



MS ISO/IEC 17025

Certificate of Accreditation

No: SAMM 088

Valid until: 14 September 2017

This is to certify that

**SIRIM STANDARDS TECHNOLOGY SDN. BHD.
SHAH ALAM, SELANGOR
MALAYSIA**

(FIELDS OF CALIBRATION: ELECTRICAL, TEMPERATURE, MASS,
DIMENSIONAL, FORCE, PRESSURE, TORQUE, VOLUMETRIC &
HYDROMETER)

has been granted accreditation in respect of the scope of accreditation described in the SCHEDULE attached, subject to the terms and conditions governing the *Skim Akreditasi Makmal Malaysia (SAMM)*, the Laboratory Accreditation Scheme of Malaysia.

"This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated January 2009)".

Issuance of this certificate is governed by Section 16 Subsection (2) and (3) of Standards of Malaysia Act 1996, (Act 549).




(FADILAH BAHARIN)
Director General
Department of Standards Malaysia

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LABORATORY LOCATION:
(PERMANENT LABORATORY)

SIRIM STANDARDS TECHNOLOGY SDN. BHD.
(Company No.: 292201-P)
LOT 12, 18 & 20, JALAN BEREMBAN 15/12
SEKSYEN 15
40200 SHAH ALAM, SELANGOR
MALAYSIA

This laboratory accredited under *Skim Akreditasi Makmal Malaysia* (SAMM) meets the requirements of MS ISO/IEC 17025:2005 'General requirements for competence of testing and calibration laboratories'. This Malaysian Standards is identical with ISO/IEC 17025:2005 published by the International Organization for Standardization (ISO).

* The expanded uncertainties are based on an estimated confidence probability of approximately 95% and have a coverage factor of $k=2$ unless stated otherwise.

FIELD OF CALIBRATION: ELECTRICAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument DC VOLTAGE	± 220 mV Range $\pm (0$ mV to 220 mV)	9 μ V/V + 0.8 μ V	Generating using calibrator model Fluke 5700A
	± 2.2 V Range $\pm (0$ V to 2.2 V)	8 μ V/V + 1.2 μ V	
	+11 V Range $\pm (0$ V to 11 V)	8 μ V/V + 4 μ V	
	± 22 V Range $\pm (0$ V to 22 V)	8 μ V/V + 8 μ V	
	± 220 V Range $\pm (0$ V to 220 V)	9 μ V/V + 0.1 mV	
	± 1100 V Range $\pm (100$ V to 1100 V)	11 μ V/V + 0.6 mV	



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FIELD OF CALIBRATION: ELECTRICAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument AC VOLTAGE	<u>2.2 mV to 220 V</u> (See Matrix A)	(See Matrix A)	Generating using calibrator model Fluke 5700A
	<u>1100 V Range (110 V to 1100 V)</u> 50 Hz to 1 kHz	90 μ V/V + 4 mV	
	<u>800 V to 1050 V</u> 1 kHz to 3 kHz 3 kHz to 10 kHz 10 kHz to 20 kHz	0.8 mV/V + 0.13 V 0.8 mV/V + 0.21 V 1.2 mV/V + 0.32 V	Generating using calibrator model Wavetek 9100
DC CURRENT	0 mA to +2.2 mA -2.2 mA to 0 mA	60 μ A/A + 0.01 μ A	Generating using calibrator model Fluke 5700A
	0 mA to +22 mA -22 mA to 0 mA	60 μ A/A + 0.1 μ A	
	0 mA to +220 mA -220 mA to 0 mA	70 μ A/A + 1 μ A	
	0 A to +1 A -1 A to 0 A	95 μ A/A + 30 μ A	
	+0.32 A to +3.2 A -3.2 A to -0.32 A	0.6 mA/A + 0.12 mA	Generating using calibrator model Wavetek 9100
	+3.2 A to +10.5 A -10.5 A to -3.2 A	0.55 mA/A + 0.94 mA	
	+10.5 A to +20 A -20 A to -10.5 A	0.55 mA/A + 4.5 mA	
	+20 A to +100 A -100 A to -20 A	0.45 mA/A + 20 mA	California 3213K

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SCOPE OF ACCREDITATION:

Matrix A

AC Voltage Measurement

Range		Frequency			
		Hz		kHz	
		10 to 20	20 to 40	0.04 to 20	20 to 50
2.2 mV	0.22 mV to 2.2 mV	0.6 + 0.005	0.24 + 0.005	0.12 + 0.005	0.41 + 0.005
22 mV	2.2 mV to 22 mV	0.6 + 0.006	0.24 + 0.006	0.12 + 0.006	0.41 + 0.006
220 mV	22 mV to 220 mV	0.6 + 0.016	0.24 + 0.01	0.11 + 0.01	0.36 + 0.01
2.2 V	0.22 V to 2.2 V	0.6 + 0.1	0.18 + 0.03	0.085 + 0.007	0.14 + 0.02
22 V	2.2 V to 22 V	0.6 + 1	0.18 + 0.3	0.085 + 0.07	0.14 + 0.2
220 V	22 V to 220 V	0.6 + 10	0.18 + 3	0.09 + 1	0.25 + 4

Range		Frequency			
		MHz			
		0.05 to 0.1	0.1 to 0.3	0.3 to 0.5	0.5 to 1
2.2 mV	0.22 mV to 2.2 mV	0.95 + 0.008	1.3 + 0.015	1.8 + 0.03	3.6 + 0.03
22 mV	2.2 mV to 22 mV	0.95 + 0.008	1.3 + 0.015	1.8 + 0.03	3.6 + 0.03
220 mV	22 mV to 220 mV	0.9 + 0.03	1.1 + 0.03	1.8 + 0.04	3.6 + 0.1
2.2 V	0.22 V to 2.2 V	0.28 + 0.08	0.48 + 0.15	1.2 + 0.4	2.4 + 1
22 V	2.2 V to 22 V	0.28 + 0.4	0.6 + 1.7	1.4 + 5	3 + 9
220 V	22 V to 220 V	0.6 + 10	1.6 + 110	5.4 + 110	13 + 220

The expanded uncertainties given in this table are expressed in mV/V + mV

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FIELD OF CALIBRATION: ELECTRICAL**SCOPE OF ACCREDITATION:**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument AC CURRENT	<u>9 μA to 2.2 A</u> (See Matrix B)	(See Matrix B)	Generating using calibrator model Fluke 5700A
	<u>0.32 A to 3.2 A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz <u>3.2 A to 10.5 A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz <u>10.5 A to 20 A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz	1 mA/A + 0.48 mA 2.5 mA/A + 2.6 mA 2 mA/A + 3 mA 5 mA/A + 10 mA 2 mA/A + 6.9 mA 5 mA/A + 23 mA	Generating using calibrator model Wavetek 9100
	<u>20 A to 100 A</u> 10 Hz to 1 kHz 1 kHz to 10 kHz	2.5 mA/A + 0.03 A 5 mA/A + 0.05 A	CA 3213K
	Residual Current	3 mA to 3 A At Time interval up to 5 s At Time interval <190 ms	For RCD Tester Calibrator (using Transmille 3200)

Matrix B

AC Current Measurement

Range	Frequency (kHz)				
	0.01 to 0.02	0.02 to 0.04	0.04 to 1	1 to 5	5 to 10
9 μ A to 220 μ A	0.8 + 0.03	0.42 + 0.025	0.16 + 0.02	0.7 + 0.05	1.8 + 0.1
0.22 mA to 2.2 mA	0.8 + 0.05	0.42 + 0.04	0.16 + 0.04	0.7 + 0.5	1.8 + 1
2.2 mA to 22 mA	0.8 + 0.5	0.42 + 0.4	0.16 + 0.4	0.7 + 10	1.8 + 0.01
22 mA to 220 mA	0.8 + 5	0.42 + 4	0.18 + 4	0.7 + 50	1.8 + 100
0.22 A to 2.2 A	-	-	0.75 + 40	0.85 + 100	10 + 200

The expanded uncertainties given in this table are expressed in mA/A + μ A

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FIELD OF CALIBRATION: ELECTRICAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument RESISTANCE Fixed Value	1 m Ω 10 m Ω 100 m Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω	0.2 m Ω / Ω 0.1 m Ω / Ω 0.02 m Ω / Ω 5 $\mu\Omega$ / Ω 0.11 m Ω / Ω 5 $\mu\Omega$ / Ω 31 $\mu\Omega$ / Ω 5 $\mu\Omega$ / Ω 0.02 m Ω / Ω 5 $\mu\Omega$ / Ω 15 $\mu\Omega$ / Ω 5 $\mu\Omega$ / Ω 14 $\mu\Omega$ / Ω 5 $\mu\Omega$ / Ω 15 $\mu\Omega$ / Ω 5 $\mu\Omega$ / Ω 24 $\mu\Omega$ / Ω 5 $\mu\Omega$ / Ω 0.05 m Ω / Ω	Fluke 5700A & Standard Resistor Fluke 742A Series
	100 M Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω	0.13 m Ω / Ω 5 $\mu\Omega$ / Ω 0.02 Ω / Ω 0.05 Ω / Ω 0.05 Ω / Ω	Fluke 5700A & Standard Resistor Takeda Riken TR45
CAPACITANCE Fixed Value	<u>20 Hz to 1 MHz</u> 1 pF, 10 pF, 100 pF, 1000 pF, 0.01 μ F, 0.1 μ F and 1 μ F	1 mF/F	HP 1600A series
CAPACITANCE	<u>≤ 350 Hz</u> 0.5 nF to 4 nF 4 nF to 40 nF 40 nF to 400 nF 400 nF to 4 μ F 4 μ F to 40 μ F 40 μ F to 400 μ F 400 μ F to 4 mF 4 mF to 40 mF	3 mF/F + 15 pF 3 mF/F + 30 pF 3 mF/F + 0.16 nF 4 mF/F + 1.6 nF 5 mF/F + 16 nF 5 mF/F + 0.16 μ F 5 mF/F + 1.6 μ F 10 mF/F + 0.06 mF	Generating using calibrator model Wavetek 9100



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FIELD OF CALIBRATION: ELECTRICAL**SCOPE OF ACCREDITATION:**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument CAPACITANCE (continued)	350 Hz to 1.5 kHz 0.5 nF to 4 nF 4 nF to 40 nF 40 nF to 400 nF 400 nF to 4 μ F 4 μ F to 40 μ F 40 μ F to 400 μ F 400 μ F to 4 mF 4 mF to 40 mF	6 mF/F + 0.03 nF 6 mF/F + 0.06 nF 6 mF/F + 0.32 nF 8 mF/F + 3.2 nF 10 mF/F + 32 nF 10 mF/F + 0.32 μ F 10 mF/F + 3.2 μ F 20 mF/F + 0.12 mF	Generating using calibrator model Wavetek 9100
INDUCTANCE Fixed Value	100 μ H @ 1 kHz (1, 10, 100) mH @ 1 kHz 1 H @ 1 kHz	2.5 mH/H 1 mH/H 1 mH/H	Ando RS-100 series
POWER/ ENERGY (DC)	1 kW to 20 kW 0.1 W to 1 kW	0.7 mW/W 0.22 mW/W	Generating using calibrator model Fluke 5520A.
POWER/ ENERGY (AC) (45 Hz to 65 Hz at PF=1)	10 kW to 20 kW 1 W to 10 kW 0.1 W to 1 W	1 mW/W 0.9 mW/W 1 mW/W	
FREQUENCY	1 μ Hz to 80 MHz (10 mVpp to 10 Vpp)	36 nHz/Hz	(Agilent 33250A, ifR2042 or Agilent E8257D) Reference to Pendulum GPS-12R Disciplined by GPS
	10 kHz to 40 GHz (+11 dBm to -135 dBm)	7 nHz/Hz	
AMPLITUDE	10 mVp-p to 10 Vp-p (1 μ Hz to 80 MHz, Into 50 Ω)	10 mVpp/Vpp + 1 mVpp	Function Generator Agilent 33250A
	+13 dBm to -144 dBm (10 kHz to 5.4 GHz)	0.58 dBm	Signal Generator ifR2042
	+11 dBm to -135 dBm (250 kHz to 40 GHz)	0.92 dBm	Signal Generator Agilent E8257D
FLATNESS	Sine Wave Relative to 1 kHz (Auto range On)	0.4 dBm	Function Generator Agilent 33250A
TIME	1 s to 24 Hrs	0.06 μ s/s + 0.021 s	Function Generator Agilent 33250A & Universal Counter HP 53132A
	20 ms to 5 s	0.7 ms	For RCD Tester Calibrator (using Transmille 3200)
Residual Current Duration	10 ms to 5 s	0.4 ms	

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument RPM Measuring Instruments (Non-Contact)	60 to 5999 rpm 6000 to 29999 rpm 30000 to 59999 rpm 60000 to 99999 rpm	0.07 rpm 7 rpm 36 rpm 70 rpm	In-House method, ESF/0303.
2. High Voltage Meter DC VOLTAGE	0.5 kV to 10 kV	5 mV/V	TDV 20 ADS & TOS 5101
AC VOLTAGE	(0.5 kV to 10 kV) @ (50/60) Hz	8 mV/V	
3. CLAMP METER DC Current <u>10 – Turn Coil</u>	3.2 A to 32 A 32 A to 105 A 105 A to 200 A	0.06 mA/A + 1.18 mA 0.55 mA/A + 9.4 mA 0.55 mA/A + 45 mA	Generating using calibrator model Wavetek 9100 c/w Current Coil
<u>50 – Turn Coil</u>	16 A to 160 A 160 A to 525 A 525 A to 1000 A	0.6 mA/A + 5.9 mA 0.55 mA/A + 47 mA 0.55 mA/A + 0.23 A	
AC Current <u>10 – Turn Coil</u>	<u>3.2 A to 32 A</u> 10 Hz to 100 Hz 100 Hz to 440 Hz <u>32 A to 200 A</u> 10 Hz to 100 Hz 100 Hz to 440 Hz	2 mA/A + 5.5 mA 7.8 mA/A + 27 mA 2.1 mA/A + 90 mA 6.7 mA/A + 0.25 A	
<u>50 – Turn Coil</u>	16 A to 160 A 10 Hz to 100 Hz <u>160 A to 1000 A</u> 10 Hz to 100 Hz	2 mA/A + 28 mA 2.1 mA/A + 0.45 A	

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
4. INSULATION TESTER	(1 k Ω to 10 k Ω) @ 10 V (10 k Ω to 100 k Ω) @ 50 V (0.1 M Ω to 1 M Ω) @ 150 V (1 M Ω to 10 M Ω) @ 300 V (10 M Ω to 100 M Ω) @ 500 V (0.1 G Ω to 1 G Ω) @ 1000 V (1 G Ω to 10 G Ω) @ 5000 V (10 G Ω to 100 G Ω) @ 5000 V (100 G Ω to 600 G Ω) @ 5000 V	0.5 m Ω/Ω 1 m Ω/Ω 10 m Ω/Ω 50 m Ω/Ω 0.1 Ω/Ω 50 m Ω/Ω	Tinsley 4720
5. OSCILLOSCOPE Vertical Deflection DC Signal	0 V to ± 6.6 V (50 Ω Load) 0 V to ± 130 V (1 M Ω Load)	2.5 mV/V + 0.04 mV 0.5 mV/V + 0.04 mV	Generating using calibrator model Fluke 5500A SC600
Vertical Deflection Square Wave Signal	± 1 mVp-p to ± 6.6 Vp-p (50 Ω Load) ± 1 mVp-p to ± 130 Vp-p (1 M Ω Load)	2.5 mVp-p/Vp-p + 0.04mVp-p 1 mVp-p/Vp-p + 0.04 mVp-p	
Horizontal Deflection Time Markers (50 Ω Load)	2 ns/div to 20 ms/div 50 ms/div to 5 s/div	2.5 μ s/s (25+(Output x 1000)) μ s/s	
Risetime	≤ 300 ps	+0 ns / -0.1 ns	
Bandwidth Frequency	50 kHz to 600 MHz 600 MHz to 40 GHz (+11 dBm to -135 dBm)	2.5 μ Hz/Hz 7 nHz/Hz	
Bandwidth Amplitude	50 kHz to 600 MHz 600 MHz to 40 GHz (+11 dBm to -135 dBm)	0.03 Vp-p 0.92 dBm	Generating using calibrator model Fluke 5500A SC600 Generating using Agilent E8257D

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FIELD OF CALIBRATION: ELECTRICAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing / Generating Instrument DC VOLTAGE	100 mV @ ± 100 % Band Span \pm (85 mV to 115 mV)	4 μ V/V	Measuring using Standard model Wavetek MTS 4950
	1 V @ ± 100 % Band Span \pm (0.9 V to 1.1 V)	2.2 μ V/V	
	10 V @ ± 100 % Band Span \pm (9 V to 11 V)	1.4 μ V/V	
	10 V @ ± 190 % Band Span \pm (18 V to 19.5 V)	1.8 μ V/V	
	100 V @ ± 100 % Band Span \pm (90 V to 110 V)	2 μ V/V	
	1000 V @ ± 100 % Band Span \pm (900 V to 1100 V)	2 μ V/V	
	± 100 mV Range \pm (100 μ V to 120 mV)	5 μ V/V + 0.3 μ V	Measuring using Multimeter model HP 3458A Opt 002
	± 1 V Range \pm (100 mV to 1.2 V)	4 μ V/V + 0.3 μ V	
	± 10 V Range \pm (1 V to 12 V)	4 μ V/V + 0.5 μ V	
	± 100 V Range \pm (10 V to 120 V)	6 μ V/V + 0.03 mV	
	± 1000 V Range \pm (100 V to 1050 V)	6 μ V/V + 0.1 mV	

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FIELD OF CALIBRATION: ELECTRICAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing / Generating Instrument AC VOLTAGE	<u>1 mV @ 100 % Band Span</u> <u>(0.85 mV to 1.15 mV)</u>		
	10 Hz Frequency Band Span (9 Hz to 11 Hz),	0.28 mV/V	
	20 Hz Frequency Band Span (18 Hz to 22 Hz),		
	30 Hz Frequency Band Span (27 Hz to 33 Hz),		
	40 Hz Frequency Band Span (36 Hz to 44 Hz),		
	55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz),		
	10 kHz Frequency Band Span (9 kHz to 11 kHz)		
	300 Hz Frequency Band Span (270 Hz to 440 Hz),	0.26 mV/V	
	1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz)		
	20 kHz Frequency Band Span (18 kHz to 22 kHz)	0.3 mV/V	
	30 kHz Frequency Band Span (27 kHz to 33 kHz),	0.39 mV/V	
	50 kHz Frequency Band Span (45 kHz to 55 kHz)		
	100 kHz Frequency Band Span (90 kHz to 110 kHz)	0.62 mV/V	
	300 kHz Frequency Band Span (270 kHz to 330 kHz)	0.75 mV/V	
	500 kHz Frequency Band Span (450 kHz to 550 kHz)	0.77 mV/V	
	1 MHz Frequency Band Span (0.9 MHz to 1.1 MHz)	1.1 mV/V	

Wavetek MTS
4950

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>2.2 mV Range</u> <u>(600 μV to 2.2 mV)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	1.7 mV/V + 1.3 μ V 0.74 mV/V + 1.3 μ V 0.42 mV/V + 1.3 μ V 0.81 mV/V + 2 μ V 1.2 mV/V + 2.5 μ V 2.3 mV/V + 4 μ V 2.4 mV/V + 8 μ V 3.5 mV/V + 8 μ V	Fluke 5790A
	<u>7 mV Range (1.9 mV to 7 mV)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.85 mV/V + 1.3 μ V 0.37 mV/V + 1.3 μ V 0.21 mV/V + 1.3 μ V 0.4 mV/V + 2 μ V 0.6 mV/V + 2.5 μ V 1.2 mV/V + 4 μ V 1.3 mV/V + 8 μ V 2.3 mV/V + 8 μ V	
	<u>10 mV @ 100 % Band Span</u> <u>(8.5 mV to 11.5 mV)</u> 10 Hz Frequency Band Span (9 Hz to 11 Hz), 20 Hz Frequency Band Span (18 Hz to 22 Hz), 30 Hz Frequency Band Span (27 Hz to 33 Hz), 40 Hz Frequency Band Span (36 Hz to 44 Hz), 55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz) 300 Hz Frequency Band Span (270 Hz to 440 Hz) & 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz)	0.16 mV/V 0.14 mV/V	Wavetek MTS 4950



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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>10 mV @ 100 % Band Span</u> (8.5 mV to 11.5 mV)		
	10 kHz Frequency Band Span (9 kHz to 11 kHz) & 20 kHz Frequency Band Span (18 kHz to 22 kHz)	0.16 mV/V	
	30 kHz Frequency Band Span (27 kHz to 33 kHz)	0.24 mV/V	
	50 kHz Frequency Band Span (45 kHz to 55 kHz), 100 kHz Frequency Band Span (90 kHz to 110 kHz), 300 kHz Frequency Band Span (270 kHz to 330 kHz)	0.59 mV/V	Wavetek MTS 4950
	500 kHz Frequency Band Span (450 kHz to 550 kHz)	0.61 mV/V	
	1 MHz Frequency Band Span (0.9 MHz to 1.1 MHz)	0.95 mV/V	
	<u>10 mV Range (1 mV to 12 mV)</u>		
	1 Hz to 40 Hz 1 MHz to 4 MHz 4 MHz to 8 MHz	0.3 mV/V + 3 μ V 0.07 V/V + 7 μ V 0.2 V/V + 8 μ V	HP 3458A Opt 002
	<u>22 mV Range (6 mV to 22 mV)</u>		
	10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.29 mV/V + 1.3 μ V 0.19 mV/V + 1.3 μ V 0.11 mV/V + 1.3 μ V 0.21 mV/V + 2 μ V 0.31 mV/V + 2.5 μ V 0.81 mV/V + 4 μ V 0.89 mV/V + 8 μ V 1.7 mV/V + 8 μ V	Fluke 5790A

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>70 mV Range (19 mV to 70 mV)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.24 mV/V + 1.5 μ V 0.12 mV/V + 1.5 μ V 65 μ V/V + 1.5 μ V 0.13 mV/V + 2 μ V 0.26 mV/V + 2.5 μ V 0.51 mV/V + 4 μ V 0.67 mV/V + 8 μ V 1.1 mV/V + 8 μ V	Fluke 5790A
	<u>100 mV @ 100 % Band Span (85 mV to 115 mV)</u> 10 Hz Frequency Band Span (9 Hz to 11 Hz), 20 Hz Frequency Band Span (18 Hz to 22 Hz), 30 Hz Frequency Band Span (27 Hz to 33 Hz), 40 Hz Frequency Band Span (36 Hz to 44 Hz) & 55 Hz Frequency Band Span (46 Hz to 64 Hz) 300 Hz Frequency Band Span (270 Hz to 440 Hz) & 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz) 10 kHz Frequency Band Span (9 kHz to 11 kHz) 20 kHz Frequency Band Span (18 kHz to 22 kHz) 30 kHz Frequency Band Span (27 kHz to 33 kHz) & 50 kHz Frequency Band Span (45 kHz to 55 kHz)	0.12 mV/V 89 μ V/V 0.11 mV/V 0.12 mV/V 0.19 mV/V	Wavetek MTS 4950



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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>100 mV @ 100 % Band Span</u> (85 mV to 115 mV) 100 kHz Frequency Band Span (90 kHz to 110 kHz) 300 kHz Frequency Band Span (270 kHz to 330 kHz) 500 kHz Frequency Band Span (450 kHz to 550 kHz) 1 MHz Frequency Band Span (0.9 MHz to 1.1 MHz)	0.36 mV/V 96 μ V/V 0.61 mV/V 0.95 mV/V	Wavetek MTS 4950
	<u>100 mV range (10 mV to 120 mV)</u> 1 Hz to 40 Hz 1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	0.07 mV/V + 4 μ V 15 mV/V + 0.01 mV 0.04 V/V + 0.07 mV 0.04 V/V + 0.08 mV 0.15 V/V + 0.1 mV	HP 3458A Opt 002
	<u>220 mV Range (60 mV to 220 mV)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.21 mV/V + 1.5 μ V 85 μ V/V + 1.5 μ V 38 μ V/V + 1.5 μ V 69 μ V/V + 2 μ V 0.16 mV/V + 2.5 μ V 0.25 mV/V + 4 μ V 0.38 mV/V + 8 μ V 1 mV/V + 8 μ V	Fluke 5790A
	<u>700 mV Range</u> (190 mV to 700 mV) 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.21 mV/V + 1.5 μ V 76 μ V/V + 1.5 μ V 33 μ V/V + 1.5 μ V 51 μ V/V + 2 μ V 79 μ V/V + 2.5 μ V 0.18 mV/V + 4 μ V 0.3 mV/V + 8 μ V 0.96 mV/V + 8 μ V	

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	1 V @ 100 % Band Span (0.9 V to 1.1 V)		Wavetek MTS 4950
	10 Hz Frequency Band Span (9 Hz to 11 Hz),	36 μ V/V	
	20 Hz Frequency Band Span (18 Hz to 22 Hz),		
	30 Hz Frequency Band Span (27 Hz to 33 Hz),		
	40 Hz Frequency Band Span (36 Hz to 44 Hz),	24 μ V/V	
	55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz),		
	300 Hz Frequency Band Span (270 Hz to 440 Hz),		
	1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz),		
	10 kHz Frequency Band Span (9 kHz to 11 kHz),		
	20 kHz Frequency Band Span (18 kHz to 22 kHz)		
	30 kHz Frequency Band Span (27 kHz to 33 kHz)	24 μ V/V	
	50 kHz Frequency Band Span (45 kHz to 55 kHz)	31 μ V/V	
	100 kHz Frequency Band Span (90 kHz to 110 kHz)	37 μ V/V	
	300 kHz Frequency Band Span (270 kHz to 330 kHz)	96 μ V/V	
	500 kHz Frequency Band Span (450 kHz to 550 kHz)	0.21 mV/V	
	1 MHz Frequency Band Span (0.9 MHz to 1.1 MHz)	0.56 mV/V	

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>1 V Range (0.1 V to 1.2 V)</u> 1 Hz to 40 Hz 1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	0.07 mV/V + 0.04 mV 15 mV/V + 0.1 mV 0.04 V/V + 0.7 mV 0.04 V/V + 0.8 mV 0.15 V/V + 1 mV	HP 3458A Opt 002
	<u>2.2 V Range (600 mV to 2.2 V)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.2 mV/V 66 μ V/V 24 μ V/V 46 μ V/V 71 μ V/V 0.16 mV/V 0.26 mV/V 0.9 mV/V	Fluke 5790A
	<u>7 V Range (1.9 V to 7 V)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.2 mV/V 67 μ V/V 24 μ V/V 48 μ V/V 81 μ V/V 0.19 mV/V 0.4 mV/V 1.2 mV/V	
	<u>10 V @ 100 % Band Span (9 V to 11 V)</u> 10 Hz Frequency Band Span (9 Hz to 11 Hz), 20 Hz Frequency Band Span (18 Hz to 22 Hz), 30 Hz Frequency Band Span (27 Hz to 33 Hz)	36 μ V/V	Wavetek MTS 4950

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>10 V @ 100 % Band Span</u> <u>(9 V to 11 V)</u>		
	40 Hz Frequency Band Span (36 Hz to 44 Hz),	24 μ V/V	
	55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz),		
	300 Hz Frequency Band Span (270 Hz to 440 Hz),		
	1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz),		
	10 kHz Frequency Band Span (9 kHz to 11 kHz),		
	20 kHz Frequency Band Span (18 kHz to 22 kHz)		
	30 kHz Frequency Band Span (27 kHz to 33 kHz),	26 μ V/V	
	50 kHz Frequency Band Span (45 kHz to 55 kHz),		
	100 kHz Frequency Band Span (90 kHz to 110 kHz)		
	300 kHz Frequency Band Span (270 kHz to 330 kHz)	83 μ V/V	
	500 kHz Frequency Band Span (450 kHz to 550 kHz)	0.19 mV/V	
	1 MHz Frequency Band Span (0.9 MHz to 1.1 MHz)	0.53 mV/V	
	<u>10 V @ 190 % Band Span</u> <u>(18 V to 19.5 V)</u>		
	1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz)	24 μ V/V	
			Wavetek MTS 4950

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>10 V Range (1 V to 12 V)</u> 1 Hz to 40 Hz 1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	0.07 mV/V + 0.4 mV 15 mV/V + 1 mV 0.04 V/V + 7 mV 0.04 V/V + 8 mV 0.15 V/V + 0.01 V	HP 3458A Opt 002
	<u>22 V Range (6 V to 22 V)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.2 mV/V 67 μ V/V 27 μ V/V 48 μ V/V 81 μ V/V 0.19 mV/V 0.4 mV/V 1.2 mV/V	Fluke 5790A
	<u>70 V Range (19 V to 70 V)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.2 mV/V 68 μ V/V 32 μ V/V 57 μ V/V 94 μ V/V 0.2 mV/V 0.41 mV/V 1.2 mV/V	
	<u>100 V Range (10 V to 120 V)</u> 1 Hz to 40 Hz	0.2 mV/V + 4 mV	HP 3458A Opt 002
	<u>100 V @ 100 % Band Span (90 V to 110 V)</u> 10 Hz Frequency Band Span (9 Hz to 11 Hz), 20 Hz Frequency Band Span (18 Hz to 22 Hz), 30 Hz Frequency Band Span (27 Hz to 33 Hz) 40 Hz Frequency Band Span (36 Hz to 44 Hz)	41 μ V/V 36 μ V/V	Wavetek MTS 4950



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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>100 V @ 100 % Band Span</u> (90 V to 110 V)		
	55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz)	36 μ V/V	
	300 Hz Frequency Band Span (270 Hz to 440 Hz), 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz), 10 kHz Frequency Band Span (9 kHz to 11 kHz), 20 kHz Frequency Band Span (18 kHz to 22 kHz)	26 μ V/V	
	30 kHz Frequency Band Span (27 kHz to 33 kHz)	29 μ V/V	
	50 kHz Frequency Band Span (45 kHz to 55 kHz)	35 μ V/V	
	100 kHz Frequency Band Span (90 kHz to 110 kHz)	64 μ V/V	
	200 kHz Frequency Band Span (180 kHz to 220 kHz)	0.24 mV/V	Wavetek MTS 4950
	<u>220 V Range (60 V to 220 V)</u>		
	10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz	0.2 mV/V 68 μ V/V 31 μ V/V 69 μ V/V 98 μ V/V 0.21 mV/V 0.5 mV/V	
	<u>700 V Range (190 V to 700 V)</u>		
	10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	0.2 mV/V 99 μ V/V 41 μ V/V 0.13 mV/V 0.5 mV/V	Fluke 5790A

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	<u>1000 V @ 70 % Band Span</u> (600 V to 800 V) 50 kHz Frequency Band Span (45 kHz to 55 kHz)	0.11 mV/V	Wavetek MTS 4950
	100 kHz Frequency Band Span (90 kHz to 110 kHz)	0.35 mV/V	
	<u>1000 V @ 100 % Band Span</u> (900 V to 1100 V) 55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz), 300 Hz Frequency Band Span (270 Hz to 440 Hz), 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz)	37 μ V/V	
	10 kHz Frequency Band Span (9 kHz to 11 kHz)	42 μ V/V	
	20 kHz Frequency Band Span (18 kHz to 22 kHz)	47 μ V/V	
	30 kHz Frequency Band Span (27 kHz to 33 kHz)	74 μ V/V	
	<u>1000 V Range (100 V to 700 V)</u> 1 Hz to 40 Hz	0.4 mV/V + 0.04 V	HP 3458A Opt 002
	<u>1000 V Range (600 V to 1050 V)</u> 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	0.2 mV/V 99 μ V/V 38 μ V/V 0.13 mV/V 0.5 mV/V	Fluke 5790A



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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument DC CURRENT	1 pA to +20 pA -20 pA to -1 pA	0.01 A/A + 3 nA 0.01 A/A + 3 nA	Keithley 6517/ Agilent 4339A
	20 pA to +200 pA -200 pA to -20 pA	0.01 A/A + 5 nA 0.01 A/A + 5 nA	
	200 pA to +2 nA -2 nA to -200 Pa	2 mA/A + 0.3 μ A 2 mA/A + 0.3 μ A	
	1 nA to +100 nA -100 nA to -1 nA	30 μ A/A + 0.04 nA 30 μ A/A + 0.04 nA	HP 3458A Opt 002
	100 nA to +1 μ A -1 μ A to -100 nA	20 μ A/A + 0.04 nA 20 μ A/A + 0.04 nA	
	1 μ A to +10 μ A -10 μ A to -1 μ A	20 μ A/A + 0.1 nA 20 μ A/A + 0.1 nA	
	10 μ A to +100 μ A -100 μ A to -10 μ A	20 μ A/A + 0.8 nA 20 μ A/A + 0.8 nA	
	100 μ A to +1 mA -1 mA to -100 μ A	20 μ A/A + 5 nA 20 μ A/A + 5 nA	
	110 μ A @ \pm 100 % Band Span \pm (90 μ to 110 μ A)	21 μ A/A	Wavetek MTS 4950
	1 mA @ \pm 100 % Band Span \pm (0.9 mA to 1.1 mA) & 10 mA @ \pm 100 % Band Span \pm (9 mA to 11 mA)	11 μ A/A	
	1 mA to +10 mA -10 mA to -1 mA 10 mA to +100 mA -100 mA to -10 mA	20 μ A/A + 0.05 μ A 20 μ A/A + 0.05 μ A 35 μ A/A + 0.5 μ A 35 μ A/A + 0.5 μ A	HP 3458A Opt 002

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument DC CURRENT	100 mA @ ± 100 % Band Span \pm (90 mA to 110 mA)	15 μ A/A	Wavetek MTS 4950
	100 mA to +1 A -1 A to -100 mA	0.11 mA/A + 0.01 mA 0.11 mA/A + 0.01 mA	HP 3458A Opt 002
	1 A @ ± 100 % Band Span \pm (0.9 A to 1.1 A)	25 μ A/A	Wavetek MTS 4950
	+1 A to +10 A -10 A to -1 A	5.1 mA 5.1 mA	HP 3458A & Guildline 9211A.
	10 A @ ± 100 % Band Span \pm (9 A to 11 A)	55 μ A/A	Wavetek MTS 4950
	+10 A to +100 A -100 A to -10 A	0.05 A 0.05 A	HP 3458A & Guildline 9211A.
AC CURRENT	5 μ A to 100 μ A 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A	HP 3458A Opt 002
	100 μ A @ 100 % Band Span (90 μ A to 110 μ A) 10 Hz Frequency Band Span (9 Hz to 11 Hz) & 20 Hz Frequency Band Span (18 Hz to 22 Hz) 30 Hz Frequency Band Span (27 Hz to 33 Hz) 40 Hz Frequency Band Span (36 Hz to 44 Hz), 55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz), 300 Hz Frequency Band Span (0.27 kHz to 0.44 kHz) & 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz)	0.13 mA/A 0.11 mA/A 85 μ A/A	Wavetek MTS 4950

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC CURRENT	<u>100 μA @ 100 % Band Span</u> <u>(90 μA to 110 μA)</u> 5 kHz Frequency Band Span (4.5 kHz to 5.5 kHz) 10 kHz Frequency Band Span (9 kHz to 11 kHz) 20 kHz Frequency Band Span (18 kHz to 22 kHz) 30 kHz Frequency Band Span (27 kHz to 33 kHz)	0.13 mA/A 0.3 mA/A 0.33 mA/A 0.4 mA/A	Wavetek MTS 4950
	<u>0.05 mA to 1 mA</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	4 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.3 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A	HP 3458A Opt 002
	<u>1 mA @ 100 % Band Span</u> <u>(0.9 mA to 1.1 mA)</u> 10 Hz Frequency Band Span (9 Hz to 11 Hz), 20 Hz Frequency Band Span (18 Hz to 22 Hz) & 30 Hz Frequency Band Span (27 Hz to 33 Hz) 40 Hz Frequency Band Span (36 Hz to 44 Hz), 55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz), 300 Hz Frequency Band Span (0.27 kHz to 0.44 kHz) & 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz) 5 kHz Frequency Band Span (4.5 kHz to 5.5 kHz)	0.12 mA/A 80 μ A/A 0.13 mA/A	Wavetek MTS 4950

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC CURRENT	<u>1 mA @ 100 % Band Span</u> (0.9 mA to 1.1 mA)		
	10 kHz Frequency Band Span (9 kHz to 11 kHz)	0.26 mA/A	Wavetek MTS 4950
	20 kHz Frequency Band Span (18 kHz to 22 kHz)	0.29 mA/A	
	30 kHz Frequency Band Span (27 kHz to 33 kHz)	0.35 mA/A	
	<u>0.5 mA to 10 mA</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.3 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A	HP 3458A Opt 002
	<u>10 mA @ 100 % Band Span</u> (9 mA to 11 mA)		
	10 Hz Frequency Band Span (9 Hz to 11 Hz) & 20 Hz Frequency Band Span (18 Hz to 22 Hz)	0.12 mA/A	Wavetek MTS 4950
	30 Hz Frequency Band Span (27 Hz to 33 Hz)	96 μ A/A	
	40 Hz Frequency Band Span (36 Hz to 44 Hz), 55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz), 300 Hz Frequency Band Span (0.27 kHz to 0.44 kHz) & 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz)	75 μ A/A	
	5 kHz Frequency Band Span (4.5 kHz to 5.5 kHz)	0.12 mA/A	

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC CURRENT	<u>10 mA @ 100 % Band Span</u> (9 mA to 11 mA) 10 kHz Frequency Band Span (9 kHz to 11 kHz)	0.26 mA/A	Wavetek MTS 4950
	20 kHz Frequency Band Span (18 kHz to 22 kHz)	0.29 mA/A	
	30 kHz Frequency Band Span (27 kHz to 33 kHz)	0.35 mA/A	
	<u>5 mA to 100 mA</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	4 mA/A + 0.02 mA 1.5 mA/A + 0.02 mA 0.6 mA/A + 0.02 mA 0.3 mA/A + 0.02 mA 0.6 mA/A + 0.02 mA 4 mA/A + 0.04 mA 5.5 mA/A + 0.15 mA	HP 3458A Opt 002
	<u>100 mA @ 100 % Band Span</u> (90 mA to 110 mA) 10 Hz Frequency Band Span (9 Hz to 11 Hz) & 20 Hz Frequency Band Span (18 Hz to 22 Hz) 30 Hz Frequency Band Span (27 Hz to 33 Hz) 40 Hz Frequency Band Span (36 Hz to 44 Hz), 55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz), 300 Hz Frequency Band Span (0.27 kHz to 0.44 kHz) & 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz) 5 kHz Frequency Band Span (4.5 kHz to 5.5 kHz)	0.12 mA/A 96 μ A/A 75 μ A/A 0.12 mA/A	Wavetek MTS 4950



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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC CURRENT	<u>100 mA @ 100 % Band Span</u> (90 mA to 110 mA)	0.26 mA/A	Wavetek MTS 4950
	10 kHz Frequency Band Span (9 kHz to 11 kHz)		
	20 kHz Frequency Band Span (18 kHz to 22 kHz)	0.29 mA/A	
	30 kHz Frequency Band Span (27 kHz to 33 kHz)	0.35 mA/A	
	<u>0.05 A to 1 A</u>		
	10 Hz to 20 Hz	4 mA/A + 0.2 mA	HP 3458A Opt 002
	20 Hz to 45 Hz	1.6 mA/A + 0.2 mA	
	45 Hz to 100 Hz	0.8 mA/A + 0.2 mA	
	100 Hz to 5 kHz	1 mA/A + 0.2 mA	
	5 kHz to 20 kHz	3 mA/A + 0.2 mA	
	20 kHz to 50 kHz	10 mA/A + 0.4 mA	
	<u>1 A @ 100 % Band Span</u> (0.9 A to 1.1 A)		
	10 Hz Frequency Band Span (9 Hz to 11 Hz) &	0.17 mA/A	Wavetek MTS 4950
	20 Hz Frequency Band Span (18 Hz to 22 Hz)		
	30 Hz Frequency Band Span (27 Hz to 33 Hz)	0.16 mA/A	
	40 Hz Frequency Band Span (36 Hz to 44 Hz),	0.11 mA/A	
	55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz),		
	300 Hz Frequency Band Span (0.27 kHz to 0.44 kHz) &		
	1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz)		
	5 kHz Frequency Band Span (4.5 kHz to 5.5 kHz)	0.22 mA/A	

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC CURRENT (continue)	<u>1 A @ 100 % Band Span</u> <u>(0.9 A to 1.1 A)</u>		
	10 kHz Frequency Band Span (9 kHz to 11 kHz)	0.26 mA/A	
	20 kHz Frequency Band Span (18 kHz to 22 kHz)	0.29 mA/A	
	30 kHz Frequency Band Span (27 kHz to 33 kHz)	0.35 mA/A	
	<u>10 A @ 100 % Band Span</u> <u>(9 A to 11 A)</u>		
	10 Hz Frequency Band Span (9 Hz to 11 Hz), 20 Hz Frequency Band Span (18 Hz to 22 Hz) & 30 Hz Frequency Band Span (27 Hz to 33 Hz)	0.24 mA/A	Wavetek MTS 4950
	40 Hz Frequency Band Span (36 Hz to 44 Hz)	0.22 mA/A	
	55 Hz Frequency Band Span (46.25 Hz to 63.75 Hz), 300 Hz Frequency Band Span (0.27 kHz to 0.44 kHz) & 1 kHz Frequency Band Span (0.9 kHz to 1.1 kHz)	0.2 mA/A	
	5 kHz Frequency Band Span (4.5 kHz to 5.5 kHz)	0.26 mA/A	
	10 kHz Frequency Band Span (9 kHz to 11 kHz)	0.34 mA/A	
	20 kHz Frequency Band Span (18 kHz to 22 kHz)	1.2 mA/A	
	<u>1 A to 50 A</u> 50 Hz/ 60 Hz	0.5 mA/A	
			HP 3458A & Zenith H007098.

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6. Sourcing/ Generating Instrument RESISTANCE	0 Ω to 10 Ω	15 $\mu\Omega/\Omega$ + 0.05 m Ω	HP 3458A Opt 002 & Keithley 6517 / Agilent 4339A
	10 Ω to 100 Ω	12 $\mu\Omega/\Omega$ + 0.5 m Ω	
	0.1 k Ω to 1 k Ω	10 $\mu\Omega/\Omega$ + 0.5 m Ω	
	1 k Ω to 10 k Ω	10 $\mu\Omega/\Omega$ + 5 m Ω	
	10 k Ω to 100 k Ω	10 $\mu\Omega/\Omega$ + 0.05 Ω	
	0.1 M Ω to 1 M Ω	15 $\mu\Omega/\Omega$ + 2 Ω	
	1 M Ω to 10 M Ω	50 $\mu\Omega/\Omega$ + 0.1 k Ω	
	10 M Ω to 100 M Ω	0.5 m Ω/Ω + 1 k Ω	
	100 M Ω to 1 G Ω	5 m Ω/Ω + 0.01 M Ω	
	1 G Ω to 2 G Ω	2.3 m Ω/Ω + 0.01 M Ω	
	2 G Ω to 20 G Ω	2.3 m Ω/Ω + 0.1 M Ω	
	20 G Ω to 200 G Ω	3.5 m Ω/Ω + 1 M Ω	
	0.2 T Ω to 2 T Ω	3.5 m Ω/Ω + 0.01 G Ω	Wavetek MTS 4950
	2 T Ω to 20 T Ω	10 m Ω/Ω + 0.1 G Ω	
	20 T Ω to 200 T Ω	12 m Ω/Ω + 1 G Ω	
	10 Ω 10 % Band Span (Zero to 2 Ω), 30 % Band Span (2 Ω to 4 Ω), 100 % Band Span (9 Ω to 11 Ω), 190 % Band Span (18 Ω to 19.5 Ω)	8 $\mu\Omega/\Omega$	
	100 Ω 30 % Band Span (20 Ω to 40 Ω), 100 % Band Span (90 Ω to 110 Ω), 190 % Band Span (180 Ω to 195 Ω)	6 $\mu\Omega/\Omega$	
	1 k Ω 30 % Band Span (0.2 k Ω to 0.4 k Ω), 100 % Band Span (0.9 k Ω to 1.1 k Ω), 190 % Band Span (1.8 k Ω to 1.95 k Ω)	3 $\mu\Omega/\Omega$	

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument RESISTANCE (continue)	<u>10 kΩ</u> 30 % Band Span (2 k Ω to 4 k Ω), 100 % Band Span (9 k Ω to 11 k Ω), 190 % Band Span (18 k Ω to 19.5 k Ω)	3 $\mu\Omega/\Omega$	Wavetek MTS 4950
	<u>100 kΩ</u> 30 % Band Span (20 k Ω to 40 k Ω), 100 % Band Span (90 k Ω to 110 k Ω) & 190 % Band Span (180 k Ω to 195 k Ω)	6 $\mu\Omega/\Omega$	
	<u>1 MΩ</u> 30 % Band Span (0.2 M Ω to 0.4 M Ω), 100 % Band Span (0.9 M Ω to 1.1 M Ω) & 190 % Band Span (1.8 M Ω to 1.95 M Ω)	11 $\mu\Omega/\Omega$	
	<u>10 MΩ</u> 30 % Band Span (2 M Ω to 4 M Ω), 100 % Band Span (9 M Ω to 11 M Ω) & 190 % Band Span (18 M Ω to 19.5 M Ω)	21 $\mu\Omega/\Omega$	
	<u>100 MΩ</u> 30 % Band Span (20 M Ω to 40 M Ω), 100 % Band Span (90 M Ω to 110 M Ω)	83 $\mu\Omega/\Omega$	
CAPACITANCE	1 pF to 1 mF @ (10 Hz to 1 MHz)	0.5 mF/F	HP 4284A
INDUCTANCE	1 μ H to 10 H @ (10 Hz to 1 MHz)	0.5 mH/H	



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FIELD OF CALIBRATION: ELECTRICAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument FREQUENCY	1 Hz to 5 GHz	0.89 pHz/Hz	HP53132A Reference to Pendulum GPS-12R Disciplined by GPS
	5 GHz to 26.5 GHz	0.89 Hz/Hz	HP8563E Reference to Pendulum GPS-12R Disciplined by GPS
AMPLITUDE/ LEVEL	-20 dBm to +30 dBm (100 kHz to 2.6 GHz)	0.04 dBm	HP 8902 with 11722A
	-30 dB to +30 dB (2.6 GHz to 18 GHz)	0.27 dBm	Agilent E4418B with HP 8481A
	-120 dB to +30 dB (30 Hz to 26.5 GHz)	1 dBm	HP8563E
TUNED RF LEVEL	-127 dB to 0 dB (2.5 MHz to 1.3 GHz)	0.07 dBm	HP 8902 with 11722A
MODULATION Related Signal: Amplitude Modulation (AM) AM Depth: 5% to 99%	Carrier Frequency 150 kHz to 10 MHz Modulation Frequency 50 Hz to 10 kHz	0.17 %	HP 8902 with 11722A
AM Depth: 5% to 99%	Carrier Frequency 150 kHz to 1300 MHz Modulation Frequency 20 Hz to 10 kHz	0.19 %	
AM Depth: 5% to 99%	Carrier Frequency 10 MHz to 1300 MHz Modulation Frequency 50 Hz to 100 kHz	0.13 %	

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument MODULATION Related Signal: Frequency Modulation (FM) FM Deviation: ≤ 40 kHz peak	Carrier Frequency 150 kHz to 10 MHz Modulation Frequency 20 Hz to 10 kHz	0.13 kHz	HP 8902 with 11722A
FM Deviation: ≤ 400 kHz peak	Carrier Frequency 10 MHz to 1300 MHz Modulation Frequency 50 Hz to 100 kHz	0.03 kHz	
FM Deviation: ≤ 400 kHz peak	Carrier Frequency 10 MHz to 1300 MHz Modulation Frequency 100 kHz to 200 kHz	0.32 kHz	
Phase Modulation (Φ M) Φ M Deviation: ≤ 40 Radians peak	Carrier Frequency 150 kHz to 10 MHz Modulation Frequency 200 Hz to 10 kHz	0.15 Radians	
Φ M Deviation: ≤ 400 Radians peak	Carrier Frequency 10 MHz to 1.3 GHz Modulation Frequency 200 Hz to 20 kHz	0.14 Radians	
DISTORTION Related Signal: Audio Distortion (-99 to 0) dB	Fundamental Frequency 20 Hz to 20 kHz	1 dB	Audio Analyzer HP 8903B
	Fundamental Frequency 20 kHz to 100 kHz	2 dB	

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument RPM generating instruments (Non-Contact)	10 to 29 rpm 30 to 59 rpm 60 to 99 rpm 100 to 299 rpm 300 to 599 rpm 600 to 999 rpm 1000 to 2999 rpm 3000 to 5999 rpm 6000 to 9999 rpm 10000 to 29999 rpm 30000 to 59999 rpm 60000 to 99999 rpm	0.014 rpm 0.036 rpm 0.07 rpm 0.14 rpm 0.37 rpm 0.7 rpm 1.4 rpm 3.6 rpm 7 rpm 14 rpm 36 rpm 70 rpm	In-House method, ESF/0303
RPM generating instruments (Contact Measurement)	20 to 29 rpm 30 to 59 rpm 60 to 99 rpm 100 to 299 rpm 300 to 599 rpm 600 to 999 rpm 1000 to 2999 rpm 3000 to 5999 rpm 6000 to 9999 rpm 10000 to 12999 rpm 13000 to 25999 rpm 26000 to 29999 rpm	0.011 rpm 0.016 rpm 0.029 rpm 0.07 rpm 0.16 rpm 0.29 rpm 0.7 rpm 1.6 rpm 2.9 rpm 7 rpm 8 rpm 14 rpm	In-House method, ESF/0303
7. High Voltage Tester DC VOLTAGE	0 kV to 9.99 kV 10 kV to <20 kV 20 kV to 35 kV >35 kV to 40 kV	5 mV/V + 2 V 20 mV/V 10 mV/V 20 mV/V	TDV 20 ADS Fluke 80K-40

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FIELD OF CALIBRATION: ELECTRICAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
AC VOLTAGE	(0 kV to 9.99 kV) @ 50/60 Hz	7 mV/V + 3 V	TDV 20 ADS Fluke 80K-40
	(10 kV to 20 kV) @ 50/60 Hz	7 mV/V + 30 V	
	(20 kV to 28 kV) @ 50/60 Hz	50 mV/V	

Signatories:

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2. Mohamed Fikri Bin Mohd Nor
3. Syahrel Bin Shari



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FIELD OF CALIBRATION: ELECTRICAL

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument DC VOLTAGE	± 220 mV Range $\pm (0$ mV to 220 mV) ± 2.2 V Range $\pm (0$ V to 2.2 V) $+11$ V Range $\pm (0$ V to 11 V) ± 22 V Range $\pm (0$ V to 22 V) ± 220 V Range $\pm (0$ V to 220 V) ± 1100 V Range $\pm (100$ V to 1100 V)	$9 \mu\text{V/V} + 0.8 \mu\text{V}$ $8 \mu\text{V/V} + 1.2 \mu\text{V}$ $8 \mu\text{V/V} + 4 \mu\text{V}$ $8 \mu\text{V/V} + 8 \mu\text{V}$ $9 \mu\text{V/V} + 0.1 \text{ mV}$ $11 \mu\text{V/V} + 0.6 \text{ mV}$	Generating using calibrator model Fluke 5700A
AC VOLTAGE	<u>2.2 mV to 220 V</u> (See Matrix C)	(See Matrix C)	
	<u>1100 V Range</u> (110 V to 1100 V) 50 Hz to 1 kHz	$90 \mu\text{V/V} + 4 \text{ mV}$	
	<u>800 V to 1050 V</u> 1 kHz to 3 kHz 3 kHz to 10 kHz 10 kHz to 20 kHz	$0.8 \text{ mV/V} + 0.13 \text{ V}$ $0.8 \text{ mV/V} + 0.21 \text{ V}$ $1.2 \text{ mV/V} + 0.32 \text{ V}$	Generating using calibrator model Wavetek 9100
DC CURRENT	$0 \mu\text{A}$ to $+220 \mu\text{A}$ $-220 \mu\text{A}$ to $0 \mu\text{A}$ 0 mA to $+2.2 \text{ mA}$ -2.2 mA to 0 mA 0 mA to $+22 \text{ mA}$ -22 mA to 0 mA 0 mA to $+220 \text{ mA}$ -220 mA to 0 mA 0 A to $+1 \text{ A}$ -1 A to 0 A	$60 \mu\text{A/A} + 0.01 \mu\text{A}$ $60 \mu\text{A/A} + 0.01 \mu\text{A}$ $60 \mu\text{A/A} + 0.1 \mu\text{A}$ $70 \mu\text{A/A} + 1 \mu\text{A}$ $95 \mu\text{A/A} + 30 \mu\text{A}$	Generating using calibrator model Fluke 5700A
	$+0.32 \text{ A}$ to $+3.2 \text{ A}$ -3.2 A to -0.32 A $+3.2 \text{ A}$ to $+11 \text{ A}$ -11 A to -3.2 A $+11 \text{ A}$ to $+20 \text{ A}$ -20 A to -11 A	$0.6 \text{ mA/A} + 0.12 \text{ mA}$ $0.55 \text{ mA/A} + 0.94 \text{ mA}$ $0.55 \text{ mA/A} + 4.5 \text{ mA}$	Generating using calibrator model Wavetek 9100
	$+20 \text{ A}$ to $+100 \text{ A}$ -100 A to -20 A	$0.45 \text{ mA/A} + 20 \text{ mA}$	California 3213K

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SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument AC CURRENT	<u>9 μA to 2.2 A</u> (See Matrix D)	(See Matrix D)	Generating using calibrator model Fluke 5700A
	<u>0.32 A to 3.2 A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz	1 mA/A + 0.48 mA 2.5 mA/A + 2.6 mA	Generating using calibrator model Wavetek 9100
	<u>3.2 A to 10.5 A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz	2 mA/A + 3 mA 5 mA/A + 10 mA	
	<u>10.5 A to 20 A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz	2 mA/A + 6.9 mA 5 mA/A + 23 mA	
	<u>20 A to 100 A</u> 10 Hz to 1 kHz 1 kHz to 10 kHz	2.5 mA/A + 0.03 A 5 mA/A + 0.05 A	CA 3213K
RESISTANCE Fixed Value	10 m Ω 100 m Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω	0.1 m Ω/Ω 0.02 m Ω/Ω 5 $\mu\Omega/\Omega$ 0.11 m Ω/Ω 5 $\mu\Omega/\Omega$ 31 $\mu\Omega/\Omega$ 5 $\mu\Omega/\Omega$ 0.02 m Ω/Ω 5 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 5 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 5 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 5 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 5 $\mu\Omega/\Omega$ 0.05 m Ω/Ω	Fluke 5700A & Standard Resistor Fluke 742A Series
	100 M Ω 1 G Ω 10 G Ω	0.13 m Ω/Ω 5 $\mu\Omega/\Omega$ 0.02 Ω/Ω	Standard Resistor Takeda Riken TR45



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SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Matrix C

AC Voltage Measurement

Range		Frequency			
		Hz		kHz	
		10 to 20	20 to 40	0.04 to 20	20 to 50
2.2 mV	0.22 mV to 2.2 mV	0.6 + 0.005	0.24 + 0.005	0.12 + 0.005	0.41 + 0.005
22 mV	2.2 mV to 22 mV	0.6 + 0.006	0.24 + 0.006	0.12 + 0.006	0.41 + 0.006
220 mV	22 mV to 220 mV	0.6 + 0.016	0.24 + 0.01	0.11 + 0.01	0.36 + 0.01
2.2 V	0.22 V to 2.2 V	0.6 + 0.1	0.18 + 0.03	0.085 + 0.007	0.14 + 0.02
22 V	2.2 V to 22 V	0.6 + 1	0.18 + 0.3	0.085 + 0.07	0.14 + 0.2
220 V	22 V to 220 V	0.6 + 10	0.18 + 3	0.09 + 1	0.25 + 4

Range		Frequency			
		MHz			
		0.05 to 0.1	0.1 to 0.3	0.3 to 0.5	0.5 to 1
2.2 mV	0.22 mV to 2.2 mV	0.95 + 0.008	1.3 + 0.015	1.8 + 0.03	3.6 + 0.03
22 mV	2.2 mV to 22 mV	0.95 + 0.008	1.3 + 0.015	1.8 + 0.03	3.6 + 0.03
220 mV	22 mV to 220 mV	0.9 + 0.03	1.1 + 0.03	1.8 + 0.04	3.6 + 0.1
2.2 V	0.22 V to 2.2 V	0.28 + 0.08	0.48 + 0.15	1.2 + 0.4	2.4 + 1
22 V	2.2 V to 22 V	0.28 + 0.4	0.6 + 1.7	1.4 + 5	3 + 9
220 V	22 V to 220 V	0.6 + 10	1.6 + 110	5.4 + 110	13 + 220

The expanded uncertainties given in this table are expressed in mV/V + mV

Matrix D

AC Current Measurement

Range	Frequency (kHz)				
	0.01 to 0.02	0.02 to 0.04	0.04 to 1	1 to 5	5 to 10
9 μ A to 220 μ A	0.8 + 0.03	0.42 + 0.025	0.16 + 0.02	0.7 + 0.05	1.8 + 0.1
0.22 mA to 2.2 mA	0.8 + 0.05	0.42 + 0.04	0.16 + 0.04	0.7 + 0.5	1.8 + 1
2.2 mA to 22 mA	0.8 + 0.5	0.42 + 0.4	0.16 + 0.4	0.7 + 10	1.8 + 0.01
22 mA to 220 mA	0.8 + 5	0.42 + 4	0.18 + 4	0.7 + 50	1.8 + 100
0.22 A to 2.2 A	-	-	0.75 + 40	0.85 + 100	10 + 200

The expanded uncertainties given in this table are expressed in mA/A + μ A

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SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument CAPACITANCE Fixed Value	<u>20 Hz to 1 MHz</u> (1, 10, 100, 1000) pF, (0.01, 0.1, 1) μ F	1 mF/F	HP 1600A series
CAPACITANCE	<u>≤ 350 Hz</u> 0.5 nF to 4 nF 4 nF to 40 nF 40 nF to 400 nF 400 nF to 4 μ F 4 μ F to 40 μ F 40 μ F to 400 μ F 400 μ F to 4 mF 4 mF to 40 mF	3 mF/F + 15 pF 3 mF/F + 30 pF 3 mF/F + 0.16 nF 4 mF/F + 1.6 nF 5 mF/F + 16 nF 5 mF/F + 0.16 μ F 5 mF/F + 1.6 μ F 10 mF/F + 0.06 mF	Wavetek 9100
	<u>350 Hz to 1.5 kHz</u> 0.5 nF to 4 nF 4 nF to 40 nF 40 nF to 400 nF 400 nF to 4 μ F 4 μ F to 40 μ F 40 μ F to 400 μ F 400 μ F to 4 mF 4 mF to 40 mF	6 mF/F + 0.03 nF 6 mF/F + 0.06 nF 6 mF/F + 0.32 nF 8 mF/F + 3.2 nF 10 mF/F + 32 nF 10 mF/F + 0.32 μ F 10 mF/F + 3.2 μ F 20 mF/F + 0.12 mF	
INDUCTANCE Fixed Value	100 μ H @ 1 kHz (1, 10, 100) mH @ 1 kHz 1 H @ 1 kHz	2.5 mH/H 1 mH/H 1 mH/H	ANDO RS-100 series
POWER/ ENERGY (DC)	1 kW to 20 kW 0.1 W to 1 kW	0.7 mW/W 0.22 mW/W	Fluke 5520A
POWER/ ENERGY (AC) (45 Hz to 65 Hz at PF=1)	10 kW to 20 kW 1 W to 10 kW 0.1 W to 1 W	1 mW/W 0.9 mW/W 1 mW/W	



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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
1. Measuring Instrument FREQUENCY	1 μ Hz to 80 MHz (10 mVpp to 10 Vpp)	37 nHz/Hz	(Agilent 33250A, ifR2042 or Agilent E8257D) Reference to Pendulum GPS- 12R Manual hold- over
	10 kHz to 40 GHz (+11 dBm to -135 dBm)	12 nHz/Hz	
AMPLITUDE	10 mVp-p to 10 Vp-p (1 μ Hz to 80 MHz, Into 50 Ω)	10 mVp-p/ Vp-p + 1 mVp-p	Function Generator Agilent 33250A
	+13 dBm to -144 dBm (10 kHz to 5.4 GHz)	0.58 dBm	Signal Generator ifR2042
	+11 dBm to -135 dBm (250 kHz to 40 GHz)	0.92 dBm	Signal Generator Agilent E8257D
FLATNESS	Sine Wave Relative to 1 kHz (Auto range On)	0.4 dBm	Function Generator Agilent 33250A
TIME	1 s to 24 Hrs	0.06 μ s/s + 0.021 s	Agilent 33250A & HP 53132A
	20 ms to 5 s	0.7 ms	For RCD Tester Calibrator (using Transmille 3200)
Residual Current Duration	10 ms to 5 s	0.4 ms	
RPM Measuring Instruments (Non-Contact)	60 to 5999 rpm 6000 to 29999 rpm 30000 to 59999 rpm 60000 to 99999 rpm	0.07 rpm 7 rpm 36 rpm 70 rpm	In-House method, ESF/0303.
2. High Voltage Meter DC VOLTAGE	0.5 kV to 10 kV	5 mV/V	TDV 20 ADS & TOS 5101
AC VOLTAGE	(0.5 kV to 10 kV) @ (50/60) Hz	8 mV/V	

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
3. CLAMP METER DC Current <u>10 – Turn Coil</u>	3.2 A to 32 A 32 A to 105 A 105 A to 200 A	0.06 mA/A + 1.18 mA 0.55 mA/A + 9.4 mA 0.55 mA/A + 45 mA	Wavetek 9100 c/w Current Coil
<u>50 – Turn Coil</u> (DC Current)	16 A to 160 A 160 A to 525 A 525 A to 1000 A	0.6 mA/A + 5.9 mA 0.55 mA/A + 47 mA 0.55 mA/A + 0.23 A	
AC Current <u>10 – Turn Coil</u>	<u>3.2 A to 32 A</u> 10 Hz to 100 Hz 100 Hz to 440 Hz	2 mA/A + 5.5 mA 7.8 mA/A + 27 mA	
	<u>32 A to 200 A</u> 10 Hz to 100 Hz 100 Hz to 440 Hz	2.1 mA/A + 90 mA 6.7 mA/A + 0.25 A	
<u>50 – Turn Coil</u> (AC Current)	<u>16 A to 160 A</u> 10 Hz to 100 Hz	2 mA/A + 28 mA	
	<u>160 A to 1000 A</u> 10 Hz to 100 Hz	2.1 mA/A + 0.45 A	
4. INSULATION TESTER	(1 k Ω to 10 k Ω) @ 10 V, (10 k Ω to 100 k Ω) @ 50 V, (0.1 M Ω to 1 M Ω) @ 150 V	0.5 m Ω / Ω	Tinsley 4720
	(1 M Ω to 10 M Ω) @ 300 V, (10 M Ω to 100 M Ω) @ 500 V	1 m Ω / Ω	
	(0.1 G Ω to 1 G Ω) @ 1000 V	10 m Ω / Ω	
	(1 G Ω to 10 G Ω) @ 5000 V	50 m Ω / Ω	
	(10 G Ω to 100 G Ω) @ 5000 V	0.1 Ω / Ω	
	(100 G Ω to 600 G Ω) @ 5000 V	50 m Ω / Ω	



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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
5. OSCILLOSCOPE Vertical Deflection DC Signal	0V to ± 6.6 V (50 Ω Load)	2.5 mV/V + 0.04 mV	Fluke 5500A SC600
	0V to ± 130 V (1 M Ω Load)	0.5 mV/V + 0.04 mV	
Square Wave Signal (Vertical Deflection)	± 1 mVp-p to ± 6.6 Vp-p (50 Ω Load)	2.5 mVp-p/Vp-p + 0.04 mVp-p	
	± 1 mVp-p to ± 130 Vp-p (1 M Ω Load)	1 mVp-p/Vp-p + 0.04 mVp-p	
Horizontal Deflection Time Markers (50 Ω Load)	2 ns/div to 20 ms/div 50 ms/div to 5 s/div	2.5 μ s/s (25+(Output x 1000)) μ s/s	
Bandwidth Frequency	50 kHz to 600 MHz	2.5 μ Hz/Hz	Generating using calibrator model Fluke 5500A SC600
	600 MHz to 40 GHz (+11 dBm to -135 dBm)	12 nHz/Hz	Agilent E8257D Reference to Pendulum GPS- 12R Manual hold- over
Bandwidth Amplitude	50 kHz to 600 MHz	0.03 Vp-p	Generating using calibrator model Fluke 5500A SC600
	600 MHz to 40 GHz (+11 dBm to -135 dBm)	0.92 dBm	Generating using Agilent E8257D
Risetime	≤ 300 ps	+ 0 ns / -0.1 ns	Fluke 5500A SC600



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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument DC VOLTAGE	± 100 mV Range $\pm (100 \mu\text{V to } 120 \text{ mV})$ ± 1 V Range $\pm (100 \text{ mV to } 1.2 \text{ V})$ ± 10 V Range $\pm (1 \text{ V to } 12 \text{ V})$ ± 100 V Range $\pm (10 \text{ V to } 120 \text{ V})$ ± 1000 V Range $\pm (100 \text{ V to } 1050 \text{ V})$	$5 \mu\text{V/V} + 0.3 \mu\text{V}$ $4 \mu\text{V/V} + 0.3 \mu\text{V}$ $4 \mu\text{V/V} + 0.5 \mu\text{V}$ $6 \mu\text{V/V} + 0.03 \text{ mV}$ $6 \mu\text{V/V} + 0.1 \text{ mV}$	HP 3458A Opt 002
AC VOLTAGE	<u>10 mV Range (1 mV to 12 mV)</u> 1 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 1 MHz 1 MHz to 4 MHz 4 MHz to 8 MHz	$0.3 \text{ mV/V} + 3 \mu\text{V}$ $0.2 \text{ mV/V} + 1.1 \mu\text{V}$ $0.3 \text{ mV/V} + 1.1 \mu\text{V}$ $1 \text{ mV/V} + 1.1 \mu\text{V}$ $5 \text{ mV/V} + 1.1 \mu\text{V}$ $12 \text{ mV/V} + 5 \mu\text{V}$ $0.07 \text{ V/V} + 7 \mu\text{V}$ $0.2 \text{ V/V} + 8 \mu\text{V}$	
	<u>100 mV range (10 mV to 120 mV)</u> 1 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz 1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	$0.07 \text{ mV/V} + 4 \mu\text{V}$ $0.07 \text{ mV/V} + 2 \mu\text{V}$ $0.14 \text{ mV/V} + 2 \mu\text{V}$ $0.3 \text{ mV/V} + 2 \mu\text{V}$ $0.8 \text{ mV/V} + 2 \mu\text{V}$ $3 \text{ mV/V} + 0.01 \text{ mV}$ $0.01 \text{ V/V} + 0.01 \text{ mV}$ $15 \text{ mV/V} + 0.01 \text{ mV}$ $0.04 \text{ V/V} + 0.07 \text{ mV}$ $0.04 \text{ V/V} + 0.08 \text{ mV}$ $0.15 \text{ V/V} + 0.1 \text{ mV}$	

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SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (Continue)	<u>1 V Range (0.1 V to 1.2 V)</u> 1 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz 1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	0.07 mV/V + 0.04 mV 0.07 mV/V + 0.02 mV 0.14 mV/V + 0.02 mV 0.3 mV/V + 0.02 mV 0.8 mV/V + 0.02 mV 3 mV/V + 0.1 mV 0.01 V/V + 0.1 mV 15 mV/V + 0.1 mV 0.04 V/V + 0.7 mV 0.04 V/V + 0.8 mV 0.15 V/V + 1 mV	HP 3458A Opt 002
	<u>10 V Range (1 V to 12 V)</u> 1 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz 1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	0.07 mV/V + 0.4 mV 0.07 mV/V + 0.2 mV 0.14 mV/V + 0.2 mV 0.3 mV/V + 0.2 mV 0.8 mV/V + 0.2 mV 3 mV/V + 1 mV 0.01 V/V + 1 mV 15 mV/V + 1 mV 0.04 V/V + 7 mV 0.04 V/V + 8 mV 0.15 V/V + 0.01 V	
	<u>100 V Range (10 V to 120 V)</u> 1 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz	0.2 mV/V + 4 mV 0.2 mV/V + 2 mV 0.2 mV/V + 2 mV 0.35 mV/V + 2 mV 1.2 mV/V + 2 mV 4 mV/V + 0.01 V 15 mV/V + 0.01 V	

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FIELD OF CALIBRATION: ELECTRICAL

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC VOLTAGE (continue)	1000 V Range (100 V to 700 V) 1 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	0.4 mV/V + 0.04 V 0.4 mV/V + 0.02 V 0.6 mV/V + 0.02 V 1.2 mV/V + 0.02 V 3 mV/V + 0.02 V	HP 3458A Opt 002 HP 3458A Opt 002
DC CURRENT	1 nA to +100 nA -100 nA to -1 nA 100 nA to +1 μ A -1 μ A to -100 nA 1 μ A to +10 μ A -10 μ A to -1 μ A 10 μ A to +100 μ A -100 μ A to -10 μ A 100 μ A to +1 mA -1 mA to -100 μ A 1 mA to +10 mA -10 mA to -1 mA 10 mA to +100 mA -100 mA to -10 mA 100 mA to +1 A -1 A to -100 mA	30 μ A/A + 0.04 nA 30 μ A/A + 0.04 nA 20 μ A/A + 0.04 nA 20 μ A/A + 0.04 nA 20 μ A/A + 0.1 nA 20 μ A/A + 0.1 nA 20 μ A/A + 0.8 nA 20 μ A/A + 0.8 nA 20 μ A/A + 5 nA 20 μ A/A + 5 nA 20 μ A/A + 0.05 μ A 20 μ A/A + 0.05 μ A 35 μ A/A + 0.5 μ A 35 μ A/A + 0.5 μ A 0.11 mA/A + 0.01 mA 0.11 mA/A + 0.01 mA	
	+1 A to +10 A -10 A to -1 A +10 A to +100 A -100 A to -10 A	5.1 mA 5.1 mA 0.05 A 0.05 A	
	+100 A to +1000 A -1000 A to -100 A	15 mA/A + 2A 15 mA/A - 2A	Kyoritsu 2003

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FIELD OF CALIBRATION: ELECTRICAL

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC CURRENT	<u>5 μA to 100 μA</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A	HP 3458A Opt 002
	<u>0.05 mA to 1 mA</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	4 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.3 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A	
	<u>0.5 mA to 10 mA</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.3 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A	
	<u>5 mA to 100 mA</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	4 mA/A + 0.02 mA 1.5 mA/A + 0.02 mA 0.6 mA/A + 0.02 mA 0.3 mA/A + 0.02 mA 0.6 mA/A + 0.02 mA 4 mA/A + 0.04 mA 5.5 mA/A + 0.15 mA	



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FIELD OF CALIBRATION: ELECTRICAL

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument AC CURRENT (continue)	<u>0.05 A to 1 A</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz 5 kHz to 20 kHz 20 kHz to 50 kHz	4 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.8 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	HP 3458A Opt 002
	<u>1 A to 50 A</u> 50 Hz/ 60 Hz	0.5 mA/A	HP 3458A & Zenith H007098.
	<u>50 A to 1000 A</u> 50 Hz/ 60 Hz 40 Hz to 1 kHz	15 mA/A + 2 A 0.03 A/A + 4 A	Kyoritsu 2003
RESISTANCE	0 Ω to 10 Ω 10 Ω to 100 Ω 0.1 k Ω to 1 k Ω 1 k Ω to 10 k Ω 10 k Ω to 100 k Ω 0.1 M Ω to 1 M Ω 1 M Ω to 10 M Ω 10 M Ω to 100 M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega$ + 0.05 m Ω 12 $\mu\Omega/\Omega$ + 0.05 m Ω 10 $\mu\Omega/\Omega$ + 0.05 m Ω 10 $\mu\Omega/\Omega$ + 5 m Ω 10 $\mu\Omega/\Omega$ + 0.05 Ω 15 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 0.1 k Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 0.01 M Ω	HP 3458A Opt 002
CAPACITANCE	1 pF to 1 mF @ (10 Hz to 1 MHz)	0.5 mF/F	HP 4284A
INDUCTANCE	1 μ H to 10 H @ (10 Hz to 1 MHz)	0.5 mH/H	

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FIELD OF CALIBRATION: ELECTRICAL

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument Signal Generator (a) FREQUENCY	1 Hz to 5 GHz	0.91 pHz/Hz	HP53132A Reference to Pendulum GPS- 12R Manual hold-over
	5 GHz to 27 GHz	0.89 Hz/Hz	HP8563E Reference to Pendulum GPS- 12R Manual hold-over
(b) AMPLITUDE/ LEVEL	-20 dBm to +30 dBm (100 kHz to 2.6 GHz)	0.04 dBm	HP 8902 with 11722A
	-30 dB to +30 dB (2.6 GHz to 18 GHz)	0.27 dBm	Agilent E4418B with HP 8481A
	-120 dB to +30 dB (30 Hz to 27 GHz)	1 dBm	HP8563E
(c) TUNED RF LEVEL	-127 dB to 0 dB (2.5 MHz to 1.3 GHz)	0.07 dBm	HP 8902 with 11722A
RPM generating instruments (Non-Contact)	10 to 29 rpm 30 to 59 rpm 60 to 99 rpm 100 to 299 rpm 300 to 599 rpm 600 to 999 rpm 1000 to 2999 rpm 3000 to 5999 rpm 6000 to 9999 rpm 10000 to 29999 rpm 30000 to 59999 rpm 60000 to 99999 rpm	0.014 rpm 0.036 rpm 0.07 rpm 0.14 rpm 0.37 rpm 0.7 rpm 1.4 rpm 3.6 rpm 7 rpm 14 rpm 36 rpm 70 rpm	In-House method, ESF/0303.

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FIELD OF CALIBRATION: ELECTRICAL

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
6. Sourcing/ Generating Instrument RPM generating instruments (Contact Measurement)	20 to 29 rpm 30 to 59 rpm 60 to 99 rpm 100 to 299 rpm 300 to 599 rpm 600 to 999 rpm 1000 to 2999 rpm 3000 to 5999 rpm 6000 to 9999 rpm 10000 to 12999 rpm 13000 to 25999 rpm 26000 to 29999 rpm	0.011 rpm 0.016 rpm 0.029 rpm 0.07 rpm 0.16 rpm 0.29 rpm 0.7 rpm 1.6 rpm 2.9 rpm 7 rpm 8 rpm 14 rpm	In-House method, ESF/0303
7. High Voltage Tester DC VOLTAGE	0 kV to 9.9 Kv 10 kV to <20 kV 20 kV to 35 kV >35 kV to 40 kV	5 mV/V + 2 V 20 mV/V 10 mV/V 20 mV/V	TDV 20 ADS Fluke 80K-40
AC VOLTAGE	(0 kV to 9.99 kV) @ 50/60Hz (10 kV to 20 kV) @ 50/60 Hz (20 kV to 28 kV) @ 50/60 Hz	7 mV/V + 3 V 7 mV/V + 30 V 50 mV/V	

Signatories:

1. Muhammed Fahimy Bin Ahmad Ta'adin
2. Mohamed Fikri Bin Mohd Nor
3. Syahrel Bin Shari



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FIELD OF CALIBRATION: TEMPERATURE

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Liquid In-glass Thermometer (Partial Immersion)	0 °C to 200 °C	2 °C	Comparison method using SPRT & PRT
Liquid-in-glass thermometer (Total Immersion)	- 80 °C to 0 °C 0 °C to 80 °C 80 °C to 250 °C 250 °C to 500 °C	0.05 °C 0.03 °C 0.05 °C 0.10 °C	Comparison method using SPRT & PRT
Platinum Resistance Thermometer	- 80 °C to 250 °C 250 °C to 600 °C 600 °C to 950 °C	0.05 °C 0.1 °C 0.5 °C	Comparison method using SPRT & PRT
Thermocouple	- 80 °C to 250 °C 250 °C to 950 °C	0.5 °C 0.6 °C	Comparison method using SPRT, PRT and Standard Thermocouple Type R
Psychrometer Thermohygrograph Thermohygrometer	10 °C to 50 °C 35 % to 95 %RH	0.5 °C 3.0 %RH	Comparison Method Using Wet and Dry bulb base on BS 1339-1 2002
Temperature switch	- 50 °C to 10 °C 10 °C to 100 °C 100 °C to 600 °C	1 °C 2 °C 3 °C	Comparison method using SPRT, PRT and Thermocouple Type R
Mechanical thermometer	- 80 °C to 50 °C 50 °C to 600 °C	0.1 °C 1.5 °C	Comparison method using SPRT, PRT and Thermocouple Type R
Temperature Calibrator (Dry block)	- 30 °C to 400 °C 400 °C to 950 °C	0.1 °C 1.2 °C	EA-10 /13 (EAL Guideline for calibration of Dry block Calibrator)

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FIELD OF CALIBRATION: TEMPERATURE

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Temperature Indicating Instruments			
K - type	- 200 °C to 0 °C 0 °C to 1300 °C	0.4 °C 0.4 °C	
J - type	- 200 °C to 0 °C 0 °C to 1100 °C	0.3 °C 0.3 °C	
T - type	- 200 °C to 0 °C 0 °C to 400 °C	0.5 °C 0.4 °C	
E - type	- 200 °C to 0 °C 0 °C to 900 °C	0.4 °C 0.3 °C	Calibration by Electrical simulation using Temperature Calibrator
R - type	0 °C to 1000 °C 1000 °C to 1700 °C	1.3 °C 1.1 °C	
S - type	0 °C to 1000 °C 1000 °C to 1700 °C	1.3 °C 1.2 °C	
Pt 100	- 200 °C to 0 °C 0 °C to 800 °C	0.2 °C 0.5 °C	

Signatories:

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2. Abdul Jalil Baharudin
3. Zulkifli Ahmad

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FIELD OF CALIBRATION: TEMPERATURE

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Humidity Chamber	20 % to 95 %RH	2.0 % of RH	AS 2853-1986 BS 1339-1 :2002
Temperature Controlled Enclosure	- 60 °C to 200 °C 200 °C to 400 °C 400 °C to 950 °C	0.8 °C 1.2 °C 2 °C	AS 2853 -1986
Temperature Indicating Instruments			
K - type	- 200 °C to 0 °C 0 °C to 1300 °C	0.4 °C 0.4 °C	
J - type	- 200 °C to 0 °C 0 °C to 1100 °C	0.3 °C 0.3 °C	
T - type	- 200 °C to 0 °C 0 °C to 400 °C	0.5 °C 0.4 °C	
E - type	- 200 °C to 0 °C 0 °C to 900 °C	0.4 °C 0.3 °C	Calibration by Electrical simulation using Temperature Calibrator
R - type	0 °C to 1000 °C 1000 °C to 1700 °C	1.3 °C 1.1 °C	
S - type	0 °C to 1000 °C 1000 °C to 1700 °C	1.3 °C 1.2 °C	
Pt 100	- 200 °C to 0 °C 0 °C to 800 °C	0.2 °C 0.5 °C	

Signatories:

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3. Zulkifli Ahmad



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FIELD OF CALIBRATION: TEMPERATURE

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Temperature Sensor with Indicator -PT100 -Thermocouple	0 °C to 300 °C	0.15 °C	Calibration by comparison method using:
	301 °C to 600 °C	0.26 °C	
	0 °C to 300 °C	0.15 °C	1-Pt100 & Type R Thermocouple as reference standards
	301 °C to 600 °C	0.26 °C	
	601 °C to 950 °C	1.1 °C	
			2-Dry Block Calibrator

Signatories:

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FIELD OF CALIBRATION: DIMENSIONAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Gauge Block	0.5 mm to 100 mm 100 mm to 250 mm	$(0.1 + 1.0 L) \mu\text{m}$ L in m	Reference Equipment: Gauge block
Gauge Block (Imperial units)	0.05 inch to 4 inch	$(0.004 + 1.0 L) \mu\text{inch}$ L in inch	Gauge block
Bevel Protractor	0 to 360 degrees : Graduation 5 min. Graduation 1 deg.	3 minute 0.5 degree	Angle block
Snap Gauge / Caliper Gauge	Up to 200 mm	5 μm	Uni. Measuring M/c
Micrometer	0.001 mm to 100 mm	2 μm	Gauge Block
Caliper	0.01 mm to 300 mm 300 mm to 600 mm 600 mm to 1000 mm	7 μm 9 μm 12 μm	Gauge Block Caliper Checker
Height Gauge	0.01 mm to 600 mm	10 μm	Caliper Checker
Caliper Checker	20 mm to 300 mm 301 mm to 600 mm	3 μm 6 μm	Long Gauge block
Calibration Tester	0 mm to 25 mm	2 μm	Dig.Length Indicator /Gauge Block
Dial / Digital Test Indicator	0.001 mm to 100 mm	2 μm	Dial gauge testing machine
Dial / Digital Gauge	0.001 mm to 100 mm	2 μm	Dial gauge testing machine
Dial / Digital Thickness Gauge	0.01 mm to 50 mm	5 μm	Gauge Block
Depth Micro-Checker	0 mm to 300 mm	6 μm	Gauge Block / Pre. Height Gauge

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FIELD OF CALIBRATION: DIMENSIONAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Feeler Gauge	0.005 mm to 2.0 mm	3 μ m	Dig.Length Indicator
Glass Scale	up to 200 mm 200 mm to 300 mm	3.8 μ m 5.6 μ m	Uni. Measuring M/c
Grind Gauge/Fine Gauge	0.001 mm to 0.15 mm	2 μ m	Dig.Length Indicator
Height master	0.001 mm to 600 mm	6 μ m	Pre. Height Gauge / Gauge Block
Ruler	0.1 mm to 2000 mm	0.1 mm	Linear scale
Mu-checker	0.1 mm to 2000 μ m	2 μ m	Gauge Block
Precision Height Gauge	0.001 mm to 600 mm	4 μ m	Gauge Block
Straight Edge	0 mm to 600 mm	1.5 μ m	Dig.Length Indicator / Straight edge
Tape	0 m to 100 m	(0.33 + 0.019 L) mm <i>L is length in unit meter</i>	Linear scale
Thickness Foil	0.001 mm to 2.0 mm	3 μ m	Dig.Length Indicator
Setting/Standard Rod	25 mm to 100 mm 100 mm to 600 mm	(0.15 + 0.0064 L) (0.11 + 0.008 L) <i>L is length in unit mm</i>	Universal Length Machine and Gauge Block
Plain Pin or Plug Gauge (Diameter Only)	0.2 mm to 50 mm	0.5 μ m	Universal Length Machine
Plain Ring Gauge (Diameter Only)	1 mm to 100 mm 100 mm to 200 mm	(0.007 L + 0.11) μ m (0.0064 L + 0.41) μ m <i>L is diameter in unit mm</i>	Universal Length Machine and Gauge Block
Thread Plug Gauge (Simple Pitch Diameter)	2 mm to 50 mm	2 μ m	Universal Length Machine (In-house Method)
Length Machine (For in-house equipment only)	0 mm to 1 m 0 mm to 10 m	0.1 mm 0.4 mm	Standard Scale

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FIELD OF CALIBRATION: DIMENSIONAL

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Universal Measuring Microscope (Individual linear axis only- <i>For in-house equipment only</i>)	0 mm to 200 mm	2.5 μ m	Standard Scale
Digital Length Indicator	0 to 25 mm	0.4 μ m	Gauge Block

Signatories:

1. Hasnah Bt Hassan
2. Abdul Jalil Baharudin
3. Mohd Hashim Effandi
4. Mohd Amri Abd Aziz
5. Dr. Wan Abd Malik Wan Mohamed



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FIELD OF CALIBRATION: DIMENSIONAL

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Profile Projector (X or Y axis only)	1 mm to 200 mm	5 μ m	Glass Scale
	201 mm to 300 mm	7 μ m	
Surface Table/Plate	2500 mm x 1600 mm	3 μ m/m	Levelnic / Plankator

Signatories:

1. Hasnah Bt Hassan
2. Abdul Jalil Baharudin
3. Mohd Hashim Effandi
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FIELD OF CALIBRATION: MASS

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Standard Weights Class E2 , F1, F2, M1, M2 & M3	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 50 kg	0.002 mg 0.002 mg 0.002 mg 0.002 mg 0.003 mg 0.004 mg 0.005 mg 0.006 mg 0.008 mg 0.010 mg 0.012 mg 0.016 mg 0.020 mg 0.025 mg 0.03 mg 0.05 mg 0.10 mg 0.23 mg 0.5 mg 1.0 mg 3.0 mg 16 mg 32 mg 78 mg	Based on OIML R111. Mass comparison using: ABBA weighing scheme for weights of OIML classes E2 and F1; and AB, AB weighing scheme for weights of OIML classes F2 and below
Weight Blocks	1 mg to 10 g Above 10 g to 50 g Above 50 g to 100 g Above 100 g to 200 g Above 200 g to 500 g Above 500 g to 1 kg Above 1 kg to 2 kg Above 2 kg to 5 kg Above 5 kg to 10 kg Above 10 kg to 20 kg Above 20 kg to 30 kg Above 30 kg to 60 kg Above 60 kg to 100 kg Above 100 kg to 200 kg Above 200 kg to 500 kg	2 mg 3 mg 5 mg 9 mg 0.02 g 0.05 g 0.09 g 0.2 g 0.5 g 0.9 g 1.3 g 2.6 g 0.02 kg 0.02 kg 0.04 kg	Mass comparison using AB, AB weighing scheme

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FIELD OF CALIBRATION: **MASS**

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Spring /Hanging Scale	up to 5 kg up to 20 kg up to 50 kg up to 100 kg	16 g 31 g 62 g 0.13 kg	

Signatories:

1. **Abdul Jalil Baharudin**
2. **Mohammad Najib Kamaruddin**
3. **Dr. Wan Abd Malik Wan Mohamed**



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FIELD OF CALIBRATION: MASS

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Analytical Balance	up to 50 g up to 100 g up to 200 g	0.13 mg 0.15 mg 1.3 mg	Reference E2
Balance / Scale (Triple Beam, Single Beam Spring, Top Pan, Mechanical & Electronic)	up to 1000 g up to 2000 g up to 5000 g up to 10000 g up to 20 kg up to 50 kg up to 100 kg up to 200 kg up to 500 kg	2 mg 0.02 g 0.02 g 0.2 g 0.2 g 2 g 13 g 0.03 kg 0.1 kg	Reference F1/F2 Reference M2
Electrical and Mechanical Platform Balance	up to 1000 kg up to 2000 kg	0.27 kg 0.66 kg	Reference M2

Signatories:

1. Abdul Jalil Baharudin
2. Mohammad Najib Kamaruddin
3. Dr. Wan Abd Malik Wan Mohamed



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FIELDS OF CALIBRATION: FORCE & TORQUE

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
FORCE MEASUREMENT			ISO 376 : 2004
Proving Rings/Load Cells	0 kgf to 100 kgf 101 kgf to 500 kgf 501 kgf to 1000 kgf 1001 kgf to 5000 kgf 5001 kgf to 10000 kgf 10001 kgf to 30000 kgf	0.04 kgf 0.2 kgf 0.3 kgf 3 kgf 26 kgf 108 kgf	LC 100 kgf LC 500 kgf LC 1000 kgf LC 5000 kgf LC 10000 kgf LC 45000 kgf
Push-pull/ Force Gauge	1 gf to 5 kgf 5 kgf to 20 kgf 20 kgf to 50 kgf 50 kgf to 100 kgf	16 gf 31 gf 62 gf 124 gf	ASTM E74-95 Reference F1 & F2
Gramme/ Dial Tension Gauge	1 gf to 50 gf 50 gf to 500 gf 500 gf to 2000 gf	1 gf 6 gf 30 gf	ASTM E74-95 Reference F1 & F2
TORQUE MEASUREMENT			
Torque wrench	0 N.m to 1 N.m 1 N.m to 50 N.m 51 N.m to 100 N.m 101 N.m to 500 N.m	0.07 N.m 0.04 N.m 0.3 N.m 1 N.m	Comparison with torque transducers with reference to BS EN ISO 6789 : 2003 Transducer 2 N.m Transducer 50 N.m Transducer 100 N.m Transducer 1000 N.m
Torque meter and analyser	0 N.m to 2 N.m 3 N.m to 50 N.m 51 N.m to 100 N.m 101 N.m to 500 N.m	0.1 % of reading 0.1 % of reading 0.1 % of reading 0.1 % of reading	BS 7882 : 2008 Reference F2 & M2

Note: LC (Load Cell)

Signatories:

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3. Abdul Latip Alias
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FIELD OF CALIBRATION: FORCE

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Universal Testing Machine / Compression mode (tension mode up to 5000 kgf)	0 kgf to 100 kgf 101 kgf to 500 kgf 501 kgf to 1000 kgf 1001 kgf to 5000 kgf 5001 kgf to 10000 kgf 10001 kgf to 60000 kgf 60001 kgf to 200000 kgf	0.04 kgf 0.2 kgf 0.3 kgf 3 kgf 26 kgf 378 kgf 460 kgf	BS EN ISO 7500- 1:2004 LC 100 kgf LC 500 kgf LC 1000 kgf LC 5000 kgf LC 10000 kgf LC 90000 kgf LC 200000 kg
Charpy / Izod Impact Tester	1 Joule to 300 Joules	1 % of reading	BS 131-7 : 1998

Note: LC (Load Cell)

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FIELD OF CALIBRATION: PRESSURE

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Pressure measuring device (Gas medium)	1 psi to 100 psi 101 psi to 1600 psi	0.01 % of pressure 0.01 % of pressure	Comparison with Dead Weight Tester based on BS EN 837-1, 837-2, 837-3 ADWT ADWT
Pressure measuring device (Oil medium)	10 psi to 800 psi 801 psi to 16000 psi	0.04 % of pressure 0.01 % of pressure	DWT DWT
	16 0001 psi to 40000 psi	0.02 % of pressure	Based on BS EN 837-1 BS EN 837-2 BS EN 837-3
Vacuum gauge	Ambient to 67 cm Hg	0.1 % of pressure	Mercury Manometer
Low Pressure Measuring Devices Mercury Manometer	0 psi to 1500 mm Hg	2 mm Hg	Reference Pressure Balance
Water Manometer	0 psi to 1500 mm H ₂ O	3 mm H ₂ O	
Deadweight Tester	10 psi to 40 000 psi	0.02 % of pressure	Cross float method OIML R110 1994(E) NCSL RISP-4 2000 EAL G26/EA-4/17 JULY 1997 Pressure Balance

Note: ADWT (Air Dead Weight Tester)
DWT (Dead Weight Tester)

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FIELD OF CALIBRATION: PRESSURE

SITE CALIBRATION: CATEGORY I

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Pressure measuring device (Oil medium)	0 psi to 500 psi 0 psi to 1000 psi 0 psi to 3000 psi 0 psi to 4500 psi 0 psi to 7500 psi 0 psi to 10 000 psi 0 psi to 12 000 psi 0 psi to 16 000 psi	0.7 % of pressure 0.7 % of pressure 0.6 % of pressure 0.4 % of pressure 0.4 % of pressure 0.7 % of pressure 0.6 % of pressure 0.6 % of pressure	BS EN 837-1 BS EN 837-2 BS EN 837-3 Pressure Balance
Vacuum Measuring Devices	Ambient to -70 cm Hg	1.0 % of pressure	Pressure Calibrator
Pressure Gauge	0 bar to 20 bar	0.5 % of pressure	Pressure Calibrator

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FIELD OF CALIBRATION: VOLUMETRIC

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Bulb Pipette	1 ml to 5 ml 5 ml to 100 ml	0.008 ml 0.03 ml	Cal .Procedure No TCP 0002 REV2.0 Ref: ISO 4748
Graduated Pipette	1 ml to 5 ml 5 ml to 100 ml	0.008 ml 0.03 ml	Cal .Procedure No TCP 0002 REV2.0 Ref: ISO 4748
Measuring Cylinder	5 ml to 100 ml 100 ml to 500 ml 500 ml to 1000 ml 1000 ml to 2000 ml	0.05 ml 0.5 ml 2.0 ml 3.0 ml	Cal .Procedure No TCP 0001 REV2.0 Ref: ISO 4748
Burette	1 ml to 50 ml	0.05 ml	Cal .Procedure No TCP 0003 REV2.0 Ref: ISO 4748
Beaker & Flasks	5 ml to 100 ml 100 ml to 1000 ml 1000 ml to 2000 ml	1.0 ml 3.0 ml 5.0 ml	Cal .Procedure No TCP 0004 REV2.0 Ref: ISO 4748
Piston-operated Volumetric apparatus	10 μ l to 20 μ l 20 μ l to 50 μ l 50 μ l to 100 μ l 100 μ l to 200 μ l 200 μ l to 500 μ l 500 μ l to 1000 μ l 1000 μ l to 5000 μ l 5000 μ l to 10000 μ l 10000 μ l	0.03 μ l 0.09 μ l 0.15 μ l 0.4 μ l 0.8 μ l 1.8 μ l 3.5 μ l 20 μ l 40 μ l	No.TCP/0005 REV.0.0 Based on ISO 8655- 6:2002

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FIELD OF CALIBRATION: HYDROMETER

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Density Hydrometer	0.600 g/ml to 0.650 g/ml	0.001 g/ml (graduation 0.0005 g/ml)	Comparison Method BS 718:1991
	0.650 g/ml to 0.700 g/ml		
	0.700 g/ml to 0.750 g/ml		
	0.750 g/ml to 0.800 g/ml		
	0.800 g/ml to 0.850 g/ml		
	0.850 g/ml to 0.900 g/ml		
	0.900 g/ml to 0.950 g/ml		
	0.950 g/ml to 1.000 g/ml		
	1.000 g/ml to 1.050 g/ml		
	1.050 g/ml to 1.100 g/ml		
	1.100 g/ml to 1.150 g/ml		
	1.150 g/ml to 1.200 g/ml		
	1.200 g/ml to 1.250 g/ml		
	1.250 g/ml to 1.300 g/ml		
	1.300 g/ml to 1.350 g/ml		
	1.350 g/ml to 1.400 g/ml		
	1.400 g/ml to 1.450 g/ml		
	1.450 g/ml to 1.500 g/ml		

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FIELD OF CALIBRATION: HYDROMETER

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm)*	Remarks
Temperature 1. Specific Gravity Hydrometer	0.6 to 0.65 0.65 to 0.7 0.7 to 0.75 0.75 to 0.8 0.8 to 0.85 0.85 to 0.9 0.9 to 0.95 0.95 to 1 1 to 1.1 1.1 to 1.2 1.2 to 1.3 1.3 to 1.4 1.4 to 1.5	0.001 (Graduation 0.0005)	Cal. Procedure No. MDL 0002 Rev.1.0 Reference: BS 718:1991

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