



# 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 17025:2017/Z540-1**

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 April 2017):

***Chemical, 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

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

*Initial Accreditation Date:*

March 07, 2020

*Issue Date:*

November 22, 2024

*Expiration Date:*

January 31, 2027

*Accreditation No.:*

97175

*Certificate No.:*

L24-897-1

*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](http://www.pjilabs.com)*



# Certificate of Accreditation: Supplement

## Total Calibration Solutions, INC

7722 Metric Drive, Mentor, OH 44060

Contact Name: Mark Hanson Phone: 440-299-4811

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

### Dimensional

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Calipers <sup>FO</sup>	Up to 40 in	(12L + 150) $\mu$ in	Gage Blocks / Surface Plate	SOP-02 Caliper Calibration SOP-01 Micrometer Calibration SOP-12 Dial and Digital Indicator Calibration SOP-06 Height Gage Calibration
Micrometers <sup>FO</sup>	Up to 6 in	(9.2L + 21) $\mu$ in		
	6 in to 20 in	(16L + 177) $\mu$ in		
Indicators, Dial, Test <sup>FO</sup>	Up to 4 in	(30L - 5.5) $\mu$ in		
Height Gages <sup>FO</sup>	Up to 48 in	(10L + 205) $\mu$ in	Gage Line Glass Standard	SOP-37 Optical Comparators
Optical Comparators X and Y Axis Linearity <sup>FO</sup>	Up to 12 in	200 $\mu$ in		
Optical Comparators Magnification <sup>FO</sup>	10 x, 20 x, 31.25 x, 50 x, 62.5 x, 100 x	200 $\mu$ in		
Optical Comparators Angle <sup>FO</sup>	0°, 5°, 10°, 15°, 20°, 25°, 30°, 45°, 90°	0.10°		

### Electrical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Equipment to Source DC Voltage <sup>FO</sup>	Up to 100 mV	1.8 $\mu$ V	HP 3458A Opt 002	GIDEP / OEM Manual
	100 mV to 1 V	7 $\mu$ V		
	1 V to 10 V	72 $\mu$ V		
	10 V to 100 V	1.2 mV		
	100 V to 1 kV	30 mV		
	1 kV to 4 kV	2.2 V	Vitretek 4700	
	4 kV to 10 kV	3.9 V	Vitretek 4700, Vitretek HVL-100	
	10 kV to 30 kV	0.027 kV		
	30 kV to 50 kV	0.045 kV		
50 kV to 100 kV	0.15 kV			
Equipment to Measure DC Voltage <sup>FO</sup>	Up to 220 mV	2.9 $\mu$ V	Fluke 5730A	
	220 mV to 2.2 V	16 $\mu$ V		
	2.2 V to 11 V	55 $\mu$ V		
	11 V to 22 V	0.11 mV		
	22 V to 220 V	1.6 mV		
	220 V to 1.1 kV	11 mV		



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Equipment to Source DC Current <sup>FO</sup>	Up to 100 $\mu$ A	7.4 nA	HP 3458A Opt 002	GIDEP / OEM Manual
	100 $\mu$ A to 1 mA	84 nA		
	1 mA to 10 mA	0.71 $\mu$ A		
	10 mA to 100 mA	10 $\mu$ A		
	100 mA to 1 A	0.16 mA		
	1 A to 3 A	11 mA		
	3 A to 11 A	40 mA	HP 3458A Opt 002, Shunt	
Equipment to Measure DC Current <sup>FO</sup>	Up to 220 $\mu$ A	17 nA	Fluke 5730A	
	220 $\mu$ A to 2.2 mA	98 nA		
	2.2 mA to 22 mA	1.2 $\mu$ A		
	22 mA to 220 mA	12 $\mu$ A		
	220 mA to 2.2 A	0.23 mA	Fluke 5560A	
	2.2 A to 3.1 A	1.0 mA		
	3.1 A to 12 A	3.5 mA		
12 A to 30.2 A	28 mA			
Equipment to Source AC Voltage At the listed frequencies <sup>FO</sup>			HP 3458A Opt 002	
Up to 1 kHz	Up to 10 mV	4.7 $\mu$ V		
1 kHz to 20 kHz	Up to 10 mV	9 $\mu$ V		
20 kHz to 100 kHz	Up to 10 mV	90 $\mu$ V		
100 kHz to 300 kHz	Up to 10 mV	0.72 mV		
Equipment to Source AC Voltage At the listed frequencies <sup>FO</sup>				
Up to 1 kHz	10 mV to 100 mV	12 $\mu$ V		
1 kHz to 20 kHz	10 mV to 100 mV	20 $\mu$ V		
20 kHz to 100 kHz	10 mV to 100 mV	0.1 mV		
100 kHz to 300 kHz	10 mV to 100 mV	0.39 mV		
Equipment to Source AC Voltage At the listed frequencies <sup>FO</sup>				
Up to 1 kHz	100 mV to 1 V	0.12 mV		
1 kHz to 20 kHz	100 mV to 1 V	0.2 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	3.6 mV		
300 kHz to 500 kHz	100 mV to 1 V	12 mV		



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Equipment to Source AC Voltage At the listed frequencies <sup>FO</sup>			HP 3458A Opt 002	GIDEP/OEM Manual
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		
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		
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 Source AC Voltage At the listed frequencies <sup>FO</sup>				
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 Source AC Voltage At the listed frequencies <sup>FO</sup>				
Up to 20 kHz	100 V to 1 kV	0.36 V		
Equipment to Source AC Voltage At the listed frequencies <sup>FO</sup>			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 Measure AC Current At the listed frequencies <sup>FO</sup>			Fluke 5560A	
3 Hz to 45 Hz	10 $\mu$ A to 120 $\mu$ A	0.036 $\mu$ A		
45 Hz to 1 kHz	10 $\mu$ A to 120 $\mu$ A	0.036 $\mu$ A		
1 kHz to 5 kHz	10 $\mu$ A to 120 $\mu$ A	0.036 $\mu$ A		
5 kHz to 10 kHz	10 $\mu$ A to 120 $\mu$ A	0.19 $\mu$ A		
10 kHz to 30 kHz	10 $\mu$ A to 120 $\mu$ A	1.6 $\mu$ A		
Equipment to Measure AC Current At the listed frequencies <sup>FO</sup>				
3 Hz to 45 Hz	120 $\mu$ A to 1.2 mA	0.36 $\mu$ A		
45 Hz to 1 kHz	120 $\mu$ A to 1.2 mA	0.36 $\mu$ A		
1 kHz to 5 kHz	120 $\mu$ A to 1.2 mA	0.36 $\mu$ A		
5 kHz to 10 kHz	120 $\mu$ A to 1.2 mA	1.5 $\mu$ A		
10 kHz to 30 kHz	120 $\mu$ A to 1.2 mA	11 $\mu$ A		



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Equipment to Measure AC Current At the listed frequencies <sup>FO</sup>			Fluke 5560A	GIDEP/OEM Manual
3 Hz to 45 Hz	1.2 mA to 12 mA	3.6 $\mu$ A		
45 Hz to 1 kHz	1.2 mA to 12 mA	3.6 $\mu$ A		
1 kHz to 5 kHz	1.2 mA to 12 mA	3.6 $\mu$ A		
5 kHz to 10 kHz	1.2 mA to 12 mA	15 $\mu$ A		
10 kHz to 30 kHz	1.2 mA to 12 mA	59 $\mu$ A		
Equipment to Measure AC Current At the listed frequencies <sup>FO</sup>				
3 Hz to 45 Hz	12 mA to 120 mA	36 $\mu$ A		
45 Hz to 1 kHz	12 mA to 120 mA	20 $\mu$ A		
1 kHz to 5 kHz	12 mA to 120 mA	33 $\mu$ A		
5 kHz to 10 kHz	12 mA to 120 mA	0.15 mA		
10 kHz to 30 kHz	12 mA to 120 mA	0.59 mA		
Equipment to Measure AC Current At the listed frequencies <sup>FO</sup>				
3 Hz to 45 Hz	120 mA to 1.2 A	0.35 mA		
45 Hz to 1 kHz	120 mA to 1.2 A	0.3 mA		
1 kHz to 5 kHz	120 mA to 1.2 A	0.33 mA		
5 kHz to 10 kHz	120 mA to 1.2 A	2.7 mA		
10 kHz to 30 kHz	120 mA to 1.2 A	5 mA		
Equipment to Measure AC Current At the listed frequencies <sup>FO</sup>				
3 Hz to 45 Hz	1.2 A to 3.1 A	1.7 mA		
45 Hz to 1 kHz	1.2 A to 3.1 A	1.2 mA		
1 kHz to 5 kHz	1.2 A to 3.1 A	1.5 mA		
5 kHz to 10 kHz	1.2 A to 3.1 A	7.9 mA		
Equipment to Measure AC Current At the listed frequencies <sup>FO</sup>				
3 to 45 Hz	3.1 A to 12 A	4.7 mA		
45 Hz to 1 kHz	3.1 A to 12 A	3.5 mA		
1 kHz to 5 kHz	3.1 A to 12 A	4.5 mA		
5 kHz to 10 kHz	3.1 A to 12 A	25 mA		
Equipment to Measure AC Current At the listed frequencies <sup>FO</sup>				
3 Hz to 45 Hz	12 A to 30.2 A	40 mA		
45 Hz to 1 kHz	12 A to 30.2 A	29 mA		
1 kHz to 5 kHz	12 A to 30.2 A	150 mA		



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Equipment to Measure AC Voltage At the listed frequencies <sup>FO</sup>			Fluke 5522A	GIDEP/OEM Manual
10 Hz to 45 Hz	Up to 33 mV	35 $\mu$ V		
45 Hz to 10 kHz	Up to 33 mV	12 $\mu$ V		
10 kHz to 20 kHz	Up to 33 mV	14 $\mu$ V		
20 kHz to 50 kHz	Up to 33 mV	42 $\mu$ 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 Measure AC Voltage At the listed frequencies <sup>FO</sup>				
10 Hz to 45 Hz	33 mV to 330 mV	0.12 mV		
45 Hz to 10 kHz	33 mV to 330 mV	60 $\mu$ V		
10 kHz to 20 kHz	33 mV to 330 mV	65 $\mu$ V		
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 Measure AC Voltage At the listed frequencies <sup>FO</sup>				
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 Measure AC Voltage At the listed frequencies <sup>FO</sup>				
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 Measure AC Voltage At the listed frequencies <sup>FO</sup>				
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		



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Equipment to Measure AC Voltage At the listed frequencies <sup>FO</sup>			Fluke 5522A	GIDEP/OEM Manual		
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 <sup>FO</sup>			HP 3458A Opt 002			
10 Hz to 5 kHz	Up to 100 $\mu$ A	0.11 $\mu$ A				
Equipment to Source AC Current At the listed frequencies <sup>FO</sup>						
10 Hz to 5 kHz	100 $\mu$ A to 1 mA	0.6 $\mu$ A				
Equipment to Source AC Current At the listed frequencies <sup>FO</sup>						
10 Hz to 5 kHz	1 mA to 10 mA	6.1 $\mu$ A				
Equipment to Source AC Current At the listed frequencies <sup>FO</sup>						
10 Hz to 5 kHz	10 mA to 100 mA	61 $\mu$ A				
Equipment to Source AC Current At the listed frequencies <sup>FO</sup>						
10 Hz to 5 kHz	100 mA to 1.1 A	1.4 mA				
Equipment to Source AC Current At the listed frequencies <sup>FO</sup>					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	14 mA				
Equipment to Source AC Current At the listed frequencies <sup>FO</sup>						
45 Hz to 1 kHz	3 A to 11 A	13 mA				
1 kHz to 5 kHz	3 A to 11 A	13 mA				
Equipment to measure AC Voltage <sup>FO</sup> up to 2.2 mV			Fluke 5730A	GIDEP / OEM Manual		
10 Hz to 20 Hz		5.3 $\mu$ V				
20 Hz to 40 Hz		4.9 $\mu$ V				
40 Hz to 20 kHz		4.9 $\mu$ V				
20 kHz to 50 kHz		5.2 $\mu$ V				
50 kHz to 100 kHz		7.1 $\mu$ V				
100 kHz to 300 kHz		14 $\mu$ V				
300 kHz to 500 kHz		27 $\mu$ V				
500 kHz to 1 MHz		30 $\mu$ V				



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Equipment to measure AC Voltage <sup>FO</sup> 2.2 mV to 22 mV	10 Hz to 20 Hz	11 $\mu$ V	Fluke 5730A	GIDEP / OEM Manual
	20 Hz to 40 Hz	7.1 $\mu$ V		
	40 Hz to 20 kHz	6.8 $\mu$ V		
	20 kHz to 50 kHz	9.8 $\mu$ V		
	50 kHz to 100 kHz	19 $\mu$ V		
	100 kHz to 300 kHz	39 $\mu$ V		
	300 kHz to 500 kHz	59 $\mu$ V		
	500 kHz to 1 MHz	93 $\mu$ V		
Equipment to measure AC Voltage <sup>FO</sup> 22 mV to 220 mV	10 Hz to 20 Hz	75 $\mu$ V		
	20 Hz to 40 Hz	32 $\mu$ V		
	40 Hz to 20 kHz	23 $\mu$ V		
	20 kHz to 50 kHz	39 $\mu$ V		
	50 kHz to 100 kHz	99 $\mu$ V		
	100 kHz to 300 kHz	0.19 mV		
	300 kHz to 500 kHz	0.39 mV		
	500 kHz to 1 MHz	0.74 mV		
Equipment to measure AC Voltage <sup>FO</sup> 220 mV to 2.2 V	10 Hz to 20 Hz	0.66 mV		
	20 Hz to 40 Hz	0.25 mV		
	40 Hz to 20 kHz	0.12 mV		
	20 kHz to 50 kHz	0.19 mV		
	50 kHz to 100 kHz	0.25 mV		
	100 kHz to 300 kHz	0.95 mV		
	300 kHz to 500 kHz	2.8 mV		
	500 kHz to 1 MHz	4.7 mV		
Equipment to measure AC Voltage <sup>FO</sup> 2.2 V to 22 V	10 Hz to 20 Hz	13 mV		
	20 Hz to 40 Hz	2.5 mV		
	40 Hz to 20 kHz	1.2 mV		
	20 kHz to 50 kHz	1.9 mV		
	50 kHz to 100 kHz	2.4 mV		
	100 kHz to 300 kHz	7.3 mV		
	300 kHz to 500 kHz	28 mV		
	500 kHz to 1 MHz	42 mV		





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Equipment to measure AC Voltage <sup>FO</sup> 22 V to 220 V	10 Hz to 20 Hz	66 mV	Fluke 5730A	
	20 Hz to 40 Hz	25 mV		
	40 Hz to 20 kHz	15 mV		
	20 kHz to 50 kHz	22 mV		
	50 kHz to 100 kHz	42 mV		
Equipment to measure AC Voltage <sup>FO</sup> 220 V to 1.1 kV	15 Hz to 50 Hz	0.40 V	Fluke 5730A	
	50 Hz to 1 kHz	99 mV		
Equipment to Measure AC Current <sup>FO</sup> up to 220 $\mu$ A	10 Hz to 20 Hz	83 nA	Fluke 5730A	
	20 Hz to 40 Hz	53 nA		
	40 Hz to 1 kHz	37 nA		
	1 kHz to 5 kHz	87 nA		
	5 kHz to 10 kHz	0.36 $\mu$ A		
Equipment to Measure AC Current <sup>FO</sup> up to 1.2 mA	10 kHz to 30 kHz	11 $\mu$ A	Fluke 5560A	
Equipment to Measure AC Current <sup>FO</sup> 220 $\mu$ A to 2.2 mA	10 Hz to 20 Hz	0.69 $\mu$ A	Fluke 5730A	
	20 Hz to 40 Hz	0.45 $\mu$ A		
	40 Hz to 1 kHz	0.31 $\mu$ A		
	1 kHz to 5 kHz	0.65 $\mu$ A		
	5 kHz to 10 kHz	3.6 $\mu$ A		
Equipment to Measure AC Current <sup>FO</sup> 1.2 mA to 12 mA	10 kHz to 30 kHz	66 $\mu$ A	Fluke 5560A	
Equipment to Measure AC Current <sup>FO</sup> 2.2 mA to 22 mA	10 Hz to 20 Hz	6.9 $\mu$ A	Fluke 5730A	
	20 Hz to 40 Hz	4.6 $\mu$ A		
	40 Hz to 1 kHz	3.1 $\mu$ A		
	1 kHz to 5 kHz	5.9 $\mu$ A		
	5 kHz to 10 kHz	34 $\mu$ A		
Equipment to Measure AC Current <sup>FO</sup> 12 mA to 120 mA	10 kHz to 30 kHz	0.66 mA	Fluke 5560A	
Equipment to Measure AC Current <sup>FO</sup> 22 mA to 220 mA	10 Hz to 20 Hz	69 $\mu$ A	Fluke 5730A	
	20 Hz to 40 Hz	46 $\mu$ A		
	40 Hz to 1 kHz	30 $\mu$ A		
	1 kHz to 5 kHz	57 $\mu$ A		
	5 kHz to 10 kHz	0.30 mA		



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Equipment to Measure AC Current <sup>FO</sup> 120 mA to 1.2 A	10 kHz to 30 kHz	5.8 mA	Fluke 5560A	GIDEP / OEM Manual
Equipment to Measure AC Current <sup>FO</sup> 220 mA to 2.2 A	20 Hz to 1 kHz	0.68 Ma	Fluke 5730A	
	1 kHz to 5 kHz	1.3 mA		
	5 kHz to 10 kHz	18 mA		
Equipment to Measure AC Current <sup>FO</sup> 2.2 A to 3.1 A	3 Hz to 45 Hz	1.7 mA	Fluke 5560A Fluke 5560A	
	45 Hz to 1 kHz	1.2 mA		
	1 kHz to 5 kHz	1.5 mA		
	5 kHz to 10 kHz	7.4 mA		
Equipment to Measure AC Current <sup>FO</sup> 3.1 A to 12 A	3 Hz to 45 Hz	5.3 mA		
	45 Hz to 1 kHz	3.8 mA		
	1 kHz to 5 kHz	5.0 mA		
	5 kHz to 10 kHz	28 mA		
Equipment to Measure AC Current <sup>FO</sup> 12 A to 30.2 A	3 Hz to 45 Hz	39 mA		
	45 Hz to 1 kHz	28 mA		
Equipment to Source Frequency <sup>FO</sup>	1 mHz to 3 GHz	28 parts in $10^{10}$	HP 53132A	
Equipment to Measure Frequency <sup>FO</sup>	1 mHz to 3 GHz	28 parts in $10^{10}$	HP E4422B Signal Generator locked to FS725 Rubidium Frequency Standard HP 53132A	



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Equipment to Source AC Current At the listed frequencies <sup>FO</sup>			HP 3458A Opt 002 with HP 34330A Shunt	GIDEP/OEM Manual
45 Hz to 1 kHz	11 A to 20.5 A	13 mA		
1 kHz to 5 kHz	11 A to 20.5 A	13 mA		
Equipment to Source Inductance <sup>FO</sup>	100 $\mu$ H to 1 mH	17 $\mu$ H	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 <sup>FO</sup>	100 $\mu$ H to 1 mH	0.24 $\mu$ H	GR 1491D Decade Box	
	1 to 10 mH	2.4 $\mu$ H		
	10 mH to 100 mH	24 $\mu$ H		
	100 mH to 1 H	0.24 mH		
	1 H to 10 H	2.3 mH		
Equipment to Source Capacitance <sup>FO</sup>	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 $\mu$ F	0.41 nF		
	1 $\mu$ F to 1.111 $\mu$ F	0.44 nF		
Equipment to Measure Capacitance At the listed frequencies <sup>FO</sup>			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 $\mu$ F	0.62 nF		



# Certificate of Accreditation: Supplement

## Total Calibration Solutions, INC

7722 Metric Drive, Mentor, OH 44060

Contact Name: Mark Hanson Phone: 440-299-4811

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

### Electrical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Equipment to Measure Capacitance At the listed frequencies <sup>FO</sup>			Fluke 5522A	GIDEP / OEM Manual
10 Hz to 10 kHz	220 pF to 400 pF	15 pF		
10 Hz to 10 kHz	0.4 nF to 1.1 nF	18 pF		
10 Hz to 3 kHz	1.1 nF to 3.3 nF	23 pF		
10 Hz to 1 kHz	3.3 nF to 11 nF	44 pF		
10 Hz to 1 kHz	11 nF to 33 nF	0.17 nF		
10 Hz to 1 kHz	33 nF to 110 nF	0.44 nF		
Equipment to Measure Capacitance At the listed frequencies <sup>FO</sup>				
10 Hz to 1 kHz	110 nF to 330 nF	0.92 nF		
10 Hz to 600 Hz	330 nF to 1.1 $\mu$ F	4.1 nF		
10 Hz to 300 Hz	1.1 $\mu$ F to 3.3 $\mu$ F	12 nF		
10 Hz to 150 Hz	3.3 $\mu$ F to 11 $\mu$ F	44 nF		
10 Hz to 120 Hz	11 $\mu$ F to 33 $\mu$ F	0.18 $\mu$ F		
10 Hz to 80 Hz	33 $\mu$ F to 110 $\mu$ F	0.7 $\mu$ F		
0 Hz to 50 Hz	110 $\mu$ F to 330 $\mu$ F	2 $\mu$ F		
Equipment to Measure Capacitance At the listed frequencies <sup>FO</sup>				
0 Hz to 20 Hz	330 $\mu$ F to 1.1 mF	12 $\mu$ F		
0 Hz to 6 Hz	1.1 mF to 3.3 mF	20 $\mu$ F		
0 Hz to 2 Hz	3.3 mF to 11 mF	89 $\mu$ 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 Measure DC Resistance <sup>FO</sup>	Up to 10 $\Omega$	1.6 m $\Omega$	ESI RS925A Resistance Decade Box	
	10 $\Omega$ to 100 $\Omega$	3.1 m $\Omega$		
	100 $\Omega$ to 1 k $\Omega$	27 m $\Omega$		
	1 k $\Omega$ to 10 k $\Omega$	0.26 $\Omega$		
	10 k $\Omega$ to 100 k $\Omega$	2.6 $\Omega$		
	100 k $\Omega$ to 1.1 M $\Omega$	29 $\Omega$		
	Up to 10 $\Omega$	1.6 m $\Omega$	Fluke 5522A	
	1.1 M $\Omega$ to 3.3 M $\Omega$	0.29 k $\Omega$		
	3.3 M $\Omega$ to 11 M $\Omega$	0.35 k $\Omega$		
	11 M $\Omega$ to 33 M $\Omega$	12 k $\Omega$		
	33 M $\Omega$ to 110 M $\Omega$	66 k $\Omega$		
	110 M $\Omega$ to 330 M $\Omega$	1.2 M $\Omega$		
330 M $\Omega$ to 1.1 G $\Omega$	18 M $\Omega$			



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Equipment to Source DC Resistance <sup>FO</sup>	Up to 10 $\Omega$	0.31 m $\Omega$	HP 3458A Opt 002	GIDEP / OEM Manual
	10 $\Omega$ to 100 $\Omega$	2.7 m $\Omega$		
	100 $\Omega$ to 1 k $\Omega$	18 m $\Omega$		
	1 k $\Omega$ to 10 k $\Omega$	0.18 $\Omega$		
	10 k $\Omega$ to 100 k $\Omega$	1.8 $\Omega$		
	100 k $\Omega$ to 1 M $\Omega$	25 $\Omega$		
	1 M $\Omega$ to 10 M $\Omega$	0.78 k $\Omega$		
10 M $\Omega$ to 100 M $\Omega$	68 k $\Omega$			
Oscilloscopes Amplitude – DC <sup>FO</sup>			Fluke 5522A / SC1100	
50 $\Omega$	-6.6 V to 6.6 V	20 mV		
1 M $\Omega$	-130 V to 130 V	15 mV		
Amplitude - Square Wave <sup>FO</sup>				
50 $\Omega$	1 mV to 6.6 V (p-p)	13 mV		
1 M $\Omega$	1 mV to 130 V (p-p)	18 mV		
Frequency	10 Hz to 10 kHz	29 Hz		
Time Markers into 50 $\Omega$ Load	1 ns to 20 ms	8.2 $\mu$ 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	0.1 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	0.2 V		
Edge Characteristics into 50 $\Omega$ Load	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 $\Omega$ Load Into 1 M $\Omega$ Load Frequency	1.8 mV to 55 V p-p	88 mV		
	1.8 mV to 55 V p-p	2 V		
	10 Hz to 100 kHz	0.29 Hz		
Pulse – Generate 50 $\Omega$ Load	22 ms to 200 ns	6.1 ns		
	45.5 Hz to 5 MHz			
Period	4 ns to 500 ns	1.2 ns		
Width				



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Input Resistance Measurement <sup>FO</sup>	40 $\Omega$ to 60 $\Omega$	56 m $\Omega$	Fluke 5522A / SC1100	GIDEP/OEM Manual
	500 k $\Omega$ to 1.5M $\Omega$	2.5 k $\Omega$		
Oscilloscope Capacitance Measurement <sup>FO</sup>	5 pF to 50 pF	1.3 pF	Fluke 5522A	
Electrical Simulation of Thermocouple Indicators Type B <sup>FO</sup>	600 $^{\circ}$ C to 800 $^{\circ}$ C	0.53 $^{\circ}$ C		
	800 $^{\circ}$ C to 1 000 $^{\circ}$ C	0.42 $^{\circ}$ C		
	1 000 $^{\circ}$ C to 1 550 $^{\circ}$ C	0.37 $^{\circ}$ C		
	1 550 $^{\circ}$ C to 1 820 $^{\circ}$ C	0.4 $^{\circ}$ C		
Electrical Simulation of Thermocouple Indicators Type C <sup>FO</sup>	0 $^{\circ}$ C to 150 $^{\circ}$ C	0.35 $^{\circ}$ C		
	150 $^{\circ}$ C to 650 $^{\circ}$ C	0.31 $^{\circ}$ C		
	650 $^{\circ}$ C to 1 000 $^{\circ}$ C	0.38 $^{\circ}$ C		
	1 000 $^{\circ}$ C to 1 800 $^{\circ}$ C	0.59 $^{\circ}$ C		
	1 800 $^{\circ}$ C to 2 316 $^{\circ}$ C	0.98 $^{\circ}$ C		
Electrical Simulation of Thermocouple Indicators Type E <sup>FO</sup>	-250 $^{\circ}$ C to -100 $^{\circ}$ C	0.58 $^{\circ}$ C		
	-100 $^{\circ}$ C to -25 $^{\circ}$ C	0.19 $^{\circ}$ C		
	-25 $^{\circ}$ C to 350 $^{\circ}$ C	0.17 $^{\circ}$ C		
	350 $^{\circ}$ C to 650 $^{\circ}$ C	0.19 $^{\circ}$ C		
	650 $^{\circ}$ C to 1 000 $^{\circ}$ C	0.25 $^{\circ}$ C		
Electrical Simulation of Thermocouple Indicators Type J <sup>FO</sup>	-210 $^{\circ}$ C to -100 $^{\circ}$ C	0.33 $^{\circ}$ C		
	-100 $^{\circ}$ C to -30 $^{\circ}$ C	0.2 $^{\circ}$ C		
	-30 $^{\circ}$ C to 150 $^{\circ}$ C	0.17 $^{\circ}$ C		
	150 $^{\circ}$ C to 760 $^{\circ}$ C	0.21 $^{\circ}$ C		
	760 $^{\circ}$ C to 1 200 $^{\circ}$ C	0.27 $^{\circ}$ C		
Electrical Simulation of Thermocouple Indicators Type K <sup>FO</sup>	-200 $^{\circ}$ C to -100 $^{\circ}$ C	0.39 $^{\circ}$ C		
	-100 $^{\circ}$ C to -25 $^{\circ}$ C	0.22 $^{\circ}$ C		
	-25 $^{\circ}$ C to 120 $^{\circ}$ C	0.19 $^{\circ}$ C		
	120 $^{\circ}$ C to 1 000 $^{\circ}$ C	0.31 $^{\circ}$ C		
	1 000 $^{\circ}$ C to 1 372 $^{\circ}$ C	0.48 $^{\circ}$ C		
Electrical Simulation of Thermocouple Indicators Type L <sup>FO</sup>	-200 $^{\circ}$ C to -100 $^{\circ}$ C	0.44 $^{\circ}$ C		
	-100 $^{\circ}$ C to 800 $^{\circ}$ C	0.32 $^{\circ}$ C		
	800 $^{\circ}$ C to 900 $^{\circ}$ C	0.22 $^{\circ}$ C		
Electrical Simulation of Thermocouple Indicators Type N <sup>FO</sup>	-200 $^{\circ}$ C to -100 $^{\circ}$ C	0.47 $^{\circ}$ C		
	-100 $^{\circ}$ C to -25 $^{\circ}$ C	0.26 $^{\circ}$ C		
	-25 $^{\circ}$ C to 120 $^{\circ}$ C	0.23 $^{\circ}$ C		
	120 $^{\circ}$ C to 410 $^{\circ}$ C	0.22 $^{\circ}$ C		
	410 $^{\circ}$ C to 1 300 $^{\circ}$ C	0.33 $^{\circ}$ C		



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### Electrical

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Electrical Simulation of Thermocouple Indicators Type R <sup>FO</sup>	0 °C to 250 °C	0.67 °C	Fluke 5522A	GIDEP/OEM Manual
	250 °C to 400 °C	0.42 °C		
	400 °C to 1 000 °C	0.4 °C		
	1 000 °C to 1 767 °C	0.48 °C		
Electrical Simulation of Thermocouple Indicators Type S <sup>FO</sup>	0 °C to 250 °C	0.56 °C	Fluke 5522A	GIDEP/OEM Manual
	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 <sup>FO</sup>	-250 °C to -150 °C	0.74 °C	Fluke 5522A	GIDEP/OEM Manual
	-150 °C to 0 °C	0.3 °C		
	0 °C to 120 °C	0.19 °C		
	120 °C to 400 °C	0.17 °C		
Electrical Simulation of Thermocouple Indicators Type U <sup>FO</sup>	-200 °C to 0 °C	0.66 °C	Fluke 5522A	GIDEP/OEM Manual
	0 °C to 600 °C	0.33 °C		
Electrical Simulation of RTD Indicators Pt 385, 100 $\Omega$ <sup>FO</sup>	-200 °C to -80 °C	0.06 °C	Fluke 5522A	GIDEP/OEM Manual
	-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		
Electrical Simulation of RTD Indicators Pt 385, 200 $\Omega$ <sup>FO</sup>	-200 °C to -80 °C	0.05 °C	Fluke 5522A	GIDEP/OEM Manual
	-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		
Electrical Simulation of RTD Indicators Pt 385, 500 $\Omega$ <sup>FO</sup>	-200 °C to -80 °C	0.05 °C	Fluke 5522A	GIDEP/OEM Manual
	-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		



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### Electrical

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Electrical Simulation of RTD Indicators Pt 385, 500 $\Omega$ <sup>FO</sup>	300 °C to 400 °C	0.09 °C	Fluke 5522A	GIDEP/OEM Manual
	400 °C to 600 °C	0.11 °C		
	600 °C to 630 °C	0.13 °C		
Electrical Simulation of RTD Indicators Pt 385, 1000 $\Omega$ <sup>FO</sup>	-200 °C to -80 °C	0.04 °C		
	-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 - Measure (0 to 360)° <sup>FO</sup>	65 Hz to 500 Hz	0.29 °		
Equipment to Source RF Power at listed Frequencies <sup>FO</sup>				
150 kHz to 1.3 GHz	-20 dBm to 30 dBm	0.21 dBm	HP 8902A / HP 11722A	
1.3 GHz to 18 GHz	-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 <sup>FO</sup>	-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 <sup>FO</sup>			HP 8902A	GIDEP/OEM Manual
Frequency: 150 kHz to 10 MHz Rate: 50 Hz to 10 kHz	5 % to 99 %	2.3 %		
Frequency: 150 kHz to 10 MHz Rate: 20 Hz to 10 kHz	Up 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	Up to 99 %	3.5 %		
Equipment to Source Frequency Modulation at the listed Frequencies and Rates <sup>FO</sup>			HP 8902A	
Frequency: 250 kHz to 10 MHz Rate: 20 Hz to 10 kHz $\leq$ 40 kHz peak	0 Hz to 4 kHz	0.12 kHz		
	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 kHz		
Equipment to Source Phase Modulation at the listed Frequencies <sup>FO</sup>				
150 kHz to 10 MHz	0 to $2\pi$ rad	0.32 rad		
10 MHz to 1.3 GHz	0 to $2\pi$ rad	0.56 rad		



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### Thermodynamic

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Equipment to measure Humidity <sup>FO</sup>	Up to 10 % RH	1.4 %	Vaisala HMT 333 / HMP75 Thunder Scientific 2500	SOP-16 Temperature and Humidity Calibration
	10 % RH to 95 % RH	0.71 %		
Equipment to measure Temperature <sup>FO</sup>	-196 °C	0.021 °C	Liquid Nitrogen Temperature Bath Fluke 5628 PRT HP 3458A Opt 002	SOP-03 Temperature Calibration
	-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 (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Equipment to Measure Frequency <sup>FO</sup>	1 MHz to 3 GHz	29 parts in $10^{10}$	HP E4422B Signal Generator locked to FS725 Rubidium Frequency Standard	GIDEP/OEM Manual
Equipment to Source Frequency <sup>FO</sup>	0.1 GHz to 3 GHz	28 parts in $10^{10}$	HP 53132A	
Equipment to measure Rotational Speed <sup>FO</sup>	Up to 10 000 rpm	0.06 rpm	HP 53132A	
	10 000 rpm to 100 000 rpm	1.2 rpm		
Timers and Stopwatches <sup>F</sup>	Up to 3 600 s	0.007 2 s	HP 5313 HP 53132a	NIST 960-12
	3 600 s to 10 800 s	0.059 s		
	Up to 24 Hours	0.25 s		

### Mechanical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Equipment to Measure Pressure <sup>FO</sup>	-1 psig to 1 psig	0.000 24 psig	Fluke 7250LP	SOP-07 Pressure and Vacuum Calibration
	1 psig to 5 psig	0.000 15 psig	Fluke PG7601 Deadweight Tester, 10 kPa/kg 6270A Pressure Controller	
	5 to 10 psig	0.000 24 psig		
	10 to 15 psig	0.000 31 psig		
	15 to 30 psig	0.000 37 psig		
	30 to 50 psig	0.000 58 psig		



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### Mechanical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Equipment to Measure Pressure <sup>FO</sup>	50 to 100 psig	0.001 9 psig	Fluke PG7601 Deadweight Tester, 200 kPa/kg 6270A Pressure Controller	SOP-07 Pressure and Vacuum Calibration
	100 to 150 psig	0.002 7 psig		
	150 to 200 psig	0.004 2 psig		
	200 to 300 psig	0.005 9 psig		
	300 to 400 psig	0.007 4 psig		
	400 to 600 psig	0.011 psig		
	600 psig to 20 000 psig	0.012 % of reading	Fluke P3116-PSI Deadweight Tester	
	20 000 psig to 40 000 psig	47 psig	Additel ADT681	
Equipment to measure Vacuum <sup>F</sup>	Up to 5 psia	0.000 15 psia	Fluke PG7601 Deadweight Tester, 10 kPa/kg	SOP-07 Pressure and Vacuum Calibration
	5 to 10 psia	0.000 24 psia	Fluke PG7601 Deadweight Tester, 10 kPa/kg	
	10 to 14.7 psia	0.000 31 psia	Fluke PG7601 Deadweight Tester, 10 kPa/kg	
Equipment to measure Mass Flow <sup>FO</sup>	0.5 sccm to 50 sccm	0.31 % of reading	Mesa Labs ML-800-3	SOP-03 Mass Flowmeter Calibration /OEM Manual
	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.	
Equipment to measure Liquid Flow <sup>FO</sup>	1 gpm to 60 gpm	0.45 % of reading	Cox Liquid Flow Standard	SOP-34 Liquid Flow
Equipment to measure Liquid Flow <sup>F</sup>	60 GPM to 225 GPM	0.74% of Reading	Hoffer HO2X2A Flow Meter	Calibration / OEMManual
Equipment to measure Torque <sup>FO</sup>	1 in-oz to 500 in-lb	0.1 % of reading	Torque Arms, F Class Weights	SOP-28 Torque Transducers / OEM Manual
	41.6 ft-lb to 800 ft-lb			
Torque Tools <sup>FO</sup>	2 in oz to 1.25 in-lb	0.6 % of reading	Mountz BMX20Z	SOP-04 Torque Tool Calibration / OEM Manual
	1.25 in-lb to 10 in-lb	0.59 % of reading	Mountz TL10i	
	10 in-lb to 500 in-lb	0.3 % 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	
Accelerometers / Vibration <sup>FO</sup>			Modal Shop 9100D / PCB 9105D	GIDEP/OEM Manual
10 Hz – 30Hz	Up to 20 g pk	4.6 % of reading		
30 Hz – 2 000 Hz	Up to 20 g pk	3.8 % of reading		
2 000 Hz – 10 kHz	Up to 20 g pk	5.3 % of reading		



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

### Mass, Force, and Weighing Devices

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED			
Equipment to measure Force-Compression and Tension <sup>F</sup>	Up to 10 lbf	0.003 lbf	Class F Weights	SOP-13 Force Calibration			
	10 to 100 lbf	0.017 lbf					
	100 to 200 lbf	0.029 lbf					
	200 to 500 lbf	0.1 lbf					
Force - Compression & Tension <sup>FO</sup>	Up to 500 lbf	0.1 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 <sup>FO</sup>	Up to 20 g (0.001 mg)	14 $\mu$ g	Class 1 Weights	SOP-10 Balance and Scale Calibration			
	20 g to 40 g (0.01 mg)	30 $\mu$ g					
	40 g to 60 g (0.01 mg)	39 $\mu$ g					
	60 g to 80 g (0.01 mg)	45 $\mu$ g					
	80 g to 100 g (0.01 mg)	71 $\mu$ g					
	100 g to 200 g (0.01 mg)	77 $\mu$ g					
	200 g to 500 g (0.1 mg)	0.89 mg					
	500 kg to 1 kg (1 mg)	2.6 mg					
	1 kg to 2 kg (1 mg)	2.8 mg					
	2 kg to 4 kg (1 mg)	4.3 mg					
	4 kg to 5 kg Res.= (1 mg)	14 mg					
	Scale <sup>FO</sup>	5 kg to 10 kg Res.= (1 mg)			24 mg	Class F Weights	SOP-10 Balance and Scale Calibration
		10 kg to 15 kg Res.= (1 mg)			99 mg		
15 kg to 20 kg Res.= (0.1 g)		0.11 g					
20 kg to 25 Res.= (0.1 g)		0.12 g					



# Certificate of Accreditation: Supplement

## Total Calibration Solutions, INC

7722 Metric Drive, Mentor, OH 44060

Contact Name: Mark Hanson Phone: 440-299-4811

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

### Mass, Force, and Weighing Devices

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Scale <sup>FO</sup>	25 kg to 100 kg Res.= (0.1 g)	0.15 g	Class F Weights	SOP-10 Balance and Scale Calibration
	100 kg to 200 kg Res.= (0.1 g)	0.21 g		
	200 kg to 255 kg Res.= (0.1 g)	0.23 g		
	Up to 20 lb Res.= (0.001 lb)	0.001 1 lb		
	20 lb to 50 lb Scale Calibration 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.= (0.1 lb)	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 <sup>FO</sup>	0.5 $\mu$ L to 2 $\mu$ L		
2 $\mu$ L to 10 $\mu$ L		0.078 $\mu$ L		
10 $\mu$ L to 20 $\mu$ L		0.08 $\mu$ L		
20 $\mu$ L to 100 $\mu$ L		0.094 $\mu$ L		
100 $\mu$ L to 200 $\mu$ L		0.16 $\mu$ L		
200 $\mu$ L to 500 $\mu$ L		0.4 $\mu$ L		
500 $\mu$ L to 1 000 $\mu$ L		0.51 $\mu$ L		
1 000 $\mu$ L to 5 100 $\mu$ L		2.5 $\mu$ L		
Mass <sup>FO</sup>	Up to 2 g	0.002 mg	Class 0 Weights with: Micro Balance Semi-Micro Balance Analytical Balance Medium Precision Balance Heavy Precision Balance	SOP-42 Mass Calibration
	2 g to 20 g	0.009 mg		
	20 g to 200 g	0.046 mg		
	200 g to 1 000 g	0.17 mg		
	1 000 g to 3 000 g	1.1 mg		
	3 000 g to 5 000 g	3.4 mg		
	5 000 g to 10 000 g	6.5 mg		
	10 kg to 30 kg	0.15 g		
	30 kg to 60 kg	0.74 g		



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

### Chemical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE (AND SPECIFICATION WHERE APPROPRIATE)	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY ( $\pm$ )	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED	CALIBRATION MEASUREMENT METHOD OR PROCEDURES USED
Conductivity Meters <sup>F</sup>	1 $\mu$ S/cm	0.56 $\mu$ S/cm	Compared to Standard Solutions	SOP-44 Conductivity / OEM Manual
	10 $\mu$ S/cm	0.59 $\mu$ S/cm		
	100 $\mu$ S/cm	2.4 $\mu$ S/cm		
	1 000 $\mu$ S/cm	6.9 $\mu$ S/cm		
	10 000 $\mu$ S/cm	190 $\mu$ S/cm		
	100 000 $\mu$ S/cm	2 400 $\mu$ S/cm		

- 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.
- 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.
- The presence of a superscript F means that the laboratory performs calibration of the indicated parameter at its fixed location.
- The presence of a superscript O means that the laboratory performs calibration of the indicated parameter onsite at customer locations.
- Measurement uncertainties obtained for calibrations performed at customer sites can be expected to be larger than the measurement uncertainties obtained at the laboratories fixed location for similar calibrations. This is due to the effects of transportation of the standards and equipment and upon environmental conditions at the customer site which are typically not controlled as closely as at the laboratories fixed location.
- The term L represents length in inches or millimeters as appropriate to the uncertainty statement.