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NO: SAMM 011
(Issue 3, 1 July 2025 replacement
of SAMM 011 dated 4 February 2025)

LABORATORY LOCATION:
(PERMANENT LABORATORY)

TRESCAL (MALAYSIA) SDN. BHD.
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FIELDS OF CALIBRATION: **HEAT & TEMPERATURE, MASS, FORCE, TORQUE, HARDNESS, PRESSURE, VOLUME, FLOW, VISCOSITY, DENSITY, OPTICAL, DIMENSIONAL, TIME & FREQUENCY, ELECTRICAL**

FIELD OF TESTING: **MECHANICAL**

This laboratory has demonstrated its technical competence to operate in accordance with MS ISO/IEC 17025:2017 (ISO/IEC 17025:2017).

This laboratory's fulfillment of the requirements of ISO/IEC 17025 means the laboratory meets both the technical competence requirements and management system requirements that are necessary for it to consistently deliver technically valid test results and calibrations. The management system requirements in ISO/IEC 17025 are written in language relevant to laboratory operations and operate generally in accordance with the principles of ISO 9001 (see Joint ISO-ILAC-IAF Communiqué dated April 2017).

*** The uncertainty covered by the CMC is expressed as the expanded uncertainty corresponding to a coverage probability of approximately 95 % and have a coverage factor of *k*=2 unless stated otherwise.**

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Sensor	-196 °C	0.3 °C	Comparison with Pt 100 in liquid nitrogen storage container
	-80 °C to -40 °C -40 °C to 30 °C 30 °C to 250 °C 250 °C to 400 °C 400 °C to 600 °C 600 °C to 800 °C 800 °C to 1000 °C 1000 °C to 1300 °C	0.05 °C 0.02 °C 0.023 °C 0.16 °C 0.21 °C 1.4 °C 1.6 °C 2.5 °C	Comparison with Pt 100 and thermocouple in liquid bath and temperature block calibrator

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Sensor with indicator	-196 °C	0.3 °C	Comparison with Pt 100 in liquid nitrogen storage container
	-80 °C to -40 °C -40 °C to 30 °C 30 °C to 250 °C 250 °C to 400 °C 400 °C to 600 °C 600 °C to 800 °C 800 °C to 1000 °C 1000 °C to 1300 °C	0.05 °C 0.02 °C 0.033 °C 0.15 °C 0.23 °C 1.4 °C 1.6 °C 2.5 °C	Comparison with Pt 100 and thermocouple in liquid bath and temperature block calibrator
Temperature Recorders / Indicators (by electrical simulation)			By electrical simulation using calibrator and reference table ITS 90
a) Type T	-270 °C to -100 °C -100 °C to 400 °C	0.5 °C 0.1 °C	
b) Type E	-250 °C to -100 °C -100 °C to 1000 °C	0.5 °C 0.1 °C	
c) Type K	-270 °C to -100 °C -100 °C to 1370 °C	1.1 °C 0.1 °C	
d) Type R	-50 °C to 500 °C 500 °C to 1760 °C	0.3 °C 0.1 °C	
e) Type J	-210 °C to 1200 °C	0.1 °C	
f) Type S	-50 °C to 500 °C 500 °C to 1760 °C	0.3 °C 0.1 °C	
g) Type B	200 °C to 500 °C 500 °C to 1800 °C	1.0 °C 0.2 °C	
h) Type N	-200 °C to -100 °C -100 °C to 1300 °C	1.0 °C 0.1 °C	
i) Pt 100	-200 °C to 850 °C	0.1 °C	

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Calibrator **(I) Simulation**			By electrical measurement using multimeter and reference table ITS 90
a) Type T	-270 °C to -100 °C -100 °C to 400 °C	0.6 °C 0.1 °C	
b) Type E	-270 °C to -100 °C -100 °C to 1000 °C	0.6 °C 0.1 °C	
c) Type K	-270 °C to -100 °C -100 °C to 1370 °C	1.1 °C 0.1 °C	
d) Type R	-50 °C to 500 °C 500 °C to 1760 °C	0.3 °C 0.1 °C	
e) Type J	-210 °C to 1200 °C	0.1 °C	
f) Type S	-50 °C to 500 °C 500 °C to 1760 °C	0.3 °C 0.2 °C	
g) Type B	100 °C to 500 °C 500 °C to 1800 °C	1.1 °C 0.3 °C	
h) Type N	-200 °C to -100 °C -100 °C to 1300 °C	1.1 °C 0.1 °C	
i) Pt 100	-200 °C to 850 °C	0.1 °C	
(II) Measurement a) Type T	-270 °C to -100 °C -100 °C to 400 °C	0.5 °C 0.1 °C	By electrical simulation using calibrator and reference table ITS 90
b) Type E	-250 °C to -100 °C -100 °C to 1000 °C	0.6 °C 0.1 °C	
c) Type K	-270 °C to -100 °C -100 °C to 1370 °C	1.1 °C 0.1 °C	
d) Type R	-50 °C to 500 °C 500 °C to 1760 °C	0.3 °C 0.1 °C	
e) Type J	-210 °C to 1200 °C	0.1 °C	
f) Type S	-50 °C to 500 °C 500 °C to 1760 °C	0.3 °C 0.1 °C	

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Calibrator (II) Measurement (continued)			
g) Type B	200 °C to 500 °C 500 °C to 1800 °C	1.1 °C 0.3 °C	By electrical simulation using calibrator and reference table ITS 90
h) Type N	-200 °C to -100 °C -100 °C to 1300 °C	1.0 °C 0.1 °C	
i) Pt 100	-200 °C to 850 °C	0.1 °C	
Liquid-in-glass Thermometer (Total Immersion)	-40 °C to -30 °C -30 °C to 30 °C 30 °C to 200 °C 200 °C to 400 °C	0.08 °C 0.045 °C 0.035 °C 0.15 °C	Comparison with Pt100 in liquid bath and temperature block calibrator
Liquid-in-glass Thermometer (Partial Immersion)	-40 °C to -30 °C -30 °C to 30 °C 30 °C to 200 °C 200 °C to 400 °C	0.08 °C 0.045 °C 0.035 °C 0.15 °C	

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature & Humidity Indicator or Recorder	-70 °C to 5 °C 5 °C to 50 °C 50 °C to 80 °C	0.3 °C 0.1 °C 0.3 °C	Comparison with Pt100 sensor in chamber and humidity calibrator
	Relative humidity at 25 °C 5 %rh to 50 %rh 50 % rh to 70 %rh 70 %rh to 95 %rh 95 %rh to 98 %rh	1.4 %rh 1.6 %rh 1.8 %rh 2.2 %rh	Comparison with thermohygrometer and wet & dry bulb in chamber and humidity calibrator
Temperature Block Calibrator	-40 °C to 400 °C 400 °C to 600 °C 600 °C to 1300 °C	0.015 °C 0.02 °C 2.8 °C	Calibration using PRT sensor and thermocouple R/S
Radiation Thermometer	50 °C to 100 °C 100 °C to 200 °C 200 °C to 400 °C 400 °C to 1200 °C	0.6 °C 1.0 °C 1.5 °C 3.3 °C	Comparison with Pt100, thermocouple and radiation thermometer

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature & Humidity Sensor (Probe Type)	Relative Humidity at 25 °C 5 %rh 10 %rh 20 %rh 35 %rh 50 %rh 80 %rh 95 %rh	 0.6 %rh 0.6 %rh 0.6 %rh 0.8 %rh 0.8 %rh 1.3 %rh 1.3 %rh	Comparison with Humidity Standard Solution with reference to ASTM E104
Infrared Ear Thermometer	35 ºC to 42 ºC	0.07 ºC	Comparison with PRT in liquid bathblackbody with reference to ASTM E1965

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Sensor with Indicator	-30 °C to 30 °C 30 °C to 200 °C 200 °C to 400 °C 400 °C to 600 °C	0.1 °C 0.08 °C 0.3 °C 0.69 °C	Comparison with Pt100 In liquid bath and temperature block calibrator
Temperature Chamber	-80 °C to -40 °C -40 °C to 250 °C 250 °C to 400 °C 400 °C to 900 °C 900 °C to 1300 °C	0.8 °C 0.2 °C 1.7 °C 2.4 °C 2.6 °C	Calibrated by using temperature recorder with thermocouple and PRT
Temperature Recorders / Indicators			
a) Type T	-200 °C to -100 °C -100 °C to 400 °C	0.6 °C 0.2 °C	
b) Type E	-200 °C to -100 °C -100 °C to 1000 °C	0.6 °C 0.2 °C	
c) Type K	-200 °C to -100 °C -100 °C to 1370 °C	1.1 °C 0.2 °C	
d) Type R	0 °C to 1760 °C	1.0 °C	By electrical simulation using calibrator and reference table ITS 90
e) Type J	-200 °C to 1200 °C	0.2 °C	
f) Type S	0 °C to 1760 °C	1.0 °C	
g) Type B	600 °C to 1800 °C	1.0 °C	
h) Type N	-200 °C to -100 °C -100 °C to 1300 °C	1.1 °C 0.2 °C	
i) Pt 100	-200 °C to 850 °C	0.2 °C	

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Humidity Chamber	5 °C to 60 °C 20 %rh to 95 %rh	0.2 °C 2.0 %rh	Calibrated by using thermohygrometer
Temperature Sensor Pt 100 Thermocouple	 -30 °C to 30 °C 30 °C to 200 °C 200 °C to 400 °C 400 °C to 600 °C -30 °C to 30 °C 30 °C to 200 °C 200 °C to 400 °C 400 °C to 600 °C	 0.10 °C 0.13 °C 0.28 °C 0.70 °C 0.3 °C 0.18 °C 0.30 °C 0.71 °C	Comparison with Pt 100 and temperature calibrator in liquid bath and temperature block calibrator

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Block Calibrator	-40 °C to 400 °C 400 °C to 600 °C 600 °C to 1300 °C	0.015 °C 0.02 °C 2.8 °C	Calibration using PRT sensor and thermocouple R/S
Temperature Liquid Bath	-40 °C to 250 °C	0.015 °C	Calibration using PRT sensor

SCOPE OF CALIBRATION: HEAT AND TEMPERATURE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature & Humidity Sensor	5 °C to 50 °C Relative humidity at 25 °C 5 %rh to 50 %rh 50 %rh to 70 %rh 70 %rh to 95 %rh	0.1 °C 1.4 %rh 1.6 %rh 1.8 %rh	Comparison with thermohygrometer and Pt100 sensor in humidity calibrator

SCOPE OF CALIBRATION: MASS

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Standard Weight / Dead Weight	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg 25 kg 30 kg	0.003 mg 0.003 mg 0.003 mg 0.003 mg 0.005 mg 0.005 mg 0.005 mg 0.006 mg 0.006 mg 0.008 mg 0.009 mg 0.009 mg 0.015 mg 0.015 mg 0.05 mg 0.08 mg 0.09 mg 0.3 mg 0.6 mg 1 mg 5 mg 15 mg 0.02 g 0.2 g 0.2 g	Calibration by comparison with standard weight of same nominal value

SCOPE OF CALIBRATION: MASS

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Balance	Up to 5 g Up to 20 g Up to 50 g Up to 220 g Up to 300 g Up to 1000 g Up to 2500 g Up to 6200 g Up to 10 kg Up to 20 kg Up to 50 kg Up to 120 kg Up to 200 kg Up to 500 kg Up to 1000 kg Up to 2500 kg Up to 4000 kg	0.06 mg 0.11 mg 0.3 mg 1.0 mg 1.5 mg 4.4 mg 23 mg 55 mg 70 mg 0.2 g 0.4 g 1.1 g 44 g 0.10 kg 0.20 kg 0.50 kg 1.0 kg	Calibrated by using standard weights
Standard Weight * (Deadweight)	20 kg 25 kg	0.2 g 0.2 g	Calibration by comparison with standard weight of same nominal value * OIML Class M2 and below/ or equivalent classification

SCOPE OF CALIBRATION: MASS

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Weighing Device (Weighing Scale, Hopper Scale & Tank Scale)	Up to 600 kg Up to 2000 kg Up to 4000 kg Up to 6000 kg Up to 8000 kg Up to 10000 kg	0.5 kg 1.1 kg 2.1 kg 3.5 kg 4.5 kg 5.4 kg	Calibration using substitution loads with general reference to Measurement Canada – Field Inspection Manual – Non automatic weighing devices, and Euramet cg-18 v4.0.

SCOPE OF CALIBRATION: FORCE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Force Measurement Device (Compression & Tension)	0 N to 5 N	0.001 N	Calibrated by using standard weights generally based on ISO 376
	5 N to 1 kN	0.03 N	Calibrated by using dead weights generally based on ISO 376
	1 kN to 10 kN 10 kN to 50 kN 50 kN to 100 kN	6.1 N 7.6 N 85 N	Calibrated by using load cell generally based on ISO 376
Force Measurement Device (Tension)	100 kN to 300 kN	410 N	
Force Measurement Device (Compression)	100 kN to 500 kN	0.3 kN	

SCOPE OF CALIBRATION: FORCE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Universal Tensile / Compression Testing Machine	980 N 9.8 kN 49 kN 98 kN 196 kN 490 kN 980 kN 2000 kN	0.03 N 7.2 N 37 N 85 N 0.32 kN 0.35 kN 3.0 kN 4.2 kN	Calibrated by using load cell based on ISO 7500-1
Load Cell	0 N to 5 N	0.012 N	Calibrated by using standard weights based on ISO 376
	5 N to 1 kN	0.03 N	Calibrated by using dead weights based on ISO 376
	1 kN to 10 kN 10 kN to 50 kN Tension mode only	7.3 N 37 N	Calibrated by using load cell based on ISO 376
	<u>Tension and Compression Mode</u> Up to 10 kN Up to 20 kN Up to 50 kN <u>Compression mode only</u> Up to 100 kN	 7.4 N 9.3 N 11 N 79 N	Calibrated by using load cell based on ISO 376

SCOPE OF CALIBRATION: TORQUE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Torque Measuring Device	0 N.m to 1 N.m 1 N.m to 2 N.m 2 N.m to 10 N.m 10 N.m to 30 N.m 30 N.m to 150 N.m 150 N.m to 400 N.m 400 N.m to 1500 N.m	0.49 % of reading 0.39 % of reading 0.31 % of reading 0.40 % of reading 0.26 % of reading 0.16 % of reading 0.12 % of reading	Calibrated using torque calibrators based on BS7882
Hand Torque Tools	0 N.m to <0.12 N.m 0.12 N.m to <0.2 N.m 0.2 N.m to <2 N.m 2 N.m to <10 N.m 10 N.m to <150 N.m 150 N.m to <400 N.m 400 N.m to 1500 N.m	3.6 % of reading 1.7 % of reading 1.5 % of reading 1.0 % of reading 0.8 % of reading 0.3 % of reading 0.3 % of reading	Calibrated using torque calibrators based on ISO 6789-2

SCOPE OF CALIBRATION: TORQUE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Hand Torque Tools	0 N.m to <0.12 N.m 0.12 N.m to <0.2 N.m 0.2 N.m to <2 N.m 2 N.m to <10 N.m 10 N.m to <150 N.m 150 N.m to <400 N.m 400 N.m to 1500 N.m	3.6 % of reading 1.7 % of reading 1.5 % of reading 1.0 % of reading 0.8 % of reading 0.3 % of reading 0.3 % of reading	Calibrated using torque calibrators based on ISO 6789-2

SCOPE OF CALIBRATION: HARDNESS

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Durometer (Type A, B, C, D, E, O, DO, OO)	0 to 100 shore hardness index	0.5 shore hardness index	Calibrated using balance, block gauges and profile projector with refer ASTM D2240:15e1 Measurements of spring force, indenter travel and indenter extension excluding indenter cone angle.

SCOPE OF CALIBRATION: PRESSURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Pressure Measuring Device Pneumatic	0 kPa to 100 kPa 1 kgf/cm^2 to 30 kgf/cm^2	0.0082 kPa 0.012% of reading	Calibrated by using dead weight tester and pressure Meter with reference as AS1349
Hydraulic	0 kgf/cm^2 to 60 kgf/cm^2 60 kgf/cm^2 to 1200 kgf/cm^2 1200 kgf/cm^2 to 2812 kgf/cm^2 2812 kgf/cm^2 to 4218 kgf/cm^2	0.012% of reading 0.015% of reading 0.011 % of reading 14 kgf/cm^2	Calibrated by using dead weight tester and High Pressure Transducer with reference to with reference to AS1349
Vacuum Absolute Pressure Measuring Device	-95 kPa to 0 kPa 0 kPa abs to 210 kPa abs 210 kPa abs to 700 kPa abs	0.011 kPa 0.070 kPa abs 0.13 kPa abs	Comparison with test gauge with reference to AS1349
Manometer	0 Pa to 500 Pa 500 Pa to 1000 Pa 1000 Pa to 3000 Pa 3000 Pa to 5000 Pa 5000 Pa to 7000 Pa	0.21 Pa 0.50 Pa 1.5 Pa 2.9 Pa 4.2 Pa	Comparison with pressure meter with reference to AS1349

SCOPE OF CALIBRATION: PRESSURE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Pressure Measuring Device Pneumatic	0 kgf/cm^2 to 10 kgf/cm^2 10 kgf/cm^2 to 30 kgf/cm^2	0.002 kgf/cm^2 0.005 kgf/cm^2	Calibrated by using test gauge, pressure calibrator and High Pressure Transducer
Hydraulic	0 kgf/cm^2 to 100 kgf/cm^2 100 kgf/cm^2 to 300 kgf/cm^2 300 kgf/cm^2 to 700 kgf/cm^2 700 kgf/cm^2 to 1400 kgf/cm^2 1400 kgf/cm^2 to 2812 kgf/cm^2 2812 kgf/cm^2 to 4218 kgf/cm^2	0.03 kgf/cm^2 0.06 kgf/cm^2 0.16 kgf/cm^2 0.23 kgf/cm^2 0.43 kgf/cm^2 14 kgf/cm^2	
Vacuum	-0.97 kgf/cm^2 to 0 kgf/cm^2	0.0017 kgf/cm^2	
Absolute Pressure Measuring Device	0 kPa abs to 200 kPa abs 200 kPa abs to 700 kPa abs	0.075 kPa abs 0.14 kPa abs	
Manometer	0 Pa to 500 Pa 500 Pa to 1000 Pa 1000 Pa to 3000 Pa 3000 Pa to 5000 Pa 5000 Pa to 7000 Pa 7 kPa to 70 kPa	0.25 Pa 0.53 Pa 1.6 Pa 3.0 Pa 4.3 Pa 0.02 kPa	

SCOPE OF CALIBRATION: VOLUME

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
POVA Pipette	0.1 µl to 2.5 µl 2.5 µl to 20 µl 20 µl to 100 µl 100 µl to 300 µl 300 µl to 1000 µl 1000 µl to 5000 µl 5000 µl to 10000 µl	0.020 µl 0.025 µl 0.1 µl 0.2 µl 0.7 µl 3.5 µl 7.1 µl	Calibrated by gravimetric method with refer to AS2162.2 & ISO 8655-6
Graduated & One Mark Pipette	Graduated 1 ml 5 ml 10 ml to 25 ml One Mark 0.5 ml to 1 ml 2 ml to 10 ml 25 ml 50 ml	 0.015 ml 0.02 ml 0.03 ml 0.01 ml 0.01 ml 0.015 ml 0.02 ml	Calibrated by gravimetric method with refer to AS2162.1
Burette	10 ml 25 ml 50 ml 100 ml	0.013 ml 0.02 ml 0.03 ml 0.06 ml	
Measuring Cylinder	10 ml 25 ml 50 ml to 100 ml 250 ml 500 ml 1000 ml 2000 ml	0.05 ml 0.13 ml 0.24 ml 0.50 ml 1.2 ml 2.4 ml 2.6 ml	
One Mark Volumetric Flask	1 ml 5 ml 10 ml 20 ml 25 ml 50 ml 100 ml 250 ml 500 ml 1000 ml 2000 ml	0.014 ml 0.014 ml 0.02 ml 0.02 ml 0.02 ml 0.03 ml 0.05 ml 0.12 ml 0.22 ml 0.45 ml 0.9 ml	

SCOPE OF CALIBRATION: VOLUME

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Dispenser / Digital Burette	1 ml to 5 ml 5 ml to 10 ml 10 ml to 25 ml 25 ml to 50 ml 50 ml to 100 ml	0.006 ml 0.007 ml 0.011 ml 0.019 ml 0.58 ml	Calibrated by gravimetric method with reference to AS 2162.2

SCOPE OF CALIBRATION: VOLUME

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Test Measure and Provers - Gravimetric Method	5 L and 10 L 20 L 50 L 100 L 200 L	0.002 L 0.004 L 0.018 L 0.018 L 0.022 L	Calibrated by gravimetric method using balance based on NIST IR 7383 SOP 14 and NIST Handbook 105-3
Test Measure and Provers – Volumetric Method	5 L and 10 L 20 L 50 L 100 L 200 L	0.002 L 0.004 L 0.008 L 0.009 L 0.016 L	Calibrated by volumetric method using standard test measures based on NIST IR 7383 SOP 19 and NIST Handbook 105-3

SCOPE OF CALIBRATION: VOLUME

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Conductivity Meter	1, 10 µS/cm 84 µS/cm 1413 µS/cm 12.88 mS/cm 111.8 mS/cm	0.36 µS/cm 1.0 µS/cm 5.4 µS/cm 0.06 mS/cm 0.43 mS/cm	Calibrated by using standard solution with reference to ASTM D 1125
pH meter	4.01 pH, 7.01 pH & 10.01 pH	0.01 pH	Calibrated by using standard solution with reference to JIS K 0102
Volumetric Instruments (Beakers, Pitchers and Volumetric Containers)	Up to 500 ml 1000 ml 2000 ml 5000 ml 10000 ml 20000 ml	4.2 ml 5.4 ml 9.6 ml 16 ml 27 ml 37 ml	Calibrated by gravimetric method with general reference to ISO 4787
Air Entrainment Meter	Range: up to 8 L 0 to 2 % 2 % to 5 % 5 % to 10 % 10 % to 20 %	 0.05 % 0.06 % 0.15 % 0.2 %	Calibrated by gravimetric method with reference to BS EN 12350-7

SCOPE OF CALIBRATION: VOLUME

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Test Measure and Provers – Volumetric Method	5 L and 10 L 20 L 50 L 100 L 200 L	0.002 L 0.004 L 0.008 L 0.009 L 0.016 L	Calibrated by volumetric method using standard test measures based on NIST IR 7383 SOP 19 and NIST Handbook 105-3
pH Meter	4.00 pH 7.00 pH 10.00 pH	0.02 pH 0.02 pH 0.02 pH	Calibrated by using Standard Buffer Solution
Conductivity Meter	84 µS/cm 1413 µS/cm 12.880 mS/cm 111.8 mS/cm	1.0 µS/cm 15 µS/cm 0.15 mS/cm 1.2 mS/cm	Calibrated using Conductivity Standard Solution

SCOPE OF CALIBRATION: FLOW

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Gas Flow			
Mass Flow Meter	0 cm^3/min to 20 cm^3/min	0.44 % of reading	
(Fluid : Air)	20 cm^3/min to 200 cm^3/min	0.74 % of reading	
	200 cm^3/min to 1 L/min	0.43 % of reading	
	1 L/min to 10 L/min	0.81 % of reading	
	10 L/min to 50 L/min	0.71 % of reading	
	50 L/min to 300 L/min	0.56 % of reading	
Volumetric Flow Meter	0 cm^3/min to 20 cm^3/min	0.48 % of reading	Calibrated by using mass flow meter based on National Measurement System, TUV NEL and manufacturer manual
(Fluid : Air)	20 cm^3/min to 200 cm^3/min	0.77 % of reading	
	200 cm^3/min to 1 L/min	0.47 % of reading	
	1 L/min to 10 L/min	0.84 % of reading	
	10 L/min to 50 L/min	0.74 % of reading	
	50 L/min to 300 L/min	0.60 % of reading	
Variable Area Flow Meter	0 cm^3/min to 20 cm^3/min	0.6 % of full scale	
(Fluid : Air)	20 cm^3/min to 200 cm^3/min	0.9 % of full scale	
	200 cm^3/min to 1 L/min	0.6 % of full scale	
	1 L/min to 10 L/min	0.9 % of full scale	
	10 L/min to 50 L/min	0.8 % of full scale	
	50 L/min to 300 L/min	0.7 % of full scale	
Liquid Flow Meter	0.1 mL/min	0.0006 mL/min	Calibrated using syringe pump and gravimetric method
	Above 0.1 mL/min to 0.5 mL/min	0.0008 mL/min	
	Above 0.5 mL/min to 1 mL/min	0.002 mL/min	
	Above 1 mL/min to 5 mL/min	0.011 mL/min	
	Above 5 mL/min to 10 mL/min	0.03 mL/min	
	Above 10 mL/min to 20 mL/min	0.10 mL/min	
	Above 20 mL/min to 25 mL/min	0.15 mL/min	

SCOPE OF CALIBRATION: VISCOSITY

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Zahn Cup	Cup No. 2 (20 mm^2/s to 250 mm^2/s) Cup No. 3 (100 mm^2/s to 800 mm^2/s) Cup No. 4 (200 mm^2/s to 1200 mm^2/s) Calibration at 25°C	1.1 mm^2/s 2.3 mm^2/s 2.8 mm^2/s	Calibrated by using viscosity standard oil with reference to ASTM D4212
Ford Cup	Cup No. 3 (49 mm^2/s to 220 mm^2/s) Cup No. 4 (70 mm^2/s to 370 mm^2/s) Cup No. 5 (200 mm^2/s to 1200 mm^2/s) Calibration at 25°C	1.1 mm^2/s 1.2 mm^2/s 4.5 mm^2/s	Calibrated by using viscosity standard oil with reference to ASTM D1200
Rotational Viscometer	7.6 mPa.s to 55.00 mPa.s 101.0 mPa.s to 393.0 mPa.s 11000 mPa.s to 40000 mPa.s Calibration at 25°C	1 % of reading	Calibrated by using standard oil by manufacturer's calibration procedure

SCOPE OF CALIBRATION: DENSITY

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Density Hydrometer	0.600 g/mL to 1.850 g/mL	0.0006 g/mL	Calibrated by using standard density hydrometer based on BS 718

SCOPE OF CALIBRATION: OPTICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Refractometer			Calibrated by using sucrose powder & weighing balance with reference to OIML R 108 & OIML R 124
Sucrose Mass Fraction	0 %Brix to 50 %Brix	0.24 %Brix	
Refractive Index	1.333 nD to 1.420 nD	0.006 nD	

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
1. Precision Caliper (Internal, External & Depth Measurement)	0 mm to 300 mm 300 mm to 600 mm 600 mm to 1000 mm	6 μm 12 μm 13 μm	Calibrated by using Caliper Checker and Gauge Block with reference to JIS B 7507 or BS EN ISO 13385-1
2. Internal Micrometer	0 mm to 175 mm 175 mm to 375 mm 375 mm to 550 mm 550 mm to 675 mm 675 mm to 825 mm 825 mm to 900 mm	2 μm 3 μm 4 μm 5 μm 6 μm 7 μm	Calibrated by using Gauge Block, Height Setting Micrometer, Dial Test Indicator, Universal Horizontal Measuring Machine with reference to JIS B 7502 or BS 959
3. External Micrometer	0 mm to 25 mm 25 mm to 75 mm 75 mm to 150 mm 150 mm to 250 mm 250 mm to 325 mm 325 mm to 425 mm 425 mm to 500 mm 500 mm to 575 mm 575 mm to 600 mm	0.4 μm 1.2 μm 1.5 μm 2.0 μm 2.5 μm 3.0 μm 3.5 μm 4.0 μm 4.5 μm	Calibrated by using Gauge Block and Optical Parallel with reference to JIS B 7502 or ISO 3611
4. Dial gauge	0 mm to 10 mm 10 mm to 50 mm 50 mm to 100 mm	0.5 μm 1.0 μm 1.5 μm	Calibrated by using Precision Indicator Tester, Micrometer Head, Dial Gauge Calibrator, Calibration Tester with reference to JIS B 7503 or DIN 879-1 or ASME B89.1.10M
5. Ruler	0 mm to 1000 mm 1000 mm to 2000 mm	0.1mm 0.2mm	Calibrated by using Linear Scale Comparator with reference to JIS B 7516

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
6. Feeler Gauge	0 mm to 3 mm	0.5 μm	Calibrated by using Linear Displacement Transducer, Universal Horizontal Measuring Machine with reference to JIS B 7524 or BS 957
7. Thickness Gauge	0 mm to 20 mm	1.0 μm	Calibrated by using Gauge Block, Balance with reference to ISO 13102, JIS B 7503
8. Precision Level / Spirit Level	0.02 mm/m 0.05 mm/m 0.1 mm/m	0.01 mm/m 0.01 mm/m 0.02 mm/m	Calibrated by using Sine Bar and Gauge Block with reference to JIS B 7510
9. Gauge Block	0 mm to 10 mm 10 mm to 25 mm 25 mm to 50 mm 50 mm to 75 mm 75 mm to 100 mm 100 mm to 150 mm 150 mm to 200 mm 200 mm to 250 mm 0 in to 0.5 in 0.5 in to 1 in 1 in to 2 in 2 in to 3 in 3 in to 4 in	0.09 μm 0.10 μm 0.13 μm 0.17 μm 0.21 μm 0.26 μm 0.33 μm 0.39 μm 5.0 μin 5.3 μin 6.3 μin 7.7 μin 9.4 μin	Calibrated by using gauge block and gauge block comparator with reference to JIS B 7506, BS 4311
10. Depth Gauge	0 mm to 100 mm 100 mm to 300 mm	2.0 μm 3.0 μm	Calibrated by using Depth Gauge Checker, Gauge Block with reference to JIS B 7518 or ISO 13385-2
11. Depth Micrometer	0 mm to 100 mm 100 mm to 300 mm	2.0 μm 3.0 μm	Calibrated by using Depth Gauge Checker, Gauge Block with reference to JIS B 7544 or BS 6468

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
12. Height Gauge	0 mm to 300 mm 300 mm to 600 mm 600 mm to 1000 mm	6.0 µm 8.0 µm 10.0 µm	Calibrated by using Caliper Checker, Gauge Block and Granite Surface Plate with reference to JIS B 7517 or BS EN ISO 13225
13. Micrometer Head & Calibration Tester for Dial Gauge and Dial Test Indicator	0 mm to 25 mm 25 mm to 50 mm	0.4 µm 0.8 µm	Calibrated by using Gauge Block, Linear Displacement Transducer and Optical Flat with reference to JIS B 7502
14. Measuring Tape	0 m to 2 m 2 m to 5 m 5 m to 10 m 10 m to 20 m 20 m to 50 m 50 m to 100 m	0.2 mm 0.3 mm 0.6 mm 1.2 mm 3.2 mm 6.3 mm	Calibrated by using Linear Scale Comparator with reference to JIS B 7512, JIS B 7522
15. Dial Test Indicator	0 mm to 0.5 mm 0.5 mm to 5 mm	0.5 µm 1.0 µm	Calibrated by using Precision Indicator Tester, Calibration Tester with reference to JIS B 7533 or ASME B89.1.10M
16.Snap Micrometer - Micrometer range - Indicator range	 0 mm to 75 mm 75 mm to 100 mm 100 mm to 125 mm 0 mm to ± 0.08 mm ± 0.15 mm	 1.5 µm 1.6 µm 1.8 µm 0.7 µm 3.2 µm	Calibrated by using Gauge Block with reference to JIS B 7520
17.Setting Rod	25 mm to 75 mm 100 mm to 150 mm 175 mm to 200 mm 225 mm to 250 mm 275 mm to 300 mm 325 mm to 375 mm 400 mm to 425 mm 450 mm to 475 mm 500 mm to 525 mm 550 mm to 600 mm	1.0 µm 1.5 µm 2.0 µm 2.5 µm 3.0 µm 3.5 µm 4.0 µm 4.5 µm 5.0 µm 5.6 µm	Calibrated by using Linear Displacement Transducer and Gauge Block with reference to JIS B 7420

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
18. Non-metallic Thickness Foil	0 mm to 2.5 mm	0.3 µm	Calibrated by using Linear Displacement Transducer with reference to BS EN ISO 2178
19. Glass Scale	0 mm to 200 mm 200 mm to 400 mm 400 mm to 1000 mm	0.01 mm 0.05 mm 0.09 mm	Calibrated by using Profile Projector, Standard Scale, Linear Scale with reference to JIS B 7541
20. Test Sieve	0.032 mm to 125 mm	2.0 µm	Calibrated by using Profile Projector, Caliper with reference to BS ISO 3310-1, BS ISO 3310-2
21. Plain Plug / Pin Gauge (Diameter only)	0 mm to 25 mm 25 mm to 50 mm 50 mm to 100 mm 100 mm to 150 mm	0.7 µm 1.1 µm 1.5 µm 1.9 µm	Calibrated by using Laser Scan Micrometer or Universal Horizontal Measuring Machine with reference to JIS B 7420, BS 969
22. Parallel Thread Plug Gauge (Major Diameter and Pitch Diameter)	2 mm to 38 mm 38 mm to 100 mm	1.2 µm 3.0 µm	Calibrated by using Universal Horizontal Measuring Machine, 3-wire pin set, Micrometer with reference to JIS B 0261 or ANSI/ASME B1.2 or ISO 1502
23.Thread Ring Gauge (Minor Diameter and Pitch Diameter)	2 mm to 38 mm	Minor Diameter : 2.8 µm Pitch Diameter : 1.2 µm	Calibrated by using Universal Horizontal Measuring Machine with reference to ANSI/ASME B1.2 or ISO 1502
	38 mm to 100 mm	Minor Diameter : 3.0 µm Pitch Diameter : 3.0 µm	

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
24. Square	0 mm to 75 mm 75 mm to 150 mm 150 mm to 300 mm 300 mm to 400 mm	6.0 µm 8.0 µm 11 µm 12 µm	Calibrated by using Square Tester, Dial Tester Indicator, Parallel Bar and Granite Tri-Square with reference to JIS 7526
25. Angle	0 ° to 180 ° (Degree)	3 minutes	Calibrated by using Angle Blocks, Beveled Protractor, Sine Bar, Gauge Blocks and Dial Test Indicator with reference to JIS B 0405
26. Dial Bore Tester / Gauge	18 mm to 100 mm (Resolution 0.001 mm) 18 mm to 100 mm (Resolution 0.01 mm)	0.001 mm 0.003 mm	Calibrated by using Micrometer Head, Gauge Block and Ring Gauge with reference to JIS B 7515
27. Microindicator	± 25 µm (Resolution: 0.5 µm) ± 50 µm to 100 µm (Resolution: 1 µm) Above 100 µm (Resolution: 2 µm)	0.2 µm 0.8 µm 1.5 µm	Calibrated by using Gauge blocks, Precision Indicator Tester, Calibration Tester with reference to JIS B 7519
28.Coating Thickness Gauge	0 mm to 2.766 mm	0.7 µm	Calibrated by using Thickness Foil
29. Linear Height	0 mm to 200 mm 200 mm to 400 mm 400 mm to 600 mm	1.0 µm 2.0 µm 2.4 µm	Calibrated by using Gauge Block with reference to BS EN ISO 13225
30. Ultrasonic Thickness Gauge	0 mm to 10 mm 10 mm to 100 mm 100 mm to 600 mm	0.002 mm 0.011 mm 0.02 mm	Calibrated by using Gauge Block, Step Wedge, Standard Block with reference to ASTM E797/E797M

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
31. Vee Block	150 mm x 150 mm x 65 mm	20 µm	Calibrated by using Dial Test Indicator and Granite Surface Plate with reference to JIS B 7540
32. Three Point Internal Micrometer	0 mm to 50 mm 50 mm to 100 mm	1.8 µm 2.3 µm	Calibrated by using Ring Gauge with reference to DIN 863-4
33. Digital Indicator	0 mm to 25 mm 25 mm to 50 mm 50 mm to 100 mm	0.4 µm 0.6 µm 1.0 µm	Calibrated by using Micrometer Head, Gauge Block, Calibration Tester, Precision Indicator Tester, Dial Gauge Calibrator with reference to ISO 13102
34. Electrical Comparator/ Precision Indicator Checker	0 mm to 2 mm	0.18 µm	Calibrated by using Gauge Block, Calibration Tester, Micrometer Head with reference to JIS B 7536
35. Plain Ring Gauge (diameter only)	2 mm to 50 mm 50 mm to 100 mm 100 mm to 150 mm	1.4 µm 1.5 µm 1.6 µm	Calibrated by Contact Method using Universal Horizontal Measuring Machine with Master Ring Gauge
36. Height Setting Micrometer & Riser Block	0 mm to 300 mm 300 mm to 600 mm	1 µm 2 µm	Calibrated by using Gauge Block with reference to ISO 7863
37. Caliper Checker	0 mm to 360 mm 360 mm to 670 mm	2.1 µm 4 µm	Calibrated by using Gauge Block
38. Taper Thread Plug Gauge (Pitch diameter at basic length, step length)	1/16 in to 2 in	0.0002 in	Calibrated by using Universal Horizontal Measuring Machine and Gauge Block with reference to ASME B1.20.5

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
39. Geometric Measurements (Jig, Fixture, Machined Part and Workpiece)			
i) Length (Contact Method)	0 mm to 11 mm 11 mm to 100 mm 100 mm to 200 mm 200 mm to 300 mm 300 mm to 400 mm 400 mm to 600 mm 600 mm to 1000 mm	0.55 µm 1.5 µm 2.0 µm 3.0 µm 3.5 µm 5.0 µm 15.0 µm	Calibrated by using Micrometer, Linear Height Gauge, Linear Displacement Transducer, Ruler, Caliper, Height Setting Micrometer
ii) Length (Non-Contact Method)	0 mm to 100 mm	2.5 µm	Calibrated by using Profile Projector, Vision Measuring Machine
iii) Diameter (Contact Method)	0 mm to 25 mm 25 mm to 100 mm 100 mm to 200 mm 200 mm to 300 mm	0.6 µm 1.5 µm 2.0 µm 2.5 µm	Calibrated by using Linear Height Gauge, Micrometer, Linear Displacement Transducer, Caliper
iv) Diameter, Radius (Non-Contact Method)	0 mm to 25 mm 25 mm to 100 mm	0.7 µm 2.5 µm	Calibrated by using Laser Scan Micrometer, Profile Projector, Vision Measuring machine
v) Angle	0 ° to 360 °	0.09 °	Calibrated by using Protractor, Angle Block, Dial Test Indicator
vi) Straightness & Parallelism	0 mm to 1000 mm	2.0 µm	Calibrated by using Dial Test Indicator & Granite Surface Plate

SCOPE OF CALIBRATION: DIMENSIONAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
1. Profile Projector Individual axis	Up to 140 mm 140 mm to 300 mm	1.6 μm 3.1 μm	Calibrated by using glass scale with reference to JIS B 7184
2. Measuring Microscopes (Individual Linear X, Y Axis Only)	Up to 20 mm Up to 50 mm Up to 100 mm Up to 150 mm Up to 200 mm Up to 300 mm	0.5 μm 0.8 μm 1.3 μm 1.8 μm 2.3 μm 3.4 μm	Calibrated by using Glass Scale according to JIS B 7153
3. Surface Plate	300 mm X 300 mm 600 mm X 600 mm 1000 mm X 1000 mm 1600 mm X 2500 mm	1.4 μm 2.0 μm 2.6 μm 3.8 μm	Calibrated by using precision inclinometer, micro indicator and variation gauge with reference to BS 817
4. Surface Plate	600 mm X 600 mm 600 mm X 1000 mm 1000 mm X 1500 mm 1500 mm X 2000 mm	1.6 μm 1.9 μm 2.0 μm 2.2 μm	Calibrated by using planekator, miroindicator and variation gauge with reference to BS 817

SCOPE OF CALIBRATION: TIME AND FREQUENCY

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
1. Tachometer - Non Contact	30 rpm to 99 rpm 100 rpm to 999 rpm 1000 rpm to 4999 rpm 5000 rpm to 9999 rpm 10000 rpm to 49999 rpm 50000 rpm to 99999 rpm	0.0073 rpm 0.010 rpm 0.062 rpm 0.072 rpm 0.62 rpm 0.72 rpm	Using light pulses synchronized to frequencies that correspond to the stated rpm values
- Contact	60 rpm to 1000 rpm 1000 rpm to 1500 rpm 1500 rpm to 6000 rpm	1.5 rpm 2 rpm 3.2 rpm	Calibrated by using tachometer calibrator
	1 rpm to 99 rpm 100 rpm to 999 rpm 1000 rpm to 4999 rpm 5000 rpm to 9999 rpm	0.032 rpm 0.26 rpm 2.1 rpm 2.6 rpm	By comparison with Optical Tachometer
2. Stopwatch and Timer	0 s to 30 s 30 s to 60 s 60 s to 300 s 300 s to 600 s 600 s to 900 s 1800 s to 3600 s 3600 s to 7200 s 7200 s to 10800 s 3 hr to 5 hr 5 hr to 7 hr 7 hr to 9 hr	0.012 s 0.012 s 0.012 s 0.012 s 0.012 s 0.012 s 0.012 s 0.012 s 0.012 s 0.24 s 0.34 s 0.43 s	By Comparison with a reference stopwatch
	1 s to 99999 s	9 µs/s + 20 µs	Calibrated by using Universal Counter

SCOPE OF CALIBRATION: TIME AND FREQUENCY

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (±)*	Remarks
1. Revolutions per minute (rpm) Measurement – Non-Contact	60 rpm to 40000 rpm	1 rpm	By comparison with Optical Tachometer
2. Tachometer – Contact	1 rpm to 99 rpm 100 rpm to 999 rpm 1000 rpm to 4999 rpm 5000 rpm to 9999 rpm	0.032 rpm 0.26 rpm 2.1 rpm 2.6 rpm	By comparison with Optical Tachometer
3. Tachometer – (Non-Contact / Stroboscope)	30 rpm to 99 rpm 100 rpm to 999 rpm 1000 rpm to 4999 rpm 5000 rpm to 9999 rpm 10000 rpm to 49999 rpm 50000 rpm to 99999 rpm	0.002 rpm 0.007 rpm 0.06 rpm 0.07 rpm 0.60 rpm 0.66 rpm	Using light pulses synchronized to frequencies that correspond to the stated rpm values
4. Stopwatch and Timer	0 s to 30 s 30 s to 60 s 60 s to 300 s 300 s to 600 s 600 s to 900 s 1800 s to 3600 s 3600 s to 7200 s 7200 s to 10800 s	0.08 s 0.08 s 0.08 s 0.08 s 0.08 s 0.08 s 0.08 s 0.08 s 0.08 s	Direct Comparison Method
	1 s to 99999 s	9 µs/s + 20 µs	Calibrated using Universal Counter

SCOPE OF TESTING: MECHANICAL (VALVE TESTING)

Materials/ Products Tested	Type of Test/ Properties Measured/ Range of Measurement	Standard Test Methods/ Equipment/Techniques
A. Pressure Relief Valves	1. "As Received" Pop Pressure Test 2. Seat Leakage Test	1. API 576 Clause 6.2.9: 2017 2. API 527 Section 2,4 & 5: 2020
B. Control Valves	1. Shell Test 2. Pressure Closure Test (Seat Leakage Test) 3. Packing Test 4. Rated Valve Travel Test 5. Dead Band Test	1. API 598: 2016 Clause 6.3, ASME B 16.34 Section 7.1 & IEC 60534-4: 2006 Section 5.4 2. API 598: 2016 Clause 6.4, 6.5 ASME B 16.34 Section 7.2 & IEC 60534-4: 2006 Section 5.5 3. IEC 60534-4: 2006 Section 5.6 4. IEC 60534-4: 2006 Section 5.7 5. IEC 60534-4: 2006 Section 5.8
C. Isolation Valves 1. Parallel Slide Valve 2. Gate Valve 3. Globe Valve 4. Check Valve 5. Plug Valve 6. Butterfly Valve 7. Ball Valve	1. Shell Test 2. Pressure Closure Test (Seat Leakage Test) 3. Back Seat Test	1. API 598: 2016 Clause 6.3 & ASME B 16.34 Section 7.1 2. API 598: 2016 Clause 6.4, 6.5 & ASME B 16.34 Section 7.2 3. API 598: 2016 Clause 6.2

SCOPE OF TESTING: MECHANICAL (VALVE TESTING)

SITE: CATEGORY I

Materials/ Products Tested	Type of Test/ Properties Measured/ Range of Measurement	Standard Test Methods/ Equipment/Techniques
A. Pressure Relief Valves	1. "As Received" Pop Pressure Test 2. Seat Leakage Test	1. API 576 Clause 6.2.9: 2017 2. API 527 Section 2,4 & 5: 2020
B. Control Valves	1. Shell Test 2. Pressure Closure Test (Seat Leakage Test) 3. Packing Test 4. Rated Valve Travel Test 5. Dead Band Test	1. API 598: 2016 Clause 6.3, ASME B 16.34 Section 7.1 & IEC 60534-4: 2006 Section 5.4 2. API 598: 2016 Clause 6.4, 6.5 ASME B 16.34 Section 7.2 & IEC 60534-4: 2006 Section 5.5 3. IEC 60534-4: 2006 Section 5.6 4. IEC 60534-4: 2006 Section 5.7 5. IEC 60534-4: 2006 Section 5.8
C. Isolation Valves 1. Parallel Slide Valve 2. Gate Valve 3. Globe Valve 4. Check Valve 5. Plug Valve 6. Butterfly Valve 7. Ball Valve	1. Shell Test 2. Pressure Closure Test (Seat Leakage Test) 3. Back Seat Test	1. API 598: 2016 Clause 6.3 & ASME B 16.34 Section 7.1 2. API 598: 2016 Clause 6.4 & 6.5 ASME B 16.34 Section 7.2 3. API 598: 2016 Clause 6.2

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement CapabilityExpressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
1. DC Voltage	(0 to 220) mV (0.0 to 2.2) V (0 to 11) V (0 to 22) V (0 to 220) V (0 to 1100) V 1 kV to 10 kV 10 kV to 40 kV	9.7 µV/V 5.4 µV/V 3.8 µV/V 4.0 µV/V 5.3 µV/V 7.1 µV/V 0.78% of the reading 0.51% of the reading	Calibrated using Multifunction Calibrator By comparison with a reference Measuring System
2. DC Current	(0 to 220) µA (0.0 to 2.2) mA (0 to 22) mA (0 to 220) mA (0.0to 2.2) A (2.2 to 2.9) A (2.9 to 10.9) A (10.9 to 20.0) A	0.068 mA/A 0.039 mA/A 0.037 mA/A 0.049 mA/A 0.081 mA/A 0.31 mA/A 0.43 mA/A 0.81 mA/A	Calibrated using Multifunction Calibrator
3. DC Current via Current Coils	(3.2 to 32) A (32 to 105) A (105 to 200) A (200 to 525) A (525 to 1000) A	2.1 mA/A 2.3 mA/A 2.6 mA/A 2.6 mA/A 2.6 mA/A	Calibrated using Multifunction Calibrator & Current Coil
4. AC Voltage	(0.0 to 220) V	(See Matrix A)	Calibrated using Multifunction Calibrator
	(220 to 1100) V	(See Matrix B)	
5. AC Current	(0 to 20) A	(See Matrix C)	
6. AC Current via Current Coils	(3.2 to 1000) A	(See Matrix D)	Calibrated using Multifunction Calibrator & Current Coil

SCOPE OF CALIBRATION: ELECTRICAL

Matrix A

AC Voltage Measurement

Range	Frequency (kHz)							
	0.01 to 0.02	0.02 to 0.04	0.04 to 20	20 to 50	50 to 100	100 to 300	300 to 500	500 to 1000
(0 to 2.2) mV	2.1	1.9	1.9	2.0	2.8	5.6	16	24
(2.2 to 22) mV	0.43	0.28	0.27	0.39	0.73	1.5	3.5	7.3
(22 to 220) mV	0.3	0.12	0.12	0.23	0.54	0.99	2.3	5.8
(0.22 to 2.2) V	0.26	0.098	0.049	0.080	0.12	0.46	1.1	1.8
(2.2 to 22) V	0.26	0.099	0.049	0.081	0.11	0.30	1.1	1.7
(22 to 220) V	0.26	0.099	0.058	0.087	0.16	-	-	-

The expanded uncertainties given at above table is expressed in mV/V

SCOPE OF CALIBRATION: ELECTRICAL

Matrix B

AC Voltage Measurement

Range	Frequency (kHz)							
	0.015 to 0.045	0.045 to 0.05	0.05 to 1	1 to 5	5 to 10	10 to 20	20 to 50	50 to 100
(220 to 250) V	0.25	0.16	0.16	0.18	0.18	0.22	0.28	1.7
(250 to 330) V	-	0.16	0.16	0.17	0.17	0.21	0.26	1.7
(330 to 1020) V	-	0.24	0.24	0.20	0.24	-	-	-
(1020 to 1100) V	-	-	0.065	-	-	-	-	-

The expanded uncertainties given at above table expressed in mV/V

Matrix C

AC Current Measurement

Range	Frequency (kHz)							
	0.01 to 0.02	0.02 to 0.04	0.04 to 1	1 to 3	3 to 5	5 to 10	10 to 20	20 to 30
(0 to 32) µA	29	29	29	29	57	57	190	280
(32 to220) µA	0.34	0.24	0.17	0.32	0.34	1.2	11	16
(220 to 320) µA	1.7	1.7	1.7	1.7	2.9	2.9	8.3	12
(0.32 to 2.2) mA	0.27	0.18	0.14	0.14	0.25	1.4	2.9	3.9
(2.2 to 3.2) mA	0.82	0.82	0.83	0.83	1.3	1.3	2.7	3.5
(3.2 to 22) mA	0.27	0.18	0.14	0.23	0.23	1.3	2.6	3.5
(22 to 32) mA	0.83	0.83	0.83	0.83	1.3	1.3	2.4	3.2
(32 to 220) mA	0.27	0.18	0.13	0.22	0.22	1.1	2.3	2.9
(220 to 320) mA	-	0.93	0.93	0.94	1.2	1.2	2.2	2.8
(0.32 to 2.2) A	-	0.28	0.28	0.49	7.1	7.1	-	-
(2.2 to 3.2) A	0.92	0.92	0.92	0.92	2.6	2.6	-	-
(3.2 to 10.5) A	1.8	1.8	1.8	1.8	4.6	4.6	-	-
(10.5 to 20) A	1.8	1.8	1.8	1.8	4.8	4.8	-	-

The expanded uncertainties given at above table is expressed in mA/A

Matrix D

AC Current via Current Coils Measurement

Range	Frequency (Hz)		
	10 to 65	**10 to 100**	**100 to 440**
(3.2 to 32.0) A	-	3.5	10
(32.0 to 200.0) A	-	4.2	9.6
(200.0 to 1000.0) A	4.2	-	-

The calibration uncertainties given at above table expressed in mA/A

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement CapabilityExpressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
7. Wideband AC Voltage (Frequency from 30 Hz to 500 kHz into 50 Ω Termination)	(0.3 to 1.1) mV (1.1 to 3) mV (3 to 11) mV (11 to 33) mV (33 to 110) mV (110 to 330) mV (0.33 to 1.1) V (1.1 to 3.5) V	9.9 mV/V 8.0 mV/V 7.7 mV/V 6.5 mV/V 6.4 mV/V 5.3 mV/V 5.4 mV/V 4.1 mV/V	Calibrated using Multifunction Calibrator
8. Wideband AC VoltageAmplitude Flatness at 1 kHz reference into 50 Ω Termination	0.3 mV to 3.5 V	(See Matrix E)	

Matrix E

Wideband ACV Amplitude Flatness

Range	Volts		
	1.1 mV	**3 mV**	**3.5 V**
10 Hz to 30 Hz	3.0	3.0	3.0
30 Hz to 120 Hz	1.1	1.1	1.1
120 Hz to 1.2 kHz	1.1	1.1	1.1
1.2 kHz to 12 kHz	1.1	1.1	1.1
12 kHz to 120 kHz	1.1	1.1	1.1
120 kHz to 1.2 MHz	4.8	2.1	1.1
1.2 MHz to 2 MHz	4.8	2.1	1.1
2 MHz to 10 MHz	6.8	4.1	2.1
10 MHz to 20 MHz	8.9	6.1	4.1
20 MHz to 30 MHz	29	16	10

The calibration uncertainties given at above table expressed in mV/V

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement CapabilityExpressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
9. Resistance	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	40 µΩ 95 µΩ 95 µΩ 46 µΩ 79 µΩ 300 µΩ 570 µΩ 0.25 mΩ 0.48 mΩ 2.5 mΩ 4.8 mΩ 250 mΩ 480 mΩ 4.0 Ω 7.6 Ω 10 Ω 19 Ω 25 kΩ	Calibrated using Multifunction Calibrator (Standard Value)
	1 Ω	8 µΩ	Calibrated using Standard Resistance
	10 Ω	11 µΩ	
	10 kΩ	7 mΩ	
	(0.0 to 10.9) Ω (11 to 32.9) Ω (33 to 109.9) Ω (0.11 to 1.09) kΩ (1.1 to 10.9) kΩ (11 to 109) kΩ (0.11 to 1.09) MΩ (1.1 to 3.29) MΩ (3.3 to 10.9) MΩ (11 to 32.9) MΩ (33 to 109.9) MΩ (110 to 330) MΩ (330 to 1100) MΩ	0.041 mΩ/Ω 0.031 mΩ/Ω 0.028 mΩ/Ω 0.028 mΩ/Ω 0.029 mΩ/Ω 0.029 mΩ/Ω 0.033 mΩ/Ω 0.062 mΩ/Ω 0.13 mΩ/Ω 0.27 mΩ/Ω 0.54 mΩ/Ω 4.8 mΩ/Ω 18 mΩ/Ω	Calibrated using Multifunction Calibrator

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
Resistance (Continued)	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (100 to 1000) Ω (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (100 to 1000) MΩ (1 to 10) GΩ (10 to 100) GΩ (100 to 1000) GΩ	23 mΩ/Ω 5.8 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 2.3 mΩ/Ω 2.3 mΩ/Ω 23 mΩ/Ω 58 mΩ/Ω 58 mΩ/Ω 58 mΩ/Ω	Calibrated using Decade Resistance Box
10. Capacitance	<u>Stim Repetition Rate ≤350 Hz</u> (0.5 to 4.0) nF (4.0 to 40.0) nF (40.0 to 400.0) nF (0.4 to 4.0) µF (4.0 to 40.0) µF (40.0 to 400.0) µF (0.4 to 4.0) mF (4.0 to 40.0) mF <u>Stim Repetition Rate 350 Hz to 1.5 kHz</u> (0.5 to 4.0) nF (4.0 to 40.0) nF (40.0 to 400.0) nF (0.4 to 4.0) µF (4.0 to 40.0) µF (40.0 to 400.0) µF (0.4 to 4.0) mF (4.0 to 40.0) mF	5.4 mF/F 3.0 mF/F 2.7 mF/F 3.5 mF/F 4.3 mF/F 4.3 mF/F 4.4 mF/F 8.9 mF/F 11 mF/F 5.9 mF/F 5.3 mF/F 6.9 mF/F 8.4 mF/F 8.4 mF/F 8.5 mF/F 18 mF/F	Calibrated using Multifunction Calibrator

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
Capacitance (continued)	<u>at 1 kHz</u> (0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (0.11 to 0.33) µF (0.33 to 1.1) µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	35 mF/F 16 mF/F 9.4 mF/F 4.0 mF/F 6.4 mF/F 4.0 mF/F 4.1 mF/F 4.1 mF/F 4.1 mF/F 4.1 mF/F 5.8 mF/F 6.4 mF/F 6.2 mF/F 6.3 mF/F 6.2 mF/F 6.2 mF/F 9.7 mF/F 15 mF/F	Calibrated using Multifunction Calibrator
	1 pF to 1 µF 1 µF to 10 µF	0.61 mF/F 12 mF/F	Calibrated using Decade Capacitance box
	<u>Fixed Value</u> 10 µF 100 µF 1000 µF	0.50 mF/F 0.70 mF/F 5.1 mF/F	Calibrated using Standard Capacitance
11. Inductance	(10 to 100) µH (100 to 1000) µH (1 to 10) mH (10 to 100) mH (100 to 1000) mH (1 to 10) H	23 mH/H 23 mH/H 23 mH/H 23 mH/H 23 mH/H 23 mH/H	Calibrated using Decade Inductance Box
	<u>Fixed Value</u> 100 µH 1 mH 10 mH 100 mH	12 mH/H 1.2 mH/H 1.2 mH/H 1.2 mH/H	Calibrated using Standard Inductance
12. Frequency	(0.01 to 12) kHz (12 to 100) kHz (0.1 to 2) MHz	0.0057 mHz/Hz 0.0057 mHz/Hz 0.0050 mHz/Hz	Calibrated using Multifunction Calibrator

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
13. DC Power	(40 to 200) mW (0.22 to 720) W (720 to 11000) W	0.71 mW/W 0.47 mW/W 1 mW/W	Calibrated using Multifunction Calibrator
14. AC Power	(45 to 65 Hz) (0.04 to 3.3) W (3.3 to 11000) W	3.1 mW/W 1.9 mW/W	
15. Power Factor	0 to 1	0.003	
16. **Oscilloscope**			
Vertical Amplitude a. ACV Square (Vp-p) 1 MΩ Load 50 Ω Load b. DC Signal 1 MΩ Load 50 Ω Load	 10 Hz to 10 kHz 1 mVp-p to 130 Vp-p 100 µV to 5 V 0 V to 130 V 4.44 mV to 2.78V	 2.9 mV/V 2.9 mV/V 0.58 mV/V 2.9 mV/V	Calibrated using Multifunction Calibrator
Time Base	1 ns 2 ns to 5 s 5 s to 15 s	0.029 ms/s 1.2 ms/s 0.12 µs/s	Calibrated using Multifunction Calibrator, Oscilloscope Calibrator
Rise Time	2 ns (Nominal) Edge function 25 mVp-p, 1 MHz into 50 Ω	0.2 ns	Calibrated using Multifunction Calibrator
Edge Function Output Period Rise Time 50 Ω Load 1 MΩ Load Fall Time 50Ω Load 1 MΩ Load	 100 ns to 100 ms 10 µs to 10 ms 100 ns to 10 ms 100 ns to 10 ms	 29 µs/s 29 µs/s 29 µs/s 29 µs/s	
Bandwidth – Amplitude Flatness at 50 kHz reference	5 mV to 5.5 V 50 kHz to 100 MHz 100 MHz to 300 MHz 5 mV to 3.5 V 300 MHz to 1050 MHz 424 mVp-p to 1.131 Vp-p 1 GHz to 2 GHz	19 mV/V 25 mV/V 59 mV/V 230 mV/V	Calibrated using Multifunction Calibrator, Oscilloscope Calibrator

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
Frequency - Accuracy	1 µHz to 0.5 Hz 0.5 Hz to 600 MHz 600 MHz to 1050 MHz 10 GHz to 2 GHz	5 µHz/Hz 2.9 µHz/Hz 2.9 µHz/Hz 0.12 µHz/Hz	Calibrated using Function Generator, Multifunction Calibrator, Oscilloscope Calibrator
Frequency - Amplitude	(0.01 to 5.00) Vpp 1 µHz to 100 kHz 100 kHz to 20 MHz 20 MHz to 30.2 MHz (5 to 10) Vpp 1 µHz to 100 kHz 100 kHz to 20 MHz 20 MHz to 30.2 MHz	 40 mV/V 40 mV/V 40 mV/V 58 mV/V 92 mV/V 210 mV/V	Calibrated using Function Generator
17. Earth Tester	0.01 Ω to 0.1 Ω 0.1 Ω to 100 Ω 100 Ω to 1 M Ω	2.3 mΩ/Ω 0.14 mΩ/Ω 2.3 mΩ/Ω	Calibrated using Decade Resistance Box
18. Insulation Tester / High Voltage Insulation Tester (up to 5 kV)	(1 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ (0.01 to 1) TΩ (1 to 10) TΩ	1.2 mΩ/Ω 2.3 mΩ/Ω 5.8 mΩ/Ω 19 mΩ/Ω 35 mΩ/Ω	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Generating/Sourcing Instrument			
19. DC Voltage	(0 to 100) mV (0 to 1) V (0 to 10) V (0 to 100) V (0 to 1000) V	14 µV/V 6.5 µV/V 5.5 µV/V 8.3 µV/V 8.6 µV/V	Calibrated using Digital Multimeter
20. DC High Voltage	1 kV to 10 kV 10 kV to 40 kV	0.97 mV/V 23 mV/V	Calibrated using Digital Multimeter and High Voltage Meter
21. DC Current	(0 to 100) µA (0 to 1) mA (0 to 10) mA (0 to 100) mA (0 to 1) A (0 to 2) A	33 µA/A 30 µA/A 29 µA/A 46 µA/A 160 µA/A 890 µA/A	Calibrated using Digital Multimeter
	(0 to 10) A	2.4 mA/A	
22. DC Current via Current Shunt	(0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 2) A (2 to 5) A (5 to 10) A (10 to 15) A (15 to 20) A (20 to 25) A (25 to 30) A	140 µA/A 14 µA/A 2.9 µA/A 140 µA/A 14 µA/A 2.9 µA/A 140 µA/A 68 µA/A 29 µA/A 16 µA/A 12 µA/A 10 µA/A 50 µA/A 50 µA/A	Calibrated using Digital Multimeter and Current Shunt
	(10 to 100) A	2.6 mA/A	
23. AC Voltage	(0 to 700) V	(See Matrix F)	Calibrated using Digital Multimeter
	700 V to 1000 V (45 to 1000) Hz (1 to 10) kHz	 14 mV/V 14 mV/V	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Generating/Sourcing Instrument			
24. AC High Voltage	50 Hz & 60 Hz (1 to 10) kV (10 to 40) kV	12 mV/V 62 mV/V	Calibrated using Digital Multimeter and High Voltage Meter
25. AC Current	10 µA to 10 A	(See Matrix G)	Calibrated using Digital Multimeter
26. AC Current via Current Shunt	10 A to 100 A 45 Hz to 65 Hz	3.1 mA/A	Calibrated using Digital Multimeter and Current Shunt
27. Resistance	(0 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	0.036 mΩ/Ω 0.023 mΩ/Ω 0.016 mΩ/Ω 0.016 mΩ/Ω 0.018 mΩ/Ω 0.030 mΩ/Ω 0.084 mΩ/Ω 0.6 mΩ/Ω 5.9 mΩ/Ω	Calibrated using Digital Multimeter
28. Frequency (100 mV to 750 V)	1 Hz to 40 Hz 40 Hz to 100 MHz	0.60 mHz/Hz 0.12 mHz/Hz	
29. Capacitance	(1 to 10) nF (10 to 100) nF (100 to 1000) nF (1 to 10) µF (10 to 100) µF (100 to 1000) µF (1 to 10) mF (10 to 50) mF	24 mF/F 12 mF/F 12 mF/F 12 mF/F 12 mF/F 17 mF/F 17 mF/F 37 mF/F	

Matrix F

AC Voltage Sourcing

Range	Frequency (Hz)							
	1 to 40	40 to 1 k	1 k to 20 k	20 k to 50 k	50 k to 100 k	100 k to 300 k	300 k to 1 M	1 M to 2 M
(1 to 10) mV	0.70	0.40	0.50	2.2	6.2	46		
(10 to 100) mV	0.22	0.11	0.20	0.41	1.0	3.6	12	17
(0.1 to 1) V	0.20	0.12	0.20	0.37	0.95	3.6	12	17
(1 to 10) V	0.20	0.12	0.20	0.40	1.0	3.9	12	18
(10 to 100) V	0.29	0.23	0.26	0.43	1.4	4.7	17	-
(100 to 700) V	0.52	0.50	0.72	1.4	3.5	-	-	-

The calibration uncertainties given in this table are expressed in mV/V

SCOPE OF CALIBRATION: ELECTRICAL

Matrix G

AC CURRENT Sourcing

Range	Frequency (Hz)						
	10 to 20	20 to 45	45 to 100	100 to 5 k	5 k to 20 k	20 k to 50 k	50 k to 100 k
(10 to 100) µA	5.0	2.1	1.1	1.1	-	-	-
(0.1 to 1) mA	4.9	2.0	0.95	0.75	0.94	5.1	8.1
(1 to 100) mA	4.9	2.0	0.94	0.6	0.94	5.1	8.1
(0.1 to 1) A	4.9	2.1	1.2	1.4	3.7	12	-
	Frequency (Hz)						
(1 to 2) A	4.2	2.5	3.6	8.1	-	-	-
(2 to 10) A	24	13	13	-	-	-	-

The calibration uncertainties given in this table are expressed in mA/A

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
RF Measuring Equipment			
30. RF Power Sensor Calibration Factor	Power Level 1.00 mW, Ref = 50 MHz 50 MHz to 1GHz 2 GHz to 5 GHz 6 GHz to 10 GHz 11 GHz to 18 GHz	 1.6 % 1.7 % 1.9 % 2.6 %	Calibration Factor Type-N 50 Ω, Direct Comparison Method using N432A, 8478B, 11667A, NRVS & NRV-Z51
31. RF Measuring a) Frequency	0.1 Hz to 18 GHz	2.0×10^{-12}	Generated using Frequency Generator DS345, HP8665A, 68369B ext ref. to EC1S-SO with GPS disciplined
b) RF Power (50 Ω)	-30 dBm to 20 dBm DC to 30 MHz 30 MHz to 6 GHz 6 GHz to 8 GHz 8 GHz to 12.4 GHz 12.4 GHz to 15 GHz 15 GHz to 16 GHz 16 GHz to 18 GHz	 0.10 dB 0.08 dB 0.09 dB 0.10 dB 0.12 dB 0.13 dB 0.14 dB	Characterized using 68369B, NRVS and NRV-Z51
32. RF Power Meter	Power Level -25 dBm (3.1623 µW) -20 dBm (10 µW) -15 dBm (31.6228 µW) -10 dBm (100 µW) -5 dBm (316.2278 µW) 0 dBm (1 mW) 5 dBm (3.1623 mW) 10 dBm (10 mW) 15 dBm (31.6228 mW) 20 dBm (100 mW)	 0.020 µW 0.017 µW 0.026 µW 0.02 µW 0.04 µW 0.0001 mW 0.0006 mW 0.002 mW 0.007 mW 0.030 mW	Generation using Agilent 11683A- H01 range calibrator, Fluke 5720A calibrator
Reference output	1 mW @ 50 MHz	0.004 mW	Agilent N432A,HP 478A-H75 and HP3458A-002

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Generating Equipment			
33. RF Generating a) Frequency	0.1 Hz to 18 GHz	2.0 x 10^{-12}	Measurement using CNT-90 ext ref to EC1S-SO with GPS disciplined
b) RF Power (50 Ω)	-30 dBm to 20 dBm		Measurement using NRVS and NRV-Z51
c) Frequency Modulation Accuracy/Deviation	-18 to 30 dBm fc: 250 kHz to 10 MHz fm: 20 Hz to 10 kHz Δf = 200 Hz to 40 kHz β > 0.2 β > 1.2 fc: 10 MHz to 6.6 GHz fm: 50 Hz to 200 kHz Δf = 250 Hz to 400 kHz β > 0.2 β > 0.45 fc: 6.6 GHz to 13.2 GHz fm: 50 Hz to 200 kHz Δf = 250 Hz to 400 kHz β > 0.2 β > 8 fc: 13.2 GHz to 26.5 GHz fm: 50 Hz to 200 kHz Δf = 250 Hz to 400 kHz β > 0.2 β > 16	 0.015 Hz/Hz 0.010 Hz/Hz 0.015 Hz/Hz 0.010 Hz/Hz 0.025 Hz/Hz 0.010 Hz/Hz 0.038 Hz/Hz 0.010 Hz/Hz	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate Δf = Peak Deviation β = Δf/fm

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Generating Equipment			
d) Amplitude Modulation Depth	-18 to 30 dBm fc: 100 kHz to 10 MHz fm: 50 Hz to 10 kHz Depth: 5% to 99% fc: 10 MHz to 3 GHz fm: 50 Hz to 100 kHz Depth: 20% to 99% Depth: 5% to 20% fc: 3 GHz to 26.5 GHz fm: 50 Hz to 100 kHz Depth: 20% to 99% Depth: 5% to 20%	0.0075 %/% 0.005 %/% 0.025 %/% 0.015 %/% 0.045 %/%	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate
e) Phase Modulation Accuracy/ Deviation	-18 to 30 dBm fc: 100 kHz to 6.6 GHz Δφ: 0.7 rad Δφ: 0.3 rad fc: 6.6 GHz to 13.2 GHz Δφ: 2.0 rad Δφ: 0.6 rad fc: 13.2 GHz to 26.5 GHz Δφ: 4.0 rad Δφ: 1.2 rad	0.01 rad/rad 0.03 rad/rad 0.01 rad/rad 0.03 rad/rad 0.01 rad/rad 0.03 rad/rad	Spectrum Analyzer Power Meter Sensor Module N5531S fc = Carrier Frequency Δφ = Phase Deviation
f) Frequency Modulation Distortion	fm: 20Hz to 1 kHz fc: 1 MHz to 6.6 GHz Δf = 500 Hz to 2.0 kHz Δf ≥ 2.0 kHz fc: 6.6 GHz to 13.2 GHz Δf ≥ 2.3 kHz Δf ≥ 4.5 kHz fc: 13.2 GHz to 26.5 GHz Δf ≥ 2.7 kHz Δf ≥ 6.0 kHz	0.12 %/% + 0.3% 0.12 %/% + 0.1% 0.12 %/% + 0.3% 0.12 %/% + 0.1% 0.12 %/% + 0.3% 0.12 %/% + 0.1%	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate Δf = Deviation

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Generating Equipment			
g) Amplitude Modulation Distortion	0.01% to 100% fm: 20 Hz to 1 kHz fc: 100 kHz to 10 MHz Depth > 1% Depth > 3% fc: 10 MHz to 26.5 GHz Depth > 1% Depth > 3%	 0.12 %/% + 0.8% 0.12 %/% + 0.3% 0.12 %/% + 1.0% 0.12 %/% + 0.4%	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate
h) Phase Modulation Distortion	<u>-18 to 30 dBm</u> fc: 100 kHz to 6.6 GHz fm: 20 Hz to 500 Hz Δφ > 0.8 rad Δφ > 2.5 rad fc: 1 MHz to 6.6 GHz fm: 500 Hz to 1 kHz Δφ > 0.4 rad Δφ > 1.0 rad fc: 6.6 GHz to 13.2 GHz fm: 20 Hz to 500 Hz Δφ > 1.8 rad Δφ > 5.5 rad fc: 6.6 GHz to 13.2 GHz fm: 500 Hz to 1 kHz Δφ > 0.8 rad Δφ > 2.5 rad fc: 13.2 GHz to 26.5 GHz fm: 20 Hz to 500 Hz Δφ > 3.5 rad Δφ > 10.0 rad fc: 13.2 GHz to 26.5 GHz fm: 500 Hz to 1 kHz Δφ > 1.2 rad Δφ > 4.0 rad	 0.0012 %/% + 0.3% 0.0012 %/% + 0.1% 0.0012 %/% + 0.3% 0.0012 %/% + 0.1% 0.0012 %/% + 0.3% 0.0012 %/% + 0.1% 0.0012 %/% + 0.3% 0.0012 %/% + 0.1% 0.0012 %/% + 0.3% 0.0012 %/% + 0.1%	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate Δφ = Phase Deviation

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Generating Equipment			
i) Modulation Rate Amplitude Modulation Frequency Modulation Phase Modulation	100 kHz to 26.5 GHz Δf ≥ 2.3 kHz fm ≤ 100 kHz ß ≥ 0.01 fm ≤ 200 kHz ß ≥ 0.01 fm ≤ 20 kHz	 0.078 Hz 0.096 Hz 0.064 Hz	 Spectrum Analyzer Power Meter Sensor Module fm = Modulation Rate β = Δf/fm
j) Tuned RF Level	(See Matrix H & I)		Spectrum Analyzer Power Meter Sensor Module with N5532B Sensor Module (Option 526)

Matrix H: Tuned RF Level (Pre-amplifier ON)		
Level Range	Calibration Measurements Capability (dB)	
	30 MHz to 2 GHz	2 GHz to 3.05 GHz
10 dBm to 16 dBm	0.25	0.36
0 dBm to 10 dBm	0.24	0.36
-10 dBm to 0 dBm	0.24	0.35
-20 dBm to -10 dBm	0.24	0.36
-30 dBm to -20 dBm	0.25	0.36
-40 dBm to -30 dBm	0.25	0.37
-50 dBm to -40 dBm	0.26	0.38
-60 dBm to -50 dBm	0.27	0.38
-70 dBm to -60 dBm	0.27	0.39
-80 dBm to -70 dBm	0.28	0.40
-90 dBm to -80 dBm	0.29	0.40
-100 dBm to -90 dBm	0.29	0.41
-110 dBm to -100 dBm	0.30	0.41
-120 dBm to -110 dBm	0.30	0.42
-130 dBm to -120 dBm	0.45	0.56
-140 dBm to -130 dBm	0.86	0.98

SCOPE OF CALIBRATION: ELECTRICAL

Matrix I: Tuned RF Level (Pre-amplifier OFF)				
Level Range	Calibration Measurement Capability (dB)			
	3.05 GHz to 6.6 GHz	6.6 GHz to 13.2 GHz	13.2 GHz to 18 GHz	18 GHz to 26.5 GHz
10 dBm to 16 dBm	0.36	0.36	0.36	0.45
0 dBm to 10 dBm	0.36	0.36	0.36	0.45
-10 dBm to 0 dBm	0.35	0.35	0.35	0.44
-20 dBm to -10 dBm	0.36	0.36	0.36	0.45
-30 dBm to -20 dBm	0.36	0.36	0.36	0.45
-40 dBm to -30 dBm	0.37	0.37	0.37	0.46
-50 dBm to -40 dBm	0.38	0.38	0.38	0.47
-60 dBm to -50 dBm	0.38	0.38	0.38	0.47
-70 dBm to -60 dBm	0.37	0.39	0.39	0.48
-80 dBm to -70 dBm	0.40	0.40	0.40	0.49
-90 dBm to -80 dBm	0.40	0.40	0.40	0.49
-100 dBm to -90 dBm	0.41	0.41	0.54	0.63
-110 dBm to -100 dBm	0.41	0.55	0.96	1.05
-120 dBm to -110 dBm	0.56	1.67		
-130 dBm to -120 dBm	0.97			

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
1. DC Voltage	(0 to 220) mV (0.0 to 2.2) V (0 to 11) V (0 to 22) V (0 to 220) V (0 to 1100) V 1 kV to 10 kV 10 kV to 40 kV	9.7 µV/V 5.4 µV/V 3.8 µV/V 4.0 µV/V 5.3 µV/V 7.1 µV/V 0.8% of the reading 0.6% of the reading	Calibrated using Multifunction Calibrator By comparison with a reference Measuring System
2. DC Current	(0 to 220) µA (0.0 to 2.2) mA (0 to 22) mA (0 to 220) mA (0.0 to 2.2) A	0.068 mA/A 0.039 mA/A 0.037 mA/A 0.049 mA/A 0.081 mA/A	Calibrated using Multifunction Calibrator
	(2.2 to 2.9) A (2.9 to 10.9) A (10.9 to 20.0) A	0.31 mA/A 0.43 mA/A 0.81 mA/A	
3. DC Current via Current Coils	(3.2 to 32) A (32 to 105) A (105 to 200) A (16 to 160) A (160 to 525) A (525 to 1000) A	2.1 mA/A 2.3 mA/A 2.6 mA/A 2.6 mA/A 2.6 mA/A 2.6 mA/A	Calibrated using Multifunction Calibrator & Current Coil
4. AC Voltage	(0.0 to 220) V	(See Matrix J)	Calibrated using Multifunction Calibrator
	(220 to 1100) V	(See Matrix K)	
5. AC Current	(0 to 20) A	(See Matrix L)	Calibrated using Multifunction Calibrator
6. AC Current via Current Coils	(3.2 to 1000) A	(See Matrix M)	Calibrated using Multifunction Calibrator & Current Coil

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Matrix J

AC Voltage Measurement

Range	Frequency (kHz)							
	0.01 to 0.02	0.02 to 0.04	0.04 to 20	20 to 50	50 to 100	100 to 300	300 to 500	500 to 1000
(0 to 2.2) mV	2.1	1.9	1.9	2.0	2.8	5.6	16	24
(2.2 to 22) mV	0.43	0.28	0.27	0.39	0.73	1.5	3.5	7.3
(22 to 220) mV	0.3	0.12	0.12	0.23	0.54	0.99	2.3	5.8
(0.22 to 2.2) V	0.26	0.098	0.049	0.080	0.12	0.46	1.1	1.8
(2.2 V to 22) V	0.26	0.099	0.049	0.081	0.11	0.30	1.1	1.7
(22 to 220) V	0.26	0.099	0.058	0.087	0.16	-	-	-

The expanded uncertainties given at above table is expressed in mV/V

Matrix K

AC Voltage Measurement

Range	Frequency (kHz)							
	0.015 to 0.045	0.045 to 0.05	0.05 to 1	1 to 5	5 to 10	10 to 20	20 to 50	50 to 100
(220 to 250) V	0.25	0.16	0.16	0.18	0.18	0.22	0.28	1.7
(250 to 330) V	-	0.16	0.16	0.17	0.17	0.21	0.26	1.7
(330 to 1020) V	-	0.24	0.24	0.20	0.24	-	-	-
(1020 to 1100) V	-	-	0.065	-	-	-	-	-

The expanded uncertainties given at above table expressed in mV/V

Matrix L

AC Current Measurement

Range	Frequency (kHz)							
	0.01 to 0.02	0.02 to 0.04	0.04 to 1	1 to 3	3 to 5	5 to 10	10 to 20	20 to 30
(0 to 32) µA	29	29	29	29	57	57	190	280
(32 to220) µA	0.34	0.24	0.17	0.32	0.34	1.2	11	16
(220 to 320) µA	1.7	1.7	1.7	1.7	2.9	2.9	8.3	12
(0.32 to 2.2) mA	0.27	0.18	0.14	0.14	0.25	1.4	2.9	3.9
(2.2 to 3.2) mA	0.82	0.82	0.83	0.83	1.3	1.3	2.7	3.5
(3.2 to 22) mA	0.27	0.18	0.14	0.23	0.23	1.3	2.6	3.5
(22 to 32) mA	0.83	0.83	0.83	0.83	1.3	1.3	2.4	3.2
(32 to 220) mA	0.27	0.18	0.13	0.22	0.22	1.1	2.3	2.9
(220 to 320) mA	-	0.93	0.93	0.94	1.2	1.2	2.2	2.8
(0.32 to 2.2) A	-	0.28	0.28	0.49	7.1	7.1	-	-
(2.2 to 3.2) A	0.92	0.92	0.92	0.92	2.6	2.6	-	-
(3.2 to 10.5) A	1.8	1.8	1.8	1.8	4.6	4.6	-	-
(10.5 to 20) A	1.8	1.8	1.8	1.8	4.8	4.8	-	-

The expanded uncertainties given at above table is expressed in mA/A

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Matrix M

AC Current via Current Coils Measurement

Range	Frequency (Hz)		
	10 to 65	10 to 100	100 to 440
(3.2 to 32.0) A	-	3.5	10
(32.0 to 200) A	-	4.2	9.6
(200.0 to 1000) A	4.2	-	-

The expanded uncertainties given at above table is expressed in mA/A

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
7. Wideband AC Voltage (Frequency from 30 Hz to 500 kHz into 50 Ω Termination)	(0.3 to 1.1) mV (1.1 to 3) mV (3 to 11) mV (11 to 33) mV (33 to 110) mV (110 to 330) mV (0.33 to 1.1) V (1.1 to 3.5) V	9.9 mV/V 8.0 mV/V 7.7 mV/V 6.5 mV/V 6.4 mV/V 5.5 mV/V 5.6 mV/V 4.1 mV/V	Calibrated using Multifunction Calibrator
8.Wideband AC Voltage Amplitude Flatnessat 1 kHz reference into 50 Ω Termination)	0.3 mV to 3.5 V	(See Matrix N)	

Matrix N

Wideband ACV Amplitude Flatness

Range	Volts		
	1.1 mV	3 mV	3.5 V
(10 to 30) Hz	3.0	3.0	3.0
(30 to 120) Hz	1.1	1.1	1.1
(0.12 to 1.2) kHz	1.1	1.1	1.1
(1.2 to 12) kHz	1.1	1.1	1.1
(12 to 120) kHz	1.1	1.1	1.1
(0.12 to 1.2) MHz	4.8	2.1	1.1
(1.2 to 2) MHz	4.8	2.1	1.1
(2 to 10) MHz	6.8	4.1	2.1
(10 to 20) MHz	8.9	6.1	4.1
(20 to 30) MHz	29	16	10

The calibration uncertainties given at above table expressed in mV/V

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
9. Resistance	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	40 µΩ 95 µΩ 95 µΩ 46 µΩ 79 µΩ 300 µΩ 570 µΩ 0.25 mΩ 0.48 mΩ 2.5 mΩ 4.8 mΩ 250 mΩ 480 mΩ 4.0 Ω 7.6 Ω 10 Ω 19 Ω 25 kΩ	Calibrated using Multifunction Calibrator (Standard Value)
	1 Ω	8 µΩ	Calibrated using Standard Resistance
	10 Ω	11 µΩ	
	10 kΩ	7 mΩ	
	(0.0 to 10.9) Ω (11 to 32.9) Ω (33 to 109.9) Ω (0.11 to 1.09) kΩ (1.1 to 10.9) kΩ (11 to 109) kΩ (0.11 to 1.09) MΩ (1.1 to 3.29) MΩ (3.3 to 10.9) MΩ (11 to 32.9) MΩ (33 to 109.9) MΩ (110 to 330) MΩ (330 to 1100) MΩ	0.041 mΩ/Ω 0.031 mΩ/Ω 0.028 mΩ/Ω 0.028 mΩ/Ω 0.029 mΩ/Ω 0.029 mΩ/Ω 0.033 mΩ/Ω 0.062 mΩ/Ω 0.13 mΩ/Ω 0.27 mΩ/Ω 0.54 mΩ/Ω 4.8 mΩ/Ω 18 mΩ/Ω	Calibrated using Multifunction Calibrator

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
Resistance (Continued)	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (100 to 1000) Ω (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (100 to 1000) MΩ (1 to 10) GΩ (10 to 100) GΩ (100 to 1000) GΩ	23 mΩ/Ω 5.8 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 0.58 mΩ/Ω 2.3 mΩ/Ω 2.3 mΩ/Ω 23 mΩ/Ω 58 mΩ/Ω 58 mΩ/Ω 58 mΩ/Ω	Calibrated using Decade Resistance Box
10. Capacitance	<u>Stim Repetition Rate ≤350 Hz</u> (0.5 to 4.0) nF (4.0 to 40.0) nF (40.0 to 400.0) nF (0.4 to 4.0) µF (4.0 to 40.0) µF (40.0 to 400.0) µF (0.4 to 4.0) mF (4.0 to 40.0) mF <u>Stim Repetition Rate 350 Hz to 1.5 kHz</u> (0.5 to 4.0) nF (4.0 to 40.0) nF (40.0 to 400.0) nF (0.4 to 4.0) µF (4.0 to 40.0) µF (40.0 to 400.0) µF (0.4 to 4.0) mF (4.0 to 40.0) mF	5.4 mF/F 3.0 mF/F 2.7 mF/F 3.5 mF/F 4.3 mF/F 4.5 mF/F 4.6 mF/F 8.9 mF/F 11 mF/F 5.9 mF/F 5.3 mF/F 6.9 mF/F 8.4 mF/F 8.4 mF/F 8.5 mF/F 18 mF/F	Calibrated using Multifunction Calibrator

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
Capacitance (continued)	<u>at 1 kHz</u> (0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (0.11 to 0.33) µF (0.33 to 1.1) µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	35 mF/F 16 mF/F 9.4 mF/F 4.0 mF/F 6.4 mF/F 4.0 mF/F 4.1 mF/F 4.1 mF/F 4.1 mF/F 4.1 mF/F 5.8 mF/F 6.4 mF/F 6.2 mF/F 6.3 mF/F 6.2 mF/F 6.2 mF/F 9.7 mF/F 15 mF/F	Calibrated using Multifunction Calibrator
	1 pF to 1 µF 1 µF to 10 µF	0.61 mF/F 12 mF/F	Calibrated using Decade Capacitance box
	<u>Fixed Value</u> 10 µF 100 µF 1000 µF	0.50 mF/F 0.70 mF/F 5.1 mF/F	Calibrated using Standard Capacitance
11. Inductance	(10 to 100) µH (100 to 1000) µH (1 to 10) mH (10 to 100) mH (100 to 1000) mH (1 to 10) H	23 mH/H 23 mH/H 23 mH/H 23 mH/H 23 mH/H 23 mH/H	Calibrated using Decade Inductance Box
	<u>Fixed Value</u> 100 µH 1 mH 10 mH 100 mH	12 mH/H 1.2 mH/H 1.2 mH/H 1.2 mH/H	Calibrated using Standard Inductance
12. Frequency	(1 to 1000) Hz (1 to 100) kHz	0.058 mHz/Hz 1.4 mHz/Hz	Calibrated using Multi-function calibrator

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
13. **Oscilloscope**			
Vertical Amplitude a. ACV Square (Vp-p) 1 MΩ Load 50 Ω Load b. DC Signal 1 MΩ Load 50 Ω Load	 <u>10 Hz to 10 kHz</u> (1.01 to 130) Vp-p 1 mV to 5 V (0 to 130) V 4.44 mV to 2.78 V	 2.9 mV/V 2.9 mV/V 0.58 mV/V 2.9 mV/V	Calibrated using Multifunction Calibrator
Time Base	1 ns 2 ns to 5 s	0.029 ms/s 1.2 ms/s	
Edge Function Output Period Rise Time 50 Ω Load 1 MΩ Load Fall Time 50 Ω Load 1 MΩ Load	 100 ns to 100 ms 10 µs to 10 ms 100 ns to 10 ms 100 ns to 10 ms	 29 µs/s 29 µs/s 29 µs/s 29 µs/s	
Bandwidth – Amplitude Flatness at 50 kHz reference	<u>5 mV to 5.5 V</u> 50 kHz to 100 MHz 100 MHz to 250 MHz <u>5 mV to 3.5 V</u> 250 MHz to 1050 MHz	19 mV/V 25 mV/V 59 mV/V	
Frequency - Accuracy	1 µHz to 0.5 Hz 0.5 Hz to 600 MHz 600 MHz to 1050 MHz	5 µHz/Hz 2.9 µHz/Hz 2.9 µHz/Hz	Calibrated using Function Generator, Multifunction Calibrator
Frequency - Amplitude	<u>(0.01 to 5.00) Vpp</u> 1 µHz to 100 kHz 100 kHz to 20 MHz 20 MHz to 30.2 MHz <u>(5 to 10) Vpp</u> 1 µHz to 100 kHz 100 kHz to 20 MHz 20 MHz to 30.2 MHz	 40 mV/V 40 mV/V 40 mV/V 58 mV/V 92 mV/V 210 mV/V	Calibrated using Function Generator

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Instrument			
14. Earth Tester	0.01 Ω to 0.1 Ω 0.1 Ω to 100 Ω 100 Ω to 1 MΩ	23 mΩ/Ω 0.14 mΩ/Ω 2.3 mΩ/Ω	Calibrated using Decade Resistance Box
15. Insulation Tester / High Voltage Insulation Tester (up to 5 kV)	(1 to 100) MΩ (0.1 to 1) GΩ (2 to 10) GΩ (0.01 to 1) TΩ (1 to 10) TΩ	1.2 mΩ/Ω 2.3 mΩ/Ω 5.8 mΩ/Ω 19 mΩ/Ω 35 mΩ/Ω	

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Generating/Sourcing Instrument			
16. DC Voltage	(0 to 100) mV (0 to 1) V (0 to 10) V (0 to 100) V (0 to 1000) V	14 µV/V 6.5 µV/V 5.5 µV/V 8.3 µV/V 8.6 µV/V	Calibrated using Digital Multimeter
17. DC High Voltage	(1 to 10) kV (10 to 40) kV	0.97 mV/V 23 mV/V	Calibrated using Digital Multimeter and High Voltage Meter
18. DC Current	(0 to 100) µA (0 to 1) mA (0 to 10) mA (0 to 100) mA (0 to 1) A (0 to 2) A	33 µA/A 30 µA/A 29 µA/A 46 µA/A 160 µA/A 890 µA/A	Calibrated using Digital Multimeter
	(0 to 10) A	2.4 mA/A	
19. DC Current via Current Shunt	(0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 2) A (2 to 5) A (5 to 10) A (10 to 15) A (15 to 20) A (20 to 25) A (25 to 30) A	140 µA/A 14 µA/A 2.9 µA/A 140 µA/A 14 µA/A 2.9 µA/A 140 µA/A 68 µA/A 29 µA/A 16 µA/A 12 µA/A 10 µA/A 50 µA/A 50 µA/A	Calibrated using Digital Multimeter & Current Shut
	(3 to 100) A (100 to 500) A	7.3 mA/A 0.33% of the reading + 0.4 A	Calibrated using Digital Multimeter and Current Shunt

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Generating/Sourcing Instrument			
20. AC Voltage	(0 to 700) V	(See Matrix O)	Calibrated using Digital Multimeter
	(700 to 1000) V (45 to 1000) Hz (1 to 10) kHz	14 mV/V 14 mV/V	
21. AC High Voltage	50 Hz & 60 Hz (1 to 10) kV (10 to 40) kV	12 mV/V 62 mV/V	Calibrated using Digital Multimeter & High Voltage Meter
22. AC Current	20 µA to 10 A	(See Matrix P)	Calibrated using Digital Multimeter
23. AC Current via Current Shunt	(10 to 100) A (45 to 65) Hz	2.5 mA/A	Calibrated using Digital Multimeter & Current Shunt
24. Resistance	(0 to 10) Ω (10 to 100) Ω (100 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ	0.031 mΩ/Ω 0.022 mΩ/Ω 0.014 mΩ/Ω 0.014 mΩ/Ω 0.015 mΩ/Ω 0.025 mΩ/Ω 0.077 mΩ/Ω 0.62 mΩ/Ω	Calibrated using Digital Multimeter
25. Frequency (100 mV to 750 V)	(3 to 5) Hz (5 to 10) Hz (10 to 40) Hz (0.03 to 300) kHz	1.2 mHz/Hz 0.58 mHz/Hz 0.35 mHz/Hz 0.12 mHz/Hz	
26. Capacitance	(0.1 to 1) µF (1 to 10) µF (10 to 100) µF (100 to 1000) µF (1000 to 9999) µF	18 mF/F 18 mF/F 18 mF/F 18 mF/F 35 mF/F	

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Matrix O

AC Voltage Source

Range	Frequency (kHz)									
	0.02 to 0.05	**0.05 to 0.1**	**0.1 to 2**	**2 to 10**	**10 to 30**	**30 to 50**	**50 to 100**	**100 to 200**	**200 to 1000**	**1000 to 2000**
(20 to 200) mV	4.6	0.99	0.47	0.50	0.56	0.72	3.7	9.0	24	60
(0.2 to 2) V	3.2	0.98	0.46	0.47	0.53	0.70	3.7	9.0	24	60
(2 to 20) V	3.1	0.98	0.52	0.64	0.75	0.98	3.6	9.0	49	-
(20 to 200) V	3.1	0.98	0.52	0.64	0.75	0.98	3.6	-	-	-
(200 to 700) V	3.1	1.3	0.75	0.87	1.1	-	-	-	-	-

The calibration uncertainties given in this table are expressed in mV/V

Matrix P

AC Current Source

Range	Frequency (kHz)			
	0.02 to 0.05	**0.05 to 0.2**	**0.2 to 1**	**1 to 10**
(20 to 200) µA	4.2	2.5	4.8	6.1
(0.2 to 2) mA	3.6	1.9	1.6	2.0
(2 to 20) mA	3.6	1.9	1.6	1.9
(20 to 200) mA	3.6	1.9	1.6	2.1
(0.2 to 2) A	4.2	2.5	3.6	8.1
(2 to 10) A	24	13	13	-

The calibration uncertainties given in this table are expressed in mA/A

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
RF Measuring Equipment			
27. RF Power Sensor Calibration Factor	Power Level 1.00 mW, Ref = 50 MHz 50 MHz to 1GHz 2 GHz to 5 GHz 6 GHz to 10 GHz 11 GHz to 18 GHz	 1.6 % 1.7 % 1.9 % 2.6 %	Calibration Factor Type-N 50 Ω, Direct Comparison Method using N432A, 8478B, 11667A, NRVS & NRV-Z51
28. RF Measurement a) Frequency	0.1 Hz to 18 GHz	2.0 x 10^{-12}	Generating using Frequency Generator DS345, HP8665A, 68369B ext ref. to EC1S-SO with GPS disciplined
b) RF Power (50 Ω)	-30 dBm to 20 dBm DC to 30 MHz 30 MHz to 6 GHz 6 GHz to 8 GHz 8 GHz to 12.4 GHz 12.4 GHz to 15 GHz 15 GHz to 16 GHz 16 GHz to 18 GHz	 0.10 dB 0.08 dB 0.09 dB 0.10 dB 0.12 dB 0.13 dB 0.14 dB	Characterized using 68369B, NRVS and NRV-Z51
29. RF Power Meter	Power Level -25 dBm (3.1623 µW) -20 dBm (10 µW) -15 dBm (31.6228 µW) -10 dBm (100 µW) -5 dBm (316.2278 µW) 0 dBm (1 mW) 5 dBm (3.1623 mW) 10 dBm (10 mW) 15 dBm (31.6228 mW) 20 dBm (100 mW)	 0.020 µW 0.017 µW 0.026 µW 0.02 µW 0.04 µW 0.0001 mW 0.0006 mW 0.002 mW 0.007 mW 0.030 mW	Generation using Agilent 11683A- H01 range calibrator, Fluke 5720A calibrator
Reference output	1mW @ 50 MHz	0.004 mW	Agilent N432A,HP 478A-H75 and HP3458A-002

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
RF Generating Equipment			
a) Frequency	0.1 Hz to 18 GHz	2.0 x 10^{-12}	Measurement using CNT-90 ext ref to EC1S-SO with GPS disciplined
b) RF Power (50 Ω)	<u>-30 dBm to 20 dBm</u> DC to 30 MHz 30 MHz to 6 GHz 6 GHz to 8 GHz 8 GHz to 12.4 GHz 12.4 GHz to 15 GHz 15 GHz to 16 GHz 16 GHz to 18 GHz	0.09 dB 0.07 dB 0.08 dB 0.09 dB 0.11 dB 0.12 dB 0.14 dB	Measurement using NRVS and NRV-Z51
c) Frequency Modulation Accuracy/Deviation	<u>-18 to 30 dBm</u> fc: 250 kHz to 10 MHz fm: 20 Hz to 10 kHz Δf = 200 Hz to 40 kHz β > 0.2 β > 1.2 fc: 10 MHz to 6.6 GHz fm: 50 Hz to 200 kHz Δf = 250 Hz to 400 kHz β > 0.2 β > 0.45 fc: 6.6 GHz to 13.2 GHz fm: 50 Hz to 200 kHz Δf = 250 Hz to 400 kHz β > 0.2 β > 8 fc: 13.2 GHz to 26.5 GHz fm: 50 Hz to 200 kHz Δf = 250 Hz to 400 kHz β > 0.2 β > 16 fc: 13.2 GHz to 26.5 GHz fm: 50 Hz to 200 kHz Δf = 250 Hz to 400 kHz β > 0.2 β > 16	 0.015 Hz/Hz 0.010 Hz/Hz 0.015 Hz/Hz 0.010 Hz/Hz 0.025 Hz/Hz 0.010 Hz/Hz 0.038 Hz/Hz 0.010 Hz/Hz 0.038 Hz/Hz 0.010 Hz/Hz	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulaton Rate Δf = Peak Deviation β = Δf/fm

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
d) Amplitude Modulation Depth	-18 to 30 dBm fc: 100 kHz to 10 MHz fm: 50 Hz to 10 kHz Depth: 5% to 99% fc: 10 MHz to 3 GHz fm: 50 Hz to 100 kHz Depth: 20% to 99% Depth: 5% to 20% fc: 3 GHz to 26.5 GHz fm: 50 Hz to 100 kHz Depth: 20% to 99% Depth: 5% to 20%	 0.0075%/% 0.005%/% 0.025%/% 0.015%/% 0.045%/%	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate
e) Phase Modulation Accuracy/Deviation	-18 to 30 dBm fc: 100 kHz to 6.6 GHz Δφ: 0.7 rad Δφ: 0.3 rad fc: 6.6 GHz to 13.2 GHz Δφ: 2.0 rad Δφ: 0.6 rad fc: 13.2 GHz to 26.5 GHz Δφ: 4.0 rad Δφ: 1.2 rad	 0.01 rad/rad 0.03 rad/rad 0.01 rad/rad 0.03 rad/rad 0.01 rad/rad 0.03 rad/rad	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency Δφ = Phase Deviation
f) Frequency Modulation Distortion	fm: 20 Hz to 1 kHz fc: 1 MHz to 6.6 GHz Δf = 500 Hz to 2.0 kHz Δf ≥ 2.0 kHz fc: 6.6 GHz to 13.2 GHz Δf ≥ 2.3 kHz Δf ≥ 4.5 kHz fc: 13.2 GHz to 26.5 GHz Δf ≥ 2.7 kHz Δf ≥ 6.0 kHz	 0.12 %/% + 0.3% 0.12 %/% + 0.1% 0.12 %/% + 0.3% 0.12 %/% + 0.1% 0.12 %/% + 0.3% 0.12 %/% + 0.1%	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate Δf = Deviation

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
g) Amplitude Modulation Distortion	0.01% to 100% fm: 20 Hz to 1 kHz fc: 100 kHz to 10 MHz Depth > 1% Depth > 3% fc: 10 MHz to 26.5 GHz Depth > 1% Depth > 3%	 0.12 %/% + 0.8% 0.12 %/% + 0.3% 0.12 %/% + 1.0% 0.12 %/% + 0.4%	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate
h) Phase Modulation Distortion	-18 to 30 dBm fc: 100 kHz to 6.6 GHz fm: 20 Hz to 500 Hz Δφ > 0.8 rad Δφ > 2.5 rad fc: 1 MHz to 6.6 GHz fm: 500 Hz to 1 kHz Δφ > 0.4 rad Δφ > 1.0 rad fc: 6.6 GHz to 13.2 GHz fm: 20 Hz to 500 Hz Δφ > 1.8 rad Δφ > 5.5 rad fc: 6.6 GHz to 13.2 GHz fm: 500 Hz to 1 kHz Δφ > 0.8 rad Δφ > 2.5 rad fc: 13.2 GHz to 26.5 GHz fm: 20 Hz to 500 Hz Δφ > 3.5 rad Δφ > 10.0 rad fc: 13.2 GHz to 26.5 GHz fm: 500 Hz to 1 kHz Δφ > 1.2 rad Δφ > 4.0 rad	 0.0012 %/% + 0.3% 0.0012 %/% + 0.1% 0.0012 %/% + 0.3% 0.0012 %/% + 0.1% 0.0012 %/% + 0.3% 0.0012 %/% + 0.1% 0.0012 %/% + 0.3% 0.0012 %/% + 0.1% 0.0012 %/% + 0.3% 0.0012 %/% + 0.1%	Spectrum Analyzer Power Meter Sensor Module fc = Carrier Frequency fm = Modulation Rate Δφ = Phase Deviation

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed asan Uncertainty(±)*	Remarks
i) Modulation Rate	100 kHz to 26.5 GHz		
Amplitude Modulation	Δf ≥ 2.3 kHzfm ≤ 100 kHz	0.078 Hz	Spectrum Analyzer Power Meter Sensor Module
Frequency Modulation	ß ≥ 0.01 fm ≤ 200 kHz	0.096 Hz	fm = Modulation Rate β = Δf/fm
Phase Modulation	ß ≥ 0.01 fm ≤ 20 kHz	0.064 Hz	
j) Tuned RF Level	See Matrix Q & R		Spectrum Analyzer Power Meter Sensor Module with N5532B Sensor Module (Option 526)

Matrix Q: Tuned RF Level (Pre-amplifier ON)

Level Range	Calibration Measurements Capability (dB)	
	30 MHz to 2 GHz	2 GHz to 3.05 GHz
10 dBm to 16 dBm	0.25	0.36
0 dBm to 10 dBm	0.24	0.36
-10 dBm to 0 dBm	0.24	0.35
-20 dBm to -10 dBm	0.24	0.36
-30 dBm to -20 dBm	0.25	0.36
-40 dBm to -30 dBm	0.25	0.37
-50 dBm to -40 dBm	0.26	0.38
-60 dBm to -50 dBm	0.27	0.38
-70 dBm to -60 dBm	0.27	0.39
-80 dBm to -70 dBm	0.28	0.40
-90 dBm to -80 dBm	0.29	0.40
-100 dBm to -90 dBm	0.29	0.41
-110 dBm to -100 dBm	0.30	0.41
-120 dBm to -110 dBm	0.30	0.42
-130 dBm to -120 dBm	0.45	0.56
-140 dBm to -130 dBm	0.86	0.98

Issue date: 1 July 2025
Valid until: 16 July 2028

NO: SAMM 011
(Issue 3, 1 July 2025 replacement
of SAMM 011 dated 4 February 2025)

SCOPE OF CALIBRATION: ELECTRICAL

SITE:CATEGORY I

Matrix R: Tuned RF Level (Pre-amplifier OFF)				
Level Range	Calibration Measurement Capability (dB)			
	3.05 GHz to 6.6 GHz	6.6 GHz to 13.2 GHz	13.2 GHz to 18 GHz	18 GHz to 26.5 GHz
10 dBm to 16 dBm	0.36	0.36	0.36	0.45
0 dBm to 10 dBm	0.36	0.36	0.36	0.45
-10 dBm to 0 dBm	0.35	0.35	0.35	0.44
-20 dBm to -10 dBm	0.36	0.36	0.36	0.45
-30 dBm to -20 dBm	0.36	0.36	0.36	0.45
-40 dBm to -30 dBm	0.37	0.37	0.37	0.46
-50 dBm to -40 dBm	0.38	0.38	0.38	0.47
-60 dBm to -50 dBm	0.38	0.38	0.38	0.47
-70 dBm to -60 dBm	0.37	0.39	0.39	0.48
-80 dBm to -70 dBm	0.40	0.40	0.40	0.49
-90 dBm to -80 dBm	0.40	0.40	0.40	0.49
-100 dBm to -90 dBm	0.41	0.41	0.54	0.63
-110 dBm to -100 dBm	0.41	0.55	0.96	1.05
-120 dBm to -110 dBm	0.56	1.67		
-130 dBm to -120 dBm	0.97			