



**PERRY JOHNSON LABORATORY
ACCREDITATION, INC.**

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

TOTAL Calibration Solutions, Inc.

7722 Metric Drive, Mentor, OH 44060

*(Hereinafter called the Organization) and hereby declares that Organization is accredited
in accordance with the recognized International Standard:*

**ISO/IEC 17025:2005
ANSI/NCSL Z540-1-1994**

This accreditation demonstrates technical competence for a defined scope and the
operation of a laboratory quality management system
(as outlined by the joint ISO-ILAC-IAF Communiqué dated January 2009):

***Dimensional, Electrical, Mechanical, Thermodynamic, Time and Frequency,
and Mass, Force and Weighing Device Calibration***
(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Tracy Szerszen
President/Operations Manager

Initial Accreditation Date:

September 4, 2017

Issue Date:

January 1, 2018

Expiration Date:

March 31, 2020

Accreditation No.:

97175

Certificate No.:

L18-7

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

*The validity of this certificate is maintained through ongoing assessments based
on a continuous accreditation cycle. The validity of this certificate should be
confirmed through the PJLA website: www.pjilabs.com*



Certificate of Accreditation: Supplement

Total Calibration Solutions, Inc.

7722 Metric Drive, Mentor, OH, 44060

Contact Name: Mark Hanson Phone: 440-229-4811

Accreditation is granted to the facility to perform the following calibrations:

Dimensional

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Calipers ^{FO}	Up to 40 in	(12L + 150) μ in	Gage Blocks / Surface Plate
Micrometers ^{FO}	Up to 6 in	(9.2L + 21) μ in	
	6 in to 20 in	(16L + 177) μ in	
Indicators, Dial, Test ^{FO}	Up to 4 in	(30L - 5.5) μ in	
Height Gages ^{FO}	Up to 48 in	(10L + 205) μ in	Gage Line Glass Standard
Optical Comparators X and Y Axis Linearity ^{FO}	Up to 12 in	200 μ in	
Optical Comparators Magnification ^{FO}	10 x, 20 x, 31.25 x, 50 x, 62.5 x, 100 x	200 μ in	
Optical Comparators Angle ^{FO}	0°, 5°, 10°, 15°, 20°, 25°, 30°, 45°, 90°	0.10°	Gage Line Glass Standard and Angle Blocks

Electrical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	
Equipment to Measure DC Voltage ^{FO}	Up to 100 mV	1.8 μ V	HP 3458A Opt 002	
	100 mV to 1 V	7 μ V		
	1 V to 10 V	72 μ V		
	10 V to 100 V	1.2 mV		
	100 V to 1 kV	30 mV		
	Equipment to Measure DC Voltage ^{FO}	1 kV to 4 kV	2.2 V	Vitrek 4700
		4 kV to 10 kV	3.9 V	
		10 kV to 30 kV	0.027 kV	Vitrek 4700, Vitrek HVL-100
		30 kV to 50 kV	0.045 kV	
Equipment to Output DC Voltage ^{FO}	50 kV to 100 kV	0.15 kV	Fluke 5522A	
	Up to 330 mV	8.2 μ V		
	330 mV to 3.3 V	41 μ V		
	3.3 V to 33 V	0.45 mV		
	33 V to 330 V	6.5 mV		
Equipment to Measure DC Current ^{FO}	330 V to 1 kV	23 mV	HP 3458A Opt 002	
	Up to 100 μ A	7.4 nA		
	100 μ A to 1 mA	84 nA		
	1 mA to 10 mA	0.71 μ A		
	10 mA to 100 mA	10 μ A		
	100 mA to 1 A	0.16 mA		



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Equipment to Measure DC Current ^{FO}	1 A to 3 A	11 mA	HP 3458A Opt 002, HP 34330A Shunt
	3 A to 11 A	40 mA	
	11 A to 20.5 A	73 mA	
Equipment to Source DC Current ^{FO}	Up to 330 μ A	0.11 μ A	Fluke 5522A
	330 μ A to 3.3 mA	0.56 μ A	
	3.3 mA to 33 mA	9.1 μ A	
	33 mA to 330 mA	87 μ A	
	330 mA to 1.1 A	0.29 mA	
	1.1 A to 3 A	1.3 mA	
	3 A to 11 A	7.1 mA	
	11 A to 20.5 A	25 mA	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			HP 3458A Opt 002
Up to 1 kHz	Up to 10 mV	4.7 μ V	
1 kHz to 20 kHz	Up to 10 mV	9.0 μ V	
20 kHz to 100 kHz	Up to 10 mV	90 μ V	
100 kHz to 300 kHz	Up to 10 mV	0.72 mV	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			
Up to 1 kHz	10 mV to 100 mV	12 μ V	
1 kHz to 20 kHz	10 mV to 100 mV	20 μ V	
20 kHz to 100 kHz	10 mV to 100 mV	0.10 mV	
100 kHz to 300 kHz	10 mV to 100 mV	0.39 mV	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			
Up to 1 kHz	100 mV to 1 V	0.12 mV	
1 kHz to 20 kHz	100 mV to 1 V	0.20 mV	
20 kHz to 50 kHz	100 mV to 1 V	0.39 mV	
50 kHz to 100 kHz	100 mV to 1 V	0.97 mV	
100 kHz to 300 kHz	100 mV to 1 V	3.60 mV	
300 kHz to 500 kHz	100 mV to 1 V	12 mV	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			
Up to 10 Hz	1 V to 10 V	3.8 mV	
10 Hz to 20 Hz	1 V to 10 V	1.4 mV	



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Equipment to Measure AC Voltage At the listed frequencies ^{FO}			HP 3458A Opt 002
20 Hz to 40 Hz	1 V to 10 V	1.2 mV	
40 Hz to 1 kHz	1 V to 10 V	1.2 mV	
1 kHz to 10 kHz	1 V to 10 V	2 mV	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			
10 kHz to 20 kHz	1 V to 10 V	2 mV	
20 kHz to 50 kHz	1 V to 10 V	3.9 mV	
50 kHz to 100 kHz	1 V to 10 V	9.6 mV	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			
Up to 1 kHz	10 V to 100 V	27 mV	
1 kHz to 20 kHz	10 V to 100 V	28 mV	
20 kHz to 50 kHz	10 V to 100 V	45 mV	
50 kHz to 100 kHz	10 V to 100 V	0.15 V	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			
Up to 20 kHz	100 V to 1 kV	0.36 V	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			Vitrek 4700
60 Hz	1 kV to 10 kV	0.021 kV	
60 Hz	10 kV to 75 kV	0.18 kV	Vitrek 4700, Vitrek HVL-100
Equipment to Source AC Voltage At the listed frequencies ^{FO}			Fluke 5522A
10 Hz to 45 Hz	Up to 33 mV	35 μ V	
45 Hz to 10 kHz	Up to 33 mV	12 μ V	
10 kHz to 20 kHz	Up to 33 mV	14 μ V	
20 kHz to 50 kHz	Up to 33 mV	42 μ V	
50 kHz to 100 kHz	Up to 33 mV	0.14 mV	
100 kHz to 500 kHz	Up to 33 mV	0.34 mV	
Equipment to Source AC Voltage At the listed frequencies ^{FO}			
10 Hz to 45 Hz	33 mV to 330 mV	0.12 mV	
45 Hz to 10 kHz	33 mV to 330 mV	60 μ V	
10 kHz to 20 kHz	33 mV to 330 mV	65 μ V	



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Equipment to Source AC Voltage At the listed frequencies ^{FO}			Fluke 5522A
20 kHz to 50 kHz	33 mV to 330 mV	0.13 mV	
50 kHz to 100 kHz	33 mV to 330 mV	0.32 mV	
Equipment to Source AC Voltage At the listed frequencies ^{FO}			
10 Hz to 45 Hz	330 mV to 3.3 V	11 mV	
45 Hz to 10 kHz	330 mV to 3.3 V	0.59 mV	
10 kHz to 20 kHz	330 mV to 3.3 V	0.73 mV	
20 kHz to 50 kHz	330 mV to 3.3 V	1.1 mV	
50 kHz to 100 kHz	330 mV to 3.3 V	2.9 mV	
100 kHz to 500 kHz	330 mV to 3.3 V	9.1 mV	
Equipment to Source AC Voltage At the listed frequencies ^{FO}			
10 Hz to 45 Hz	3.3 V to 33 V	11 mV	
45 Hz to 10 kHz	3.3 V to 33 V	5.9 mV	
10 kHz to 20 kHz	3.3 V to 33 V	9.1 mV	
20 kHz to 50 kHz	3.3 V to 33 V	13 mV	
50 kHz to 100 kHz	3.3 V to 33 V	33 mV	
Equipment to Source AC Voltage At the listed frequencies ^{FO}			
45 Hz to 1 kHz	33 V to 330 V	69 mV	
1 kHz to 10 kHz	33 V to 330 V	79 mV	
10 kHz to 20 kHz	33 V to 330 V	94 mV	
20 kHz to 50 kHz	33 V to 330 V	0.12 V	
50 kHz to 100 kHz	33 V to 330 V	0.53 V	
Equipment to Source AC Voltage At the listed frequencies ^{FO}			
45 Hz to 1 kHz	330 V to 1.02 kV	0.34 V	
1 kHz to 5 kHz	330 V to 1.02 kV	0.28 V	
5 kHz to 10 kHz	330 V to 1.02 kV	0.33 V	
Equipment to Source AC Current At the Listed frequencies ^{FO}			Fluke 5522A
10 Hz to 20 Hz	29 μ A to 330 μ A	0.82 μ A	
20 Hz to 45 Hz	29 μ A to 330 μ A	0.64 μ A	
45 Hz to 1 kHz	29 μ A to 330 μ A	0.55 μ A	



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Equipment to Source AC Current At the listed frequencies ^{FO}			Fluke 5522A
1 kHz to 5 kHz	29 μ A to 330 μ A	1.2 μ A	
5 kHz to 10 kHz	29 μ A to 330 μ A	3 μ A	
10 kHz to 30 kHz	29 μ A to 330 μ A	6 μ A	
Equipment to Source AC Current At the listed frequencies ^{FO}			
10 Hz to 20 Hz	330 μ A to 3.3 mA	7.6 μ A	
20 Hz to 45 Hz	330 μ A to 3.3 mA	4.8 μ A	
45 Hz to 1 kHz	330 μ A to 3.3 mA	3.9 μ A	
1 kHz to 5 kHz	330 μ A to 3.3 mA	8 μ A	
5 kHz to 10 kHz	330 μ A to 3.3 mA	19 μ A	
10 kHz to 30 kHz	330 μ A to 3.3 mA	38 μ A	
Equipment to Source AC Current At the listed frequencies ^{FO}			
10 Hz to 20 Hz	3.3 mA to 33 mA	66 μ A	
20 Hz to 45 Hz	3.3 mA to 33 mA	34 μ A	
45 Hz to 1 kHz	3.3 mA to 33 mA	17 μ A	
1 kHz to 5 kHz	3.3 mA to 33 mA	32 μ A	
5 kHz to 10 kHz	3.3 mA to 33 mA	74 μ A	
10 kHz to 30 kHz	3.3 mA to 33 mA	0.14 mA	
Equipment to Source AC Current At the listed frequencies ^{FO}			
10 Hz to 20 Hz	33 mA to 330 mA	0.65 mA	
20 Hz to 45 Hz	33 mA to 330 mA	0.34 mA	
45 Hz to 1 kHz	33 mA to 330 mA	0.16 mA	
1 kHz to 5 kHz	33 mA to 330 mA	0.41 mA	
5 kHz to 10 kHz	33 mA to 330 mA	0.81 mA	
10 kHz to 30 kHz	33 mA to 330 mA	1.6 mA	
Equipment to Source AC Current At the listed frequencies ^{FO}			
10 Hz to 45 Hz	330 mA to 1.1 A	2.2 mA	
45 Hz to 1 kHz	330 mA to 1.1 A	0.71 mA	
1 kHz to 5 kHz	330 mA to 1.1 A	8.1 mA	
5 kHz to 10 kHz	330 mA to 1.1 A	35 mA	



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Equipment to Source AC Current At the listed frequencies ^{FO}			Fluke 5522A	
10 Hz to 45 Hz	1.1 A to 3 A	6.2 mA		
45 Hz to 1 kHz	1.1 A to 3 A	2.2 mA		
1 kHz to 5 kHz	1.1 A to 3 A	21 mA		
Equipment to Source AC Current At the listed frequencies ^{FO}				
45 Hz to 100 Hz	3 A to 11 A	10 mA		
100 Hz to 1 kHz	3 A to 11 A	15 mA		
1 kHz to 5 kHz	3 A to 11 A	0.38 A		
Equipment to Source AC Current At the listed frequencies ^{FO}				
45 Hz to 100 Hz	11 A to 20.5 A	34 mA		
100 Hz to 1 kHz	11 A to 20.5 A	41 mA		
1 kHz to 5 kHz	11 A to 20.5 A	0.70 A		
Equipment to Measure AC Current At the listed frequencies ^{FO}				HP 3458A Opt 002
10 Hz to 5 kHz	Up to 100 μ A	0.11 μ A		
Equipment to Measure AC Current At the listed frequencies ^{FO}				
10 Hz to 5 kHz	100 μ A to 1 mA	0.6 μ A		
Equipment to Measure AC Current At the listed frequencies ^{FO}				
10 Hz to 5 kHz	1 mA to 10 mA	6.1 μ A		
Equipment to Measure AC Current At the listed frequencies ^{FO}				
10 Hz to 5 kHz	10 mA to 100 mA	61 μ A		
Equipment to Measure AC Current At the listed frequencies ^{FO}				
10 Hz to 5 kHz	100 mA to 1.1 A	1.4 mA		
Equipment to Measure AC Current At the listed frequencies ^{FO}			HP 3458A Opt 002 with HP 34330A Shunt	
10 Hz to 40 Hz	1.1 A to 3.3 A	13 mA		
40 Hz to 1 kHz	1.1 A to 3.3 A	12 mA		
1 kHz to 5 kHz	1.1 A to 3.3 A	0.2 A		



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Equipment to Measure AC Current At the listed frequencies ^{FO}			HP 3458A Opt 002 with HP 34330A Shunt	
45 Hz to 1 kHz	3 A to 11 A	43 mA		
45 Hz to 1 kHz	3 A to 11 A	43 mA		
Equipment to Measure AC Current At the listed frequencies ^{FO}				
45 Hz to 1 kHz	11 A to 20.5 A	12 mA		
1 kHz to 5 kHz	11 A to 20.5 A	0.2 A		
Equipment to Source Inductance ^{FO}	100 μ H to 1 mH	17 μ H	GR 1491D Decade Box , RLC GenRad 1689	
	1 mH to 10 mH	0.14 mH		
	10 mH to 100 mH	0.69 mH		
	100 mH to 1 H	6.9 mH		
	1 H to 10 H	69 mH		
Equipment to Measure Inductance ^{FO}	100 μ H to 1 mH	0.24 μ H	RLC GenRad 1689	
	1 to 10 mH	2.4 μ H		
	10 mH to 100 mH	24 μ H		
	100 mH to 1 H	0.24 mH		
	1 H to 10 H	2.3 mH		
Equipment to Measure Capacitance ^{FO}	Up to 1 nF	0.64 pF	RLC GenRad 1689	
	1 nF to 10 nF	2.4 pF		
	10 nF to 100 nF	26 pF		
	100 nF to 1 μ F	0.41 nF		
	1 μ F to 1.111 μ F	0.44 nF		
Equipment to Source Capacitance At the listed frequencies ^{FO}			1423A Decade Box	
20 Hz to 1 kHz	100 pF to 1 nF	0.67 pF		
20 Hz to 1 kHz	1 nF to 10 nF	42 pF		
20 Hz to 1 kHz	10 nF to 100 nF	74 pF		
20 Hz to 1 kHz	100 nF to 1 μ F	0.62 nF		
Equipment to Measure Capacitance ^{FO}	10 Hz to 10 kHz	220 pF to 400 pF	Fluke 5522A	
	10 Hz to 10 kHz	0.4 nF to 1.1 nF		15 pF
	10 Hz to 3 kHz	1.1 nF to 3.3 nF		18 pF
	10 Hz to 1 kHz	3.3 nF to 11 nF		23 pF
	10 Hz to 1 kHz	11 nF to 33 nF		44 pF
	10 Hz to 1 kHz	33 nF to 110 nF		0.17 nF
	10 Hz to 1 kHz	110 nF to 330 nF		0.44 nF



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Equipment to Source Capacitance At the listed frequencies ^{FO}			Fluke 5522A
10 Hz to 1 kHz	110 nF to 330 nF	0.92 nF	
10 Hz to 600 Hz	330 nF to 1.1 μ F	4.1 nF	
10 Hz to 300 Hz	1.1 μ F to 3.3 μ F	12 nF	
10 Hz to 150 Hz	3.3 μ F to 11 μ F	44 nF	
10 Hz to 120 Hz	11 μ F to 33 μ F	0.18 μ F	
10 Hz to 80 Hz	33 μ F to 110 μ F	0.70 μ F	
0 Hz to 50 Hz	110 μ F to 330 μ F	2.0 μ F	
Equipment to Source Capacitance At the listed frequencies ^{FO}			Fluke 5522A
0 Hz to 20 Hz	330 μ F to 1.1 mF	12 μ F	
0 Hz to 6 Hz	1.1 mF to 3.3 mF	20 μ F	
0 Hz to 2 Hz	3.3 mF to 11 mF	89 μ F	
0 Hz to 0.6 Hz	11 mF to 33 mF	0.31 mF	
0 Hz to 0.2 Hz	33 mF to 110 mF	1.4 mF	
Equipment to Source DC Resistance ^{FO}	Up to 10 Ω	1.6 m Ω	ESI RS925A Resistance Decade Box
	10 Ω to 100 Ω	3.1 m Ω	
	100 Ω to 1 k Ω	27 m Ω	
	1 k Ω to 10 k Ω	0.26 Ω	
	10 k Ω to 100 k Ω	2.6 Ω	
	100 k Ω to 1.1 M Ω	29 Ω	
	Up to 10 Ω	1.6 m Ω	
	1.1 M Ω to 3.3 M Ω	0.29 k Ω	
	3.3 M Ω to 11 M Ω	0.35 k Ω	
	11 M Ω to 33 M Ω	12 k Ω	
	33 M Ω to 110 M Ω	66 k Ω	
	110 M Ω to 330 M Ω	1.2 M Ω	
	330 M Ω to 1.1 G Ω	18 M Ω	
	Equipment to Measure DC Resistance ^{FO}	Up to 10 Ω	0.31 m Ω
10 Ω to 100 Ω		2.7 m Ω	
100 Ω to 1 k Ω		18 m Ω	
1 k Ω to 10 k Ω		0.18 Ω	
10 k Ω to 100 k Ω		1.8 Ω	



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Equipment to Measure DC Resistance ^{FO}	100 k Ω to 1 M Ω	25 Ω	HP 3458A Opt 002
	1 M Ω to 10 M Ω	0.78 k Ω	
	10 M Ω to 100 M Ω	68 k Ω	
Oscilloscopes Amplitude – DC ^{FO}			Fluke 5522A / SC1100
50 Ω	-6.6 V to 6.6 V	20 mV	
1 M Ω	-130 V to 130 V	15 mV	
Amplitude - Square Wave			
50 Ω	1 mV to 6.6 V (p-p)	13 mV	
1 M Ω	1 mV to 130 V (p-p)	18 mV	
Frequency	10 Hz to 10 kHz	29 Hz	
Time Markers into 50 Ω Load	1 ns to 20 ms	8.2 μ s	
	50 ms to 5 s	29 ms	
Leveled Sine Wave (5 mV to 5.5 V) p-p	50 kHz reference	0.13 V	
	50 kHz to 100 MHz	0.10 V	
	100 MHz to 300 MHz	0.14 V	
	300 MHz to 600 MHz	0.26 V	
Leveled Sine Wave (5 mV to 3.5 V) p-p	600 MHz to 1.1 GHz	0.20 V	
Edge Characteristics into 50 Ω Load Rise Time Amplitude Frequency	Up to 300 ps	+0/-120 ps	
	4.5 mV to 2.75 V	63 mV	
	1 kHz to 10 MHz	29 Hz	
Wave Generator Square, Sine, Triangle Amplitude Into 50 Ω Load Into 1 M Ω Load Frequency	1.8 mV to 55 V p-p	88 mV	
	1.8 mV to 55 V p-p	2.0 V	
	10 Hz to 100 kHz	0.29 Hz	
Pulse – Generate 50 Ω Load Period Width	22 ms to 200 ns 45.5 Hz to 5 MHz	6.1 ns	
	4 ns to 500 ns	1.2 ns	
Input Resistance Measurement	40 Ω to 60 Ω	56 m Ω	
	500 k Ω to 1.5M Ω	2.5 k Ω	
Oscilloscope Capacitance Measurement	5 pF to 50 pF	1.3 pF	



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Electrical Simulation of Thermocouple Indicators Type B ^{FO}	600 °C to 800 °C	0.53 °C	Fluke 5522A
	800 °C to 1 000 °C	0.42 °C	
	1 000 °C to 1 550 °C	0.37 °C	
	1 550 °C to 1 820 °C	0.40 °C	
Electrical Simulation of Thermocouple Indicators Type C ^{FO}	0 °C to 150 °C	0.35 °C	
	150 °C to 650 °C	0.31 °C	
	650 °C to 1 000 °C	0.38 °C	
	1 000 °C to 1 800 °C	0.59 °C	
	1 800 °C to 2 316 °C	0.98 °C	
Electrical Simulation of Thermocouple Indicators Type E ^{FO}	-250 °C to -100 °C	0.58 °C	
	-100 °C to -25 °C	0.19 °C	
	-25 °C to 350 °C	0.17 °C	
	350 °C to 650 °C	0.19 °C	
	650 °C to 1 000 °C	0.25 °C	
Electrical Simulation of Thermocouple Indicators Type J ^{FO}	-210 °C to -100 °C	0.33 °C	
	-100 °C to -30 °C	0.20 °C	
	-30 °C to 150 °C	0.17 °C	
	150 °C to 760 °C	0.21 °C	
	760 °C to 1 200 °C	0.27 °C	
Electrical Simulation of Thermocouple Indicators Type K ^{FO}	-200 °C to -100 °C	0.39 °C	
	-100 °C to -25 °C	0.22 °C	
	-25 °C to 120 °C	0.19 °C	
	120 °C to 1 000 °C	0.31 °C	
	1 000 °C to 1 372 °C	0.48 °C	
Electrical Simulation of Thermocouple Indicators Type L ^{FO}	-200 °C to -100 °C	0.44 °C	
	-100 °C to 800 °C	0.32 °C	
	800 °C to 900 °C	0.22 °C	
Electrical Simulation of Thermocouple Indicators Type N ^{FO}	-200 °C to -100 °C	0.47 °C	
	-100 °C to -25 °C	0.26 °C	
	-25 °C to 120 °C	0.23 °C	
	120 °C to 410 °C	0.22 °C	
	410 °C to 1 300 °C	0.33 °C	



Certificate of Accreditation: Supplement

Total Calibration Solutions, Inc.

7722 Metric Drive, Mentor, OH, 44060
 Contact Name: Mark Hanson Phone: 440-229-4811

Accreditation is granted to the facility to perform the following calibrations:

Electrical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Electrical Simulation of Thermocouple Indicators Type R ^{FO}	0 °C to 250 °C	0.67 °C	Fluke 5522A
	250 °C to 400 °C	0.42 °C	
	400 °C to 1 000 °C	0.40 °C	
	1 000 °C to 1 767 °C	0.48 °C	
Electrical Simulation of Thermocouple Indicators Type S ^{FO}	0 °C to 250 °C	0.56 °C	
	250 °C to 1 000 °C	0.43 °C	
	1 000 °C to 1 400 °C	0.44 °C	
	1 400 °C to 1 767 °C	0.54 °C	
Electrical Simulation of Thermocouple Indicators Type T ^{FO}	-250 °C to -150 °C	0.74 °C	
	-150 °C to 0 °C	0.30 °C	
	0 °C to 120 °C	0.19 °C	
	120 °C to 400 °C	0.17 °C	
Electrical Simulation of Thermocouple Indicators Type U ^{FO}	-200 °C to 0 °C	0.66 °C	
	0 °C to 600 °C	0.33 °C	
Electrical Simulation of RTD Indicators Pt 385, 100 Ω ^{FO}	-200 °C to -80 °C	0.06 °C	
	-80 °C to 0 °C	0.06 °C	
	0 °C to 100 °C	0.09 °C	
	100 °C to 300 °C	0.11 °C	
	300 °C to 400 °C	0.12 °C	
	400 °C to 630 °C	0.14 °C	
	630 °C to 800 °C	0.27 °C	
Electrical Simulation of RTD Indicators Pt 385, 200 Ω ^{FO}	-200 °C to -80 °C	0.05 °C	
	-80 °C to 0 °C	0.05 °C	
	0 °C to 100 °C	0.05 °C	
	100 °C to 260 °C	0.06 °C	
	260 °C to 300 °C	0.15 °C	
	300 °C to 400 °C	0.18 °C	
	400 °C to 600 °C	0.18 °C	
	600 °C to 630 °C	0.19 °C	



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Electrical Simulation of RTD Indicators Pt 385, 500 Ω ^{FO}	-200 °C to -80 °C	0.05 °C	Fluke 5522A
	-80 °C to 0 °C	0.06 °C	
	0 °C to 100 °C	0.06 °C	
	100 °C to 260 °C	0.07 °C	
	260 °C to 300 °C	0.09 °C	
	300 °C to 400 °C	0.09 °C	
	400 °C to 600 °C	0.11 °C	
	600 °C to 630 °C	0.13 °C	
Electrical Simulation of RTD Indicators Pt 385, 1000 Ω ^{FO}	-200 °C to -80 °C	0.04 °C	Fluke 5522A
	-80 °C to 0 °C	0.04 °C	
	0 °C to 100 °C	0.08 °C	
	100 °C to 260 °C	0.06 °C	
	260 °C to 300 °C	0.07 °C	
	300 °C to 400 °C	0.08 °C	
	400 °C to 600 °C	0.08 °C	
	600 °C to 630 °C	0.27 °C	
Phase Angle - Source (0 to 360)° ^{FO}	65 Hz to 500 Hz	0.29 °	Fluke 5522A
Equipment to measure RF Power at listed Frequencies ^{FO}			
150 kHz to 1.3 GHz	-20 dBm to 30 dBm	0.21 dBm	HP 8902A / HP 11722A
1.3GHz to 18GHz	-70 dBm to 10 dBm	0.23 dBm	AGILENT E4418B / E4412A
	10 dBm to 20 dBm	0.16 dBm	
Tuned RF Absolute Power – Measure 2.5 MHz to 1.3 GHz ^{FO}	-20 dBm to 10 dBm	0.15 dBm	HP 8902A / HP 11722A
	-40 dBm to -20 dBm	0.16 dBm	
	-50 dBm to -40 dBm	0.11 dBm	
	-60 dBm to -50 dBm	0.07 dBm	
	-70 dBm to -60 dBm	0.11 dBm	
	-80 dBm to -70 dBm	0.11 dBm	
	-90 dBm to -80 dBm	0.07 dBm	
	-100 dBm to -90 dBm	0.07 dBm	
	-110 dBm to -100 dBm	0.16 dBm	
	-120 dBm to -110 dBm	0.13 dBm	
-127 dBm to -120 dBm	0.13 dBm		



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Equipment to Measure Amplitude Modulation at the listed Frequencies and Rates ^{FO}				
Frequency: 150 kHz to 10 MHz Rate: 50 Hz to 10 kHz	5 % to 99 %	2.3 %	HP 8902A	
Frequency: 150 kHz to 10 MHz Rate: 20 Hz to 10 kHz	to 99 %	3.5 %		
Frequency: 10 MHz to 1.3 GHz Rate: 50 Hz to 50 kHz	5 % to 99 %	1.2 %		
Frequency: 10 MHz to 1.3 GHz Rate: 20 Hz to 100 kHz	to 99 %	3.5 %		
Equipment to Measure Frequency Modulation at the listed Frequencies and Rates ^{FO}				
Frequency: 250 kHz to 10 MHz Rate: 20 Hz to 10 kHz \leq 40 kHz peak	0 Hz to 4 kHz	0.12 kHz	HP 8902A	
	4 kHz to 40 kHz	1.1 kHz		
Frequency: 10 MHz to 1.3 GHz Rate: 50 Hz to 100 kHz \leq 400 kHz peak	0 Hz to 4 kHz	0.18 kHz		
	4 kHz to 40 kHz	0.64 kHz		
	40 kHz to 400 kHz	4.8 kHz		
Frequency: 10 MHz to 1.3 GHz Rate: 20 Hz to 200 kHz \leq 400 kHz peak	0 Hz to 4 kHz	0.3 kHz		
	4 kHz to 40 kHz	2.5 kHz		
	40 kHz to 400 kHz	24.0 kHz		
Equipment to Measure Phase Modulation at the listed Frequencies ^{FO}				
150 kHz to 10 MHz	0 to 2π rad	0.32 rad		
10 MHz to 1.3 GHz	0 to 2π rad	0.56 rad		



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Accreditation is granted to the facility to perform the following calibrations:

Thermodynamic

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Humidity ^{FO}	Up to 10 % RH	1.4 %	Vaisala HMT 333 / HMP75 Thunder Scientific 2500
	10 % RH to 95 % RH	0.71 %	
Temperature ^{FO}	-196 °C	0.021 °C	Liquid Nitrogen Temperature Bath Fluke 5628 PRT HP 3458A Opt 002
	-95 °C to -20 °C	0.021 °C	
	-20 °C to 150 °C	0.017 °C	
	150 °C to 660 °C	0.062 °C	

Time and Frequency

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Frequency – Source ^{FO}	1 MHz to 3 GHz	29 parts in 10 ¹⁰	HP E4422B Signal Generator locked to FS725 Rubidium Frequency Standard
Frequency – Measure ^{FO}	0.1 GHz to 3 GHz	28 parts in 10 ¹⁰	HP 53132A

Mechanical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Pressure Gages & Transducers ^{FO}	-1 psig to 1 psig	0.000 24 psig	Fluke 7250LP
	1 psig to 5 psig	0.03 % of reading	Fluke PM600-A1.4M with Fluke 6270A Pressure Controller
	5 psig to 200 psig	0.015 % of reading	
	200 psig to 20 000 psig	0.012 % of reading	Fluke 93116 Deadweight Tester
Vacuum ^{FO}	Up to 15 psia	0.03 % of reading	Druck DPI 145
Mass Flow ^{FO}	0.5 sccm to 50 sccm	0.31 % of reading	Mesa Labs ML-800-3
	50 sccm to 5 000 sccm	0.16 % of reading	Mesa Labs ML-800-24
	5 slpm to 100 slpm	0.18 % of reading	Mesa Labs ML-800-75
	100 slpm to 5 000 slpm	0.28 % of reading	Fluke molbox+ mass flow terminal and Fluke 5E2-S, 2E3-S, or 1E4-S molbloc.
Liquid Flow ^{FO}	1 gpm to 60 gpm	0.45 % of reading	Cox Liquid Flow Standard



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Mechanical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Equipment to Source Torque ^{FO}	2.5 in-lb to 500 in-lb	0.1 % of reading	Torque Arms, F Class Weights
	41.6 ft-lb to 800 ft-lb		
Torque Tools ^{FO}	0.12 in-lb to 1.25 in-lb	0.6 % of reading	Mountz BMX20Z
	1.25 in-lb to 10 in-lb	0.59 % of reading	Mountz TL10i
	10 in-lb to 500 in-lb	0.30 % of reading	Norbar 50621
	42 ft-lb to 75 ft-lb	0.31 % of reading	Norbar 50593
	75 ft-lb to 750 ft-lb	0.31 % of reading	Norbar 50597

Mass, Force, and Weighing Devices

Force - Compression & Tension ^{FO}	Up to 500 lbf	0.10 lbf	Class F Weights
	500 lbf to 1 000 lbf	0.63 lbf	Load Cells
	1 000 lbf to 2 500 lbf	2.1 lbf	
	2 500 lbf to 5 000 lbf	2.7 lbf	
	5 000 lbf to 7 500 lbf	5.3 lbf	
	7 500 lbf to 10 000 lbf	6.3 lbf	
	10 000 lbf to 25 000 lbf	22 lbf	
	25 000 lbf to 50 000 lbf	31 lbf	
Laboratory and Precision Balances ^{FO}	Up to 20 g (0.001mg)	14 μ g	Class 1 Weights
	20 to 40 g (0.01mg)	30 μ g	
	40 to 60 g (0.01mg)	39 μ g	
	60 to 80g (0.01mg)	45 μ g	
	80 to 100 g (0.01mg)	71 μ g	
	100 to 200 g (0.01mg)	77 μ g	
	200 to 500 g (0.1mg)	0.89 mg	
	500 to 1 kg (1mg)	2.6 mg	
	1 kg to 2 kg (1mg)	2.8 mg	
	2 kg to 4 kg (1mg)	4.3 mg	



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Mass, Force, and Weighing Devices

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Laboratory and Precision Balances ^{FO}	4 kg to 5 kg Res.= (1 mg)	14 mg	Class 1 Weights
	5 kg to 10 kg Res.= (1 mg)	24 mg	
	10 kg to 15 kg Res.= (1 mg)	99 mg	
	15 kg to 20 kg Res.= (0.1 g)	0.11g	
	4 kg to 5 kg Res.= (1 mg)	14 mg	
Scale ^{FO}	Up to 20 lb Res.= (0.001 lb)	0.001 1 lb	Class F Weights
	20 lb to 50 lb Res.= (0.01 lb)	0.007 4 lb	
	50 lb to 100 lb Res.= (0.01 lb)	0.009 6 lb	
	100 lb to 600 lb Res.= (0.1 lb)	0.077 lb	
	600 lb to 1 000 lb Res.= (0.1lb)	0.12 lb	
	1 000 lb to 2 000 lb Res.= (0.1 lb)	0.17 lb	
	2 000 lb to 3 000 lb Res.= (0.5 lb)	0.37 lb	
	3 000 lb to 4 000 lb Res.= (0.5 lb)	0.48 lb	
Pipettes ^{FO}	0.5 μ L to 2 μ L	0.076 μ L	Micro-Balance
	2 μ L to 10 μ L	0.078 μ L	
	10 μ L to 20 μ L	0.080 μ L	
	20 μ L to 100 μ L	0.094 μ L	
	100 μ L to 200 μ L	0.16 μ L	
	200 μ L to 500 μ L	0.40 μ L	
	500 μ L to 1 000 μ L	0.51 μ L	
1 000 μ L to 5 100 μ L	2.5 μ L		



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Accreditation is granted to the facility to perform the following calibrations:

1. The CMC (Calibration and Measurement Capability) stated for calibrations included on this scope of accreditation represents the smallest measurement uncertainty attainable by the laboratory when performing a more or less routine calibration of a nearly ideal device under nearly ideal conditions. It is typically expressed at a confidence level of 95 % using a coverage factor k (usually equal to 2). The actual measurement uncertainty associated with a specific calibration performed by the laboratory will typically be larger than the CMC for the same calibration since capability and performance of the device being calibrated and the conditions related to the calibration may reasonably be expected to deviate from ideal to some degree.
2. The laboratories range of calibration capability for all disciplines for which they are accredited is the interval from the smallest calibrated standard to the largest calibrated standard used in performing the calibration. The low end of this range must be an attainable value for which the laboratory has or has access to the standard referenced. Verification of an indicated value of zero in the absence of a standard is common practice in the procedure for many calibrations but by its definition it does not constitute calibration of zero capacity.
3. The presence of a superscript FO means that the laboratory performs calibration of the indicated parameter both at its fixed location and onsite at customer locations. Example: Outside Micrometer^{FO} would mean that the laboratory performs this calibration at its fixed location and onsite at customer locations.
4. The term L represents length in inches or millimeters as appropriate to the uncertainty statement.

