Result	Pass
Instrument	FL-1	Type	S and K
Serial Number		Standard	IPTS68 and IPTS 48
Procedure	CC-1	Data type	As Found
Technician		Date Verified	11/18/2021

Instruments Used

Model	Serial Number	Description	Calibration date	Calibration Due date	Certificate Number
CC-1	001	SYSCON Calibration Checker	11/17/2021	11/18/2022	20221014-001-CC1

Table 1: Test Results

	Test Point(°F)		As Found Reading (°F)			
	Type K	Type S	Chan 1 K-68	Chan 2 K-68	Chan 3 K-68	Chan 4 S-68
TEST POINT 1	2050	2450				
TEST POINT 2	2150	2700				
TEST POINT 3	2250	3050				

Checked By _____ Date _____

Figure 24: Verification of Calibration FL-1 in Fahrenheit mode

Troubleshooting

Preliminary Check

Follow the instrument startup cycle to verify if the instrument is set to the correct mode.

Troubleshooting CC-1

Table 4: Troubleshooting

Issue	Probable Cause	Recommended Action
Unit does not power on	Dead battery	• Charge the unit via the USB port. • If the unit won't power on after that, return instrument for repairs.
DUT will not show ready, CC-1 is in Temperature/Curve mode	Temperature/Curve mode was started early.	• Abort the current CC-1 cycle and return to Idle mode. • Ensure that the correct TC type is selected, and the corresponding cable is being used. • Wait for the DUT to return to a ready state and then move the CC-1 to Temperature/Curve mode.
DUT will not show ready, CC-1 is in ready mode	Broken connector cables	• Short the DUT connector using a jumper • If the DUT goes to ready, the connector cables are broken, return the instrument for repair
DUT shows ready while CC-1 is in Temperature/Curve mode	Wrong TC type was selected	• Abort the current CC-1 cycle and return to Idle mode • Select the correct TC type and move the CC-1 to Temperature/Curve mode