

Laboratory Electronics Regional Test Laboratory (West), Plot No. F 7 & 8, MIDC Area, Andheri (East) Mumbai, Maharashtra

Accreditation Standard ISO/IEC 17025: 2005

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
<u>ELECTRO TECHNICAL CALIBRATION</u>				
I.	SOURCE			
1.	DC Voltage ^{\$}	10 μ V to 1mV 1 mV to 100 mV 100 mV to 1000 V 1V ,10 V	0.005% to 0.002% 0.002% to 0.0005% 0.0005% to 0.0003% 0.0002%,0.0001%	Using DC Ref. STD. Fluke 7000/ MFC Fluke 5720A/Wavetek4808 Ref. div. Fluke 752/REF. Divider Esi Sr 1010/ Null Detector ESI/ by Direct Method
3.	DC Current ^{\$}	100 pA to 1nA 1nA to 100 μ A 100 μ A to 1 A 1 A to 20 A 20 A to 100 A 100 A to 500 A 20 A to 1000 A	0.05% to 0.0045% 0.0045% to 0.002% 0.002% 0.002% to 0.006% 0.006% to 0.01% 0.01% to 0.04% 0.3%	Using V/R method/ MFC Wavetek 4808/Fluke 5720A/Trans cond Ampl.Ballantine 1620A/Fluke 5220A/ Std. R L&N 4030 / Direct /Ref. DMM 8508A/DMM 1281/HP3458 / Direct Std R Tinsley3111/1682 / MFC Wavetek 9100/Fluke5520/Current coil/ Direct Method

Vishal Shukla
Convenor

Avijit Das
Program Manager

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
4	DC Resistance ^s	0.1 m Ω to 100 m Ω 100 m Ω to 1 Ω 1 Ω to 1 M Ω 1M Ω to 10 G Ω 10 G Ω to 1T Ω	0.001% 0.001% to 0.0002% 0.0002% to 0.0005% 0.0005% to 0.0085% 0.0085% to 0.2%	Using Std R Tinsley 660/5576/3111/1682/ Direct/ Std R L&N 4030/Tinsley 5685/ Std R IETSRL-10M/100M, Fluke 8508A-7000k/ Std R Box Tinsley 4720 (discrete Values in step of 10)
5	AC Voltage ^s	10 Hz to 10 kHz 1 mV to 100 mV 100 mV to 10 V 10 V to 1000 V 10kHz to 30 kHz 1 mV to 100 mV 100 mV to 10 V 10 V to 1000V 30kHz to 100 kHz 1 mV to 100 mV 100 mV to 10 V 10 V to 200 V 100kHz to 1 MHz 1mV to 10 V	0.29% to 0.015% 0.015% to 0.004% 0.004% to 0.009% 0.24% to 0.009% 0.009% to 0.005% 0.005% to 0.013% 0.3% to 0.01% 0.01% to 0.0083% 0.0083% to 0.09% 1.3% to 0.21%	Using MFC Wavetek 4808/Fluke5720A / MTS Wavetek 4950 Direct/Comparison

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
7.	AC Current ^s	10 Hz to 1 kHz 10 μ A to 100 mA 100 mA to 10 A 10 A to 100 A 1kHz to 5 kHz 10 μ A to 100 μ A 100 μ A to 100 m A 100 mA to 20 A 50/60 Hz 20 A to 1000 A	0.018% 0.018% to 0.032% 0.032% to 0.1% 0.2% to 0.05% 0.05% to 0.03% 0.03% to 0.09% 0.30%	Using Direct/ MFC Wavetek 4808/ Fluke 5720A/ Tran Cond Ampl. Ballantine 1620A/fluke 5220A /fluke8508/Wavetek 4950/ Std R Tinsley 5685/ HP3548/Std R Tinsley 5685/ Fluke 5220/5520/Std R tinsley 3111/ Using 10 & X 50 turn coil with MFC Fluke 5520A/Wavetek 9100
8.	AC Resistance ^s	1kHz 1 m Ω 10 m Ω , 100 m Ω 1 Ω , 10 Ω , 100 Ω , 1k Ω , 10 k Ω	0.017% 0.008% to 0.012% 0.0008% to 0.003%	Using Direct Std. Resistor Tinsley 5576/660/1682/3111/5685 series (Discrete values)
9.	Capacitance	1kHz 1pF 10 pF to 1000 pF 1000 pF to 1 μ F 1 μ F to 10 mF 100Hz 10 mF to 1000 mF	0.042% 0.002% to 0.001% 0.001% to 0.011% 0.011% to 0.1% 0.13%	Using Direct / Std Capacitors GR 1404/ Std Capacitors GR 1409/ (Discrete Values)/ Std cap. IET/HAC 4 Terminal Capacitor GR 1417

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
10.	Inductance [§]	1kHz 100 μ H to 10 H	0.02% to 0.052%	Using Std Inductor GR 1482 series /Direct Method
11.	Temperature Simulation [§] Thermocouple type K Thermocouple type J Thermocouple type E Thermocouple type T Thermocouple type N Thermocouple type R Thermocouple type S Thermocouple type B Thermocouple type C Thermocouple type L Thermocouple type U RTD – Pt 385, 100ohm RTD – Pt 385, 1000 ohm	(-)270 $^{\circ}$ C to 1372 $^{\circ}$ C (-)210 $^{\circ}$ C to 1200 $^{\circ}$ (-)270 $^{\circ}$ C to 1000 $^{\circ}$ C (-)270 $^{\circ}$ C to 400 $^{\circ}$ C (-)270 to 1300 $^{\circ}$ C (-)50 to 1768 $^{\circ}$ C (-)50 $^{\circ}$ C to 1768 $^{\circ}$ C 0 $^{\circ}$ C to 1820 $^{\circ}$ C 0 $^{\circ}$ C to 2320 $^{\circ}$ C (-)200 $^{\circ}$ C to 900 $^{\circ}$ C (-)200 $^{\circ}$ C to 600 $^{\circ}$ C (-)199 $^{\circ}$ C to 650 $^{\circ}$ C (-)199 $^{\circ}$ C to 650 $^{\circ}$ C	0.11 $^{\circ}$ C 0.08 $^{\circ}$ C 0.11 $^{\circ}$ C 0.09 $^{\circ}$ C 0.06 $^{\circ}$ C 0.2 $^{\circ}$ C 0.2 $^{\circ}$ C 0.07 $^{\circ}$ C 0.09 $^{\circ}$ C 0.02 $^{\circ}$ C 0.02 $^{\circ}$ C 0.042 $^{\circ}$ C 0.042 $^{\circ}$ C	Using For Calibration of Temp. Indicator/Controller/Indicator/Process Calibrator) MFC FLUKE 5720A/WAVETEK 4808 /Direct Method
12.	Frequency [§]	1mHz to 18GHz	4E-10 to 7E-11	Using Direct / CNT 85R Rubidium clock/Frequency counter with R&S SMT06/ /Gigatronics 9000S synthesized signal generators

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
13.	Time- Period ^s (Interval)	3.3 ns to 1000 s	1.3 E-10 to 4.5 E-10	Using Direct/ CNT 85R Rubidium clock/Frequency counter with R&S SMT06/ /Gigatronics 9000S synthesized signal generators Direct Method
14.	RF Level/Power ^s	10 kHz to 3 GHz (-)50 dBm to +13 dBm 3 GHz to 18 GHz (-) 50 dBm to +13 dBm	0.16 dB to 0.25 dB 0.25dB	Using Synthesized signal generators R&S SMT 06/Gigatronics9000s Direct With RF Level Meter URV-35 RF Power Meter Gigatronics 8541 & power sensors
15.	Power/Energy ^s 1 ϕ 3 ϕ	20V to 600 V / 10mA to 100A 40 Hz to 70 Hz Power factor 0.1 to 1 Lead/Lag 20 mW to 60 kW 20V to 300 V / 10mA to 20A 40 Hz to 70 Hz Power factor 0.1 to 1 Lead/Lag 60 mW to 6 kW	0.2% to 0.021% 0.2% to 0.027%	Using Direct/ Rotek 8100 Power Energy calibration Calibrator Using Rotek 8100 Power Energy calibration Calibrator

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
16.	Phase angle ^{\$} (V-V/V-I)	40-70Hz +180° to -180° (20 V to 600 V) (10 mA to 100 A)	0.017 deg	Using Direct/ Power energy calibration system Rotek 8100
17.	Power Factor ^{\$} lag/lead	40-70Hz 0.1PF to 1PF (20 V to 600 V) (10 mA to 100 A)	0.013 deg	Using Direct/ Power energy calibration system Rotek 8100/ MSB 100
18.	DC Power ^{\$}	(1 V to 1000 V) (100 mA to 20 A) 100 mW to 20 kW	0.07%	Using Direct / MFC FLUKE 5520A
19	Oscilloscope ^{\$} parameters			Using DIRECT/ MFC FLUKE 5520A/ WAVETEK 9100/ MFC 5520A/R&S SIG. GEN. SMT-06
	Amplitude (Vertical Deflection Factor	1mV to 130V(1M Ω) 1mV to 6.6 V (50 Ω)	1.04% To 0.1%	
	Time base	2ns to 20ms 20ms to 5s	0.00025% to 0.0025%	
	Bandwidth	Up to 3GHz	2% to 5%	

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
II.	MEASURE			
1.	DC Voltage ^s	10 μ V to 1mV 1mV to 100 mV 100 mV to 1000 V	0.015% to 0.007% 0.007% to 0.0005% 0.0005% to 0.0003%	Using Direct/Nullmethod/ Nanovoltmeter Agilent 34420A /MTS 4950/ Nanovoltmeter Agilent 34420A /MTS 4950/ Ref DMM Fluke 8508A/ Ref Divider fluke 752/DC Ref Std fluke 7000/Null Detector ESI
2.	DC High Voltage ^s	1 kV to 10kV 10kV to 50kV	0.016% to 0.2% 0.2% to 0.5%	Using Direct/ HV divider fluke 80E/DMMFLUKE 87III Direct/ HVdivider process Instruments- 100 /DMM Agilent US1253B
3.	DC Current ^s	100 pA to 1nA 1nA to 100 μ A 100 μ A to 100 mA 100 mA to 1A 1A to 20 A 20 A to 100 A 100 A to 500 A	0.05% to 0.0034% 0.0034% to 0.002% 0.002% to 0.001% 0.001% to 0.002% 0.002% to 0.006% 0.006% to 0.01% 0.01% to 0.02%	Using V/R method Std R Fluke/L&N 4030 series /5685 series/DMM8508/HP3458/ /AC/DC STD R Tinsley 3111/660/5576/ V/I Method

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (±)	Remarks
4.	DC Resistance ^s	0.1 mΩ to 100 mΩ 100 mΩ to 1 Ω 1 Ω to 1MΩ 1MΩ to 1GΩ 1GΩ to 1TΩ	0.001% 0.001% to 0.0003% 0.0003% 0.0003% to 0.001% 0.001% to 0.05%	Using Guildline 6622A DCC Bridge/Std R tinsley 5685 series/1659/ 1682/ 3111/660/5576/ DIRECT/Divider /Null Std R L&N 4030 series / DMM8508A/ keithley high R meter/ MFC 4808/5520/ Null detector
5.	AC Voltage ^s	10 Hz to 10 kHz 1 mV to 100 mV 100 mV to 10 V 10 V to 1000 V 10kHz to 30 kHz 1 mV to 100 mV 100 mV to 10 V 10 V to 1000 V 30kHz to 100 kHz 1 mV to 100 mV 100 mV to 10 V 10 V to 200 V 100kHz to 1 MHz 1mV to 10 V	0.20 % to 0.015% 0.015% to 0.004% 0.004% to 0.013% 0.24% to 0.009% 0.009% to 0.005% 0.005% to 0.013% 0.3% to 0.009% 0.009% to 0.005% 0.005% to 0.09% 1.4% to 0.21%	Using DMM fluke8508/MTS Wavetek 4950/ HP3458A Comparison
6.	AC High Voltage ^s	50Hz 1kV to 35kV 35kV to 50kV	0.1% to 0.5% 0.5% to 1%	Using Direct/ HVdivider process 100E /DMM Agilent US1253B

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
7.	AC Current ^s	10 Hz to 1 kHz 10 μ A to 100 mA 100 mA to 10 A 10 A to 100 A 1kHz to 5 kHz 10 μ A to 100 μ A 100 μ A to 100 mA 100 mA to 20 A 50/60 Hz 1A to 3200 A	0.01 to 0.023% 0.01% to 0.043% 0.043 % to 0.05% 0.2% to 0.05% 0.05% to 0.03% 0.03% to 0.09% 0.2%	Using Direct/ Ref DMM Fluke 8508A/MTS Wavetek 4950/ HP3548/Std R Tinsley 5685/ /Std R tinsley 3111/1682/1659/ & Std R tinsley 5576/660/DMM 1281 Using CT
8.	AC Resistance ^s	1kHz 1m Ω to 100 m Ω 100 m Ω to 1 Ω 1 Ω to 10 k Ω	0.02% to 0.01% 0.01% to 0.004% 0.004%	Using AC/DC Std. Resistor Tinsley 3111/1682/5576/5685 series Ref multimeter Fluke 8508A / MTS 4950/ LCR Bridge Wavetek 4808/ HP3458 /Precision Component Analyser waynkerr 6430/Video bridge ESI2160/ Direct/Comparison

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
9.	Capacitance ^{\$}	1kHz 1pF to 10 pF 10 pF to 1000 pF 1000 pF to 1 μ F 1 μ F to 10 mF 100Hz 10 mF to 1000 mF	0.02% to 0.005% 0.005% 0.005% to 0.011% 0.011% to 0.05% 0.05%	Using Capacitance Measuring Assembly Gr 1620A / Std Capacitors GR 1404/ Std Capacitors GR 1409/IET 4 Terminal Capacitor GR 1417/ MFC Wavetek 4808/MTS Wavetek 4950 /Direct/Comparison
10.	Inductance ^{\$}	1kHz 100 μ H to 100 H	0.02% to 0.055%	Using Video Bridge ESI 2160 / Component Analyser waynkerr 6430B/ STD Inductor GR 1482 series Direct/comparison

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
11.	Temperature Simulation [§] Thermocouple type K Thermocouple type J Thermocouple type E Thermocouple type T Thermocouple type N Thermocouple type R Thermocouple type S Thermocouple type B Thermocouple type C Thermocouple type L Thermocouple type U RTD Pt 385, 100 ohm, RTD Pt 385, 1000 ohm	(-)270 °C to 1372°C (-)210 °C to 1200° (-)270 °C to 1000°C (-)270 °C to 400 °C (-)270 to 1300°C (-)50 to 1768°C (-)50 °C to 1768°C 0 °C to 1800°C 0 °C to 2320°C (-)200 °C to 900°C (-)200 °C to 600°C (-)200 °C to 650°C (-)200 °C to 650°C	0.094 °C 0.086 °C 0.055 °C 0.038 °C 0.076 °C 0.12 °C 0.12 °C 0.076 °C to 0.9 °C 0.25 °C 0.04 °C 0.03 °C 0.01 °C 0.01 °C	Using For Calibration of Temp. Indicator/Controller/Indicator/Process Calibrator) Using DMM Datron 1281/ Nonovoltmeter Agilent 34420A Direct
12.	Frequency [§]	1mHz to 18 GHz	2.1E-10 to 7E-11	Using Rubidium Frequency counter cnt 85R /Frequency counter HP//aplab1148/anritsu MF 1602/Direct
13.	Time-period/ Time-Interval [§]	3.3 ns to1000 s 100 ms to 1000 s	3.2E-10 to 7.8E-11 2E-3 to 2.4E-7	Using Rubidium Frequency counter cnt 85R /Frequency counter HP//aplab1148/anritsu MF 1602/ Direct/Comparison Freq. counter PM 6672/

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
14.	RF Level/Power ^{\$}	100kHz to 3 GHz -50 dBm to +13 dBm 3 GHz to 18 GHz -50 dBm to +13 dBm	0.23 db 0.24 dB	Using RF Level Meter URV-35/ RF Power Meter Gigatronics 8541 Direct
15.	Power/Energy ^{\$} 1 ϕ 3 ϕ	40 Hz to 70 Hz 20 V to 600 V 10mA to 100A 0.1 PF to UPF 20 mW to 60 kW 20 V to 600 V 10 mA to 100 A 0.1 PF to 1 UPF 60 mW to 60 kW	0.2% to 0.02% 0.2% to 0.032%	Using Direct/comparison Rotek 8100 source with MSB 100
16.	Phase angle ^{\$} (V-V/V-I)	40 to 70 Hz +180° to -180° (20 V to 600 V) (10 mA to 100 A)	0.007 deg to 0.013deg	Using Rotek 8100 source with MSB 100 / Direct/Comparison
17.	Power Factor ^{\$}	40 to 70 Hz 0.05PF to 1PF lag/lead(20V to 600V,10mA to 100A)	0.006deg to 0.007 deg	Using Rotek 8100 source with MSB 100/ Direct/Comparison
18.	Potential Transformer(PT) ^{\$} Ratio Error Phase angle Error	50 Hz 220 V /110 V,63.5 V to 33 kV/110 V,63.5 V 0 to 360 min	0.2% 3 min.	Using CT-PT Test Bench Amber IXR-2000 & std Potential Transformers/ Direct/Comparison

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
II. WEIGHING SCALE AND BALANCE				
1.	Electronic Weighing Balance ^s d \geq 0.002 mg d \geq 0.01 mg	1 mg to 20 g 1 mg to 200 g	0.03 mg 0.14 mg	Calibration of Class 1 weighing balances and coarser as per OIML R-76-1 E1 Class Standard Weights 1 mg - 200g
	d \geq 0.1 g	50 g to 12 kg	61 mg	Calibration of Class 2 weighing balances and coarser as per OIML R - 76-1 E 1 class Standard weights 1mg - 200 g & E 2 class standard weights 500 g - 10 kg
III. VOLUME				
1.	Glassware Pipette, Burette, Measuring Cylinder, Volumetric Flask ^s	1ml \leq V < 200 ml	60 μ l	Using weighing balance with:0.01 mg/0.02 mg/o.05 mg, distilled water & standard weights Calibration of Glassware based on Gravimetric method as per ISO 4787
2.	Micro pipettes ^s	10 μ l \leq V < 50 μ l 50 μ l < V < 1 ml 1 ml < V < 5 ml	0.5 μ l 10 μ l 50 μ l	Using weighing balance with:0.01mg, distilled water & standard weights Calibration of Micro Pipettes based on Gravimetric method as per ISO 8655

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
IV.	ACCELERATION AND SPEED			
1.	Tachometer (RPM Meter) (Contact) (Non Contact) #	50 rpm to 10000 rpm 30 rpm to 100000 rpm	0.28% to 0.18% 0.5% to 0.05%	Using Digital Tachometer Monarch & RPM generator(AC/DC Motor) By Direct/Comparison Method

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THERMAL CALIBRATION

I.	TEMPERATURE			
1.	Temperature (Fixed Point Calibration) SPRT,RTD ^s	Triple Point of water 0.01 °C	5.82 m °C	Using Fixed Point Cells(Mini), SPRT & AC Thermometry Bridge Using Liquid Nitrogen apparatus by Fixed Point Calibration Method
		Melting Point of Ga 29.4646 °C	5.0 m °C	
		Melting Point of Sn 231.928°C	5.5 m °C	
		Melting Point of Zn 419.527°C	6.32 m °C	
		Melting Point of Al (660.323°C	9.78 m °C	
		Triple Point of Hg (-)38.8344 °C	5.90 m °C	
		Boiling Point of LN ₂ (-) 196 °C	7.04 m °C	

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Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
2.	Liquid-in-glass Thermometer [§]	(-) 80°C to 250°C	0.14°C	Using Oil bath, Cold bath (Methanol), PRT & DTI by Comparison Calibration Method
3.	RTD with or without indicator, Data logger, Scanners [§]	(-) 80°C to 250°C 250°C to 600°C	0.07°C 0.16°C	Using Oil bath, Cold bath (Methanol), PRT & DTI Comparison Calibration Method
4.	Digital Temperature Indicator of chambers, freezers, Bath [§]	(-) 80°C to 250°C 250°C to 600°C	0.05°C 0.10°C	Using PRT / `S' type thermocouple, Dry block furnace. & Black stack. Single point Calibration Method
5.	Thermocouples with or without indicator, Data logger, Scanner [§]	50°C to 600°C 300°C to 1100°C	0.16°C 1.36°C	Using PRT / `S' type thermocouple, Dry block furnace. & Black stack Comparison Calibration Method
6.	RTD, Temperature Indicator with Sensors [*]	(-) 25°C to 600°C	0.2°C	Using PRT with Black Stack, Dry Block Calibrator by Single Position Calibration
7.	Temperature Indicators of Ovens, Baths, Deep Freezers & Chambers etc [*]	(-) 25°C to 600°C 200°C to 1100°C	0.2°C 1.39°C	Using PRT with Black Stack, Dry Block Calibrator by Single Position Calibration

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Convenor

Avijit Das
Program Manager

Laboratory **Electronics Regional Test Laboratory (West), Plot No. F 7 & 8, MIDC Area, Andheri (East) Mumbai, Maharashtra**

Accreditation Standard **ISO/IEC 17025: 2005**

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Validity **02.01.2019 to 01.01.2021** **Last Amended on --**

“In view of the transition for ISO/IEC 17025:2017, the validity of this accreditation certificate will cease on 30.11.2020”

Sl.	Quantity Measured / Instrument	Range/Frequency	*Calibration Measurement Capability (\pm)	Remarks
8.	Temperature Indicator with Sensor of Oven, Deep Freezer & Chamber*	(-) 80 ⁰ C to 200 ⁰ C	0.50 ⁰ C	Using Five , Nine, Fifteen Class A, Pt-100 Sensors, PRT & DTI by Multi Position Calibration
II.	SPECIFIC HEAT AND HUMIDITY			
1.	Specific Heat & Humidity. RH & Temperature Indicators with Inbuilt Or External sensors, Thermohyrometer [§]	20% RH – 95% RH @25 °C (25 °C to 55 °C) @ 50% RH	1.0 % RH 0.2 °C	RH / Temperature Indicator with Sensor & Chamber.
2.	RH and Temperature Indicator of Chambers*	20% RH – 95% RH @25 °C (25 °C to 55 °C) @ 50% RH	1.5% RH 0.3 °C	RH / Temperature Indicator with Sensor & Chamber.

Vishal Shukla
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