

Laboratory Institute for Design of Electrical Measuring Instruments, Swatantryaveer
Tatya Tope Marg, Chunabhatti, Sion, Mumbai, Maharashtra

Accreditation Standard ISO/IEC 17025:2005

Discipline Electro-Technical Calibration **Issue Date** 31.08.2014

Certificate Number C-0085 **Valid Until** 30.08.2016

Last Amended on 23.09.2014 **Page** 1 of 12

Quantity Measured/ Instrument	Range / Frequency	*Calibration Measurement Capability (\pm)	Remarks
<u>SOURCE</u>			
1. DC Voltage [#]	100 mV	4 ppm	Using Fluke 7001 with Ref. Divider 752A by Direct / Comparison Method
	1 V	3 ppm	
	10 V	2 ppm	
2. DC Resistance [#]	40 $\mu\Omega$ (1500A/60 mV)	0.15 %	Using DC Shunts by Direct Method
	60 $\mu\Omega$ (1000A/60 mV)	0.15 %	
	100 $\mu\Omega$ (600A/60 mV)	0.15 %	
	150 $\mu\Omega$ (400A/60 mV)	0.15 %	
	240 $\mu\Omega$ (250A/60 mV)	0.15 %	
	600 $\mu\Omega$ (100A/60 mV)	0.15 %	
	1 m Ω	0.006 %	Using Standard DC Shunts/ Resistors by Direct Method
	8 m Ω	0.01 %	
	10 m Ω	0.004 %	
	16 m Ω	0.01 %	
	100 m Ω	0.004 %	
	1 Ω	5 ppm	Using Reference Standard by Direct Method
	10 k Ω	6 ppm	
	10 Ω	15 ppm	Using Standard Resistor by Direct Method
	100 Ω	15 ppm	
1 M Ω	40 ppm		
10M Ω	16 ppm		
100 M Ω	98 ppm		
100 M Ω to 1G Ω	0.12 % to 0.5 %	Using Decade Megohm box by Direct Method	
1G Ω	0.03 %	Using Standard Resistor by Direct Method	

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	1 G Ω to 10 G Ω	0.5 %	Using Decade Megohm box by Direct Method
	10 G Ω	1.2 %	Using Standard Resistor by Direct Method
	10 G Ω to 1 T Ω	0.5 % to 5 %	Using Decade Megohm box by Direct Method
	1 T Ω 100 T Ω	2 % 3 %	Using Standard Resistor by Direct Method
3. AC Voltage ^{\$}	40 Hz to 70 Hz 10 V to 480 V	10 ppm to 30 ppm	Using Precision Power Calibration System by Direct Method
4. AC Current ^{\$}	40 Hz to 70 Hz 50 mA to 100 A	15 ppm to 30 ppm	Using Precision Power Calibration System by Direct Method
5. Active / Reactive / Apparent power / Energy ^{\$} 1 ϕ / 3 ϕ	40 Hz to 70 Hz 25 V to 480 V AC 0.05 to 100 A AC PF = 0.01 to 1	25 ppm to 60 ppm	Using Precision Power Calibration System by Direct Method
6. Active / Reactive Power / Energy ^{\$} 1 ϕ / 3 ϕ	50 Hz 1 V to 25 V AC & 480 V to 700 V AC 1 mA to 50 mA AC 100 A to 200 A AC PF = 0.01 to 1	0.1 % to 0.6 %	Using Rotek Power / Energy Calibrator by Direct Method

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7. Power Factor/Phase Angle ^s	0 to UNITY PF (0 to 360°) 10V to 480 V, 0.05A to 100 A	0.0012°	Using Precision Power Calibration System by Direct Method
8. Frequency [#]	40 mHz to 10 MHz	6.0 X 10 ⁻⁷ to 1X 10 ⁻¹⁰	Using Rubidium Standard GPS Controlled by Direct Method
	5 MHz to 4GHz	1 X 10 ⁻¹⁰	Using RF Reference Source (Clock Locked with GPS) by Direct Method
9. Time Interval [#]	1 ms to 2000 ms	0.02 %	Using Meter Calibration System-9000 by Direct Method
10. AC Resistance [#]	50 Hz & 1 kHz 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω	700 ppm 250 ppm 170 ppm 110 ppm 110 ppm	Using Standard Resistors Discrete Values by Direct Method
11. Inductance [#]	1kHz 100 μ H 1 mH 10 mH 100 mH 1 H 10 H	0.3 % 0.2 % 0.2 % 0.2 % 0.1 % 0.3 %	Using Standard Inductors Discrete Values by Direct Method

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12. Capacitance [#]	1kHz		Using Standard Capacitors Discrete Values by Direct Method	
	1pF	0.022 %		
	10 pF	0.014 %		
	100 pF	0.009 %		
	0.001 μ F	0.015 %		
	0.01 μ F	0.015 %		
	0.1 μ F	0.015 %		
	1 μ F	0.018 %		
	10 μ F	0.07 %		
	100 μ F	0.08 %		
	1000 μ F	0.1 %		
	1 mF to 11 mF	0.7 %		Using Multifunction Calibrator by Direct Method
	11 mF to 33 mF	0.7 % to 1.0 %		
	33 mF to 110 mF	1.0 % to 1.5%		
	100 Hz		Using Standard Capacitors Discrete Values by Direct Method	
	10 μ F	0.3 %		
	100 μ F	0.3 %		
	1000 μ F	0.3 %		
13. DC Power / Energy [#]	33 mV to 1000 V 3.3 mA to 20.5 A	0.15 %	Using Fluke Calibrator 5520A with Timer by Direct Method	
14 Tan Delta [#]	0.02 % to 18 %	1.5 %	Using Tan Delta Calibrator by Direct Method	
15 Oscilloscope [#]				
a. Bandwidth	50 kHz to 1.1 GHz 5 mV to 30 mV	6.30 %	Using Multifunction Calibrator 5520A by Direct Method	

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Amplitude (Deflection Factor)	10 mV to 130V (1M Ω)	0.5 % to 0.2 %	
	10 mV to 6.6 V (50 Ω)	0.5 % to 0.2 %	
b. Time Base (Marker)	1 ns to 5 s	20 ppm	
16 Power Quality# Harmonics	1 to 50	0.4 %	Using Multifunction Calibrator 5520A by Direct Method
17. Transformer Turns Ratio (TTR) #	0.8 to 2000	0.05 %	Using TTR Calibrator by Direct Method
18. RF Power# (With 50 Ω Level head)	10 Hz to 128 MHz +20dBm to + 24 dBm 100 mW to 251 mW	4.6 %	Using RF Calibrator Model -9640A by Direct Method
	10 Hz to 1.4 GHz -48 dBm to +20 dBm 15.85 nW to 100 mW	6.0 %	
	1.4 GHz to 4GHz -48 dBm to +14 dBm 15.85 nW to 25.12mW	15 %	
	100 kHz to 4 GHz -94 dBm to - 48dBm 0.398 pW to 15.85 nW	30 %	
	10 MHz to 3 GHz -130 dBm to - 94 dBm 0.1fW to 0.398pW	50 %	

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RF Power[#] (With 75 Ω Level head)	10 Hz to 125MHz +18dBm to -54 dBm 63.10 mW to 3.98 mW	5.2 %	Using RF Calibrator Model -9640A by Direct Method
	125 MHz to 4 GHz +14 dBm to -54 dBm 25.12 mW to 3.98 mW	16 %	
	100 kHz to 4GHz -90 dBm to -54 dBm 1 pW to 3.98mW	23 %	
	100 kHz to 3 GHz -100 dBm to - 90dBm 100 fW to 1 pW	30 %	
	10 MHz to 3 GHz -120 dBm to - 100 dBm 1fW to 100 fW	50 %	
19. RF Attenuation[#]	1 dB to 116 dB	0.03 dB to 0.2 dB	Using RF Calibrator Model -9640A by Direct Method
20. Amplitude Modulation[#]	Carrier Frequency 50 kHz to 4 GHz Modulation Depth 0.1% to 99 % Modulation Rate 1 Hz to 220 kHz	4.2 %	Using RF Calibrator Model -9640A by Direct Method
21. Frequency Modulation[#]	Carrier Frequency 9 kHz to 4 GHz Modulation Rate 1Hz to 300 kHz Deviation \leq 750 kHz	4 %	Using RF Calibrator Model -9640A by Direct Method

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<u>MEASURE</u>			
22. DC Voltage[#]	10 μ V to 100 μ V 100 μ V to 1mV 1mV to 10 mV 10 mV to 1050 V	0.7% to 0.07% 0.07% to 70 ppm 70 ppm to 10 ppm 10 ppm to 4 ppm	Using DC Voltage 7001, DMM8508A, Ref. Divider 752A by Direct / Comparison Method
DC High Voltage[#] (At lab up to 100kV At Site up to 200kV)	1kV to 10 kV 10 kV to 20 kV 20 kV to 40 kV 40 kV to 200 kV	4.5 % to 0.59 % 0.59 % to 1.21 % 1.21 % to 0.83 % 0.83 % to 1.01 %	Using HV Source with HV Divider and kV Meter KVM – 200B by Direct / Comparison Method
23. DC Current^{\$}	1 pA to 10 μ A	2 % to 150 ppm	Using Keithely Electrometer with Std. Resistor / DMM with Std.
DC Current⁺	10 μ A to 1 A 1 A to 20 A 20 A to 100 A 100 A to 1500 A	150ppm to 20 ppm 20 ppm to 50 ppm 50 ppm to 130 ppm 130 ppm to 0.15 %	Resistor /Shunt by Direct / Comparison Method
24. DC Resistance^{\$}	1 $\mu\Omega$ to 1 m Ω 1 m Ω to 100 M Ω 100 M Ω to 100 G Ω 100 G Ω to 1 T Ω 1 T Ω to 100 T Ω 100 T Ω to 10 P Ω	0.05 % to 5 ppm 5 ppm to 12 ppm 12 ppm to 200 ppm 200 ppm to 0.1 % 0.1 % to 1.5 % 1.5 % to 6 %	Using DCC Bridge 6242 B & Automated Dual Source high resistance ratio bridge 6600A by Direct/ Comparison Method
25. AC Voltage[#]	10 Hz to 20 kHz 1 mV 10 Hz to 1 kHz 2 mV to 2 V 2 V to 200 V 200 V to 1000 V	500 ppm 450 ppm to 25 ppm 25 ppm to 50 ppm 50 ppm to 25 ppm	Using AC /DC Transfer Standard, Multifunction Calibrator, Reference Multimeter by Direct / Comparison Method

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	1 kHz to 1 MHz 2 mV to 20 V	800 ppm to 25 ppm	
	1 kHz to 300 kHz 20 V to 60 V	25ppm to 50 ppm	
	1 kHz to 100 kHz 60 V to 1000 V	25 ppm to 60 ppm	
AC High Voltage[#] (At lab up to 100kV At Site up to 200kV)	50 Hz 1kV to 40 kV 40 kV to 200 kV	4.13 % to 0.4 % 0.4 % to 1.29 %	Using HV Source with HV Divider and kV Meter KVM – 200B by Direct / Comparison Method
26. AC Current[#]	10 Hz to 10 kHz 10 μ A to 2 A	0.03 % to 0.015 %	Using Standard Shunt with AC measurement standard 5790A /Reference Multimeter 8508A by Direct / Comparison Method
	10 Hz to 5 kHz 2A to 20 A	0.03 % to 0.015%	
	50Hz & 1 kHz 20A to 140 A	0.02 %	Using Std. Resistor with AC Measurement Standard by Direct / Comparison Method
	50 Hz 140A to 3500 A	0.06 %	Using Power / Energy Reference MT 3000 with Std. CT by Direct / Comparison Method

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27. Frequency #	40 mHz to 10 Hz 10 Hz to 3.4 GHz	0.012 % to 1 ppm 1 ppm	Using MF Calibrator-MC-2/ Frequency Counter-1120 by Direct Method
Period	25 s to 294 ps	0.012 % to 0.0015 %	Using Frequency Counter1120, MC 2 Calibrator by Direct Method
28. Current Transformer#			
Ratio Error Phase Angle Error	5A to 10000A AC 50Hz	0.06% 2.1 min	Using Eltel CT/PT Test System by Direct / Comparison Method
29. Potential Transformer#			
Ratio Error Phase Angle Error	1.1kV to 33 kV AC 50Hz	0.06% 2.4 min	Using Eltel CT/PT Test System by Direct / Comparison Method
30. Time Interval#	1 msec to 24 hrs & above	0.02 %	Using Time Interval Meter / Frequency Counter by Direct /Comparison Method
31. Active / Reactive / Apparent Power / Energy# (Three Phase /Single Phase)	40 Hz to 70 Hz 30 V to 480 V 1 mA to 120 A PF = 0.01 to 1	400ppm to 130ppm/PF	Using Power / Energy Comparator COM -3003 by Direct /Comparison Method

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	40 Hz to 70Hz 40 V to 480 V 120 A to 300 A PF = 0.01 to 1	0.03% to 0.25% / PF	Using Power / Energy Test System , MT 3000 by Direct /Comparison Method
32. Power Factor Phase Angle[#]	50 Hz 0 to UNITY PF (0 to 360°) 30V to 320 V, 1 mA to 120 A	0.008°	Using Power / Energy Comparator COM -3003 by Direct /Comparison Method
33. Capacitance[#]	1 kHz 10 pF to 1 nF 1 nF to 100 uF 100 uF to 100 mF	0.6 % 0.6 % to 0.06 % 0.06% to 0.6 %	Using RLC DigiBridge, 1689 by Direct /Comparison Method
	100 Hz 1 uF to 1 mF 1 mF to 10 mF	0.12 % to 0.3 % 0.3 % to 1.4 %	
34. Inductance[#]	1 kHz 100 μ H to 100 mH 100 mH to 10 H	0.26% to 0.04 % 0.04% to 0.06 %	Using RLC DigiBridge, 1689 by Direct /Comparison Method
35. AC Resistance[#]	1 kHz 100 m Ω to 1 Ω 1 Ω to 10 k Ω 10 k Ω to 10 M Ω 50 Hz 0.1 Ω to 1 M Ω	0.83% to 0.1 % 0.1% to 0.05 % 0.05% to 0.3 % 0.3 to 0.6 %	Using RLC DigiBridge, 1689 by Direct /Comparison Method

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36. DC Power / Energy [#]	10 V to 600 V 1 A to 30 A	0.2%	Using Digital Power Meter, WT 2030 , Timer by Direct Method
37. Temperature Simulation (Indicator/Controller/Recorder)			
a. Thermocouple Type			
K Type	-200 °C to 1370°C	0.036°C to 0.021 °C	Using Reference Multimeter 8508A, 3458 A,34420A Fluke 5720A by Simulation Method / Comparison Method
J Type	-200 °C to 1200°C	0.025°C to 0.015 °C	
N Type	-200 °C to 1300°C	0.055°C to 0.02 °C	
E Type	-270 °C to 1000 °C	0.26°C to 0.01 °C	
T Type	-250 °C to 400 °C	0.093°C to 0.01°C	
R Type	-50 °C to 1768°C	0.19°C to 0.05 °C	
S Type	-50 °C to 1768°C	0.15°C to 0.015 °C	
B Type	600 °C to 1800°C	0.095°C to 0.05°C	
C Type	0 °C to 2300°C	0.04°C to 0.07°C	
L Type	-200 °C to 900 °C	0.02°C to 0.015°C	
U Type	-200 °C to 600 °C	0.03°C to 0.01°C	
b. RTD	-200 °C to 850 °C	0.001°C to 0.02°C	
38. Harmonics Order #	1 to 40 Fundamental frequency 45 Hz to 65Hz	0.5%	Using Power / Energy Standard, MT 3000 by Direct Method
39. Impulse #	1kV to 15kV 10 ns to 100µs.	6.3% 0.1%	Using Digital Oscilloscope DSO 90254 with H V Probe by Direct Method
40. CT / PT Burden [#]	1 VA to 100 VA	0.3 %	Using Power / Energy Standard, MT 3000 by Direct Method

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41. Transformer Turns Ratio Meter Calibrator [#]	0.8 to 2100	0.025 %	Using AC Measurement Standard 5790A with MFC 5720A by Direct Method
42. Ratio and Phase Angle of CT/ PT Comparator [#] (AITTS)	50 Hz 0.05 A to 6A 25 V to 150 V	0.075 % 2.5 min	Using Power / Energy Standard, MT 3000 by Comparison Method
43. DC Resistance [*]	0.1 Ω to 2 Ω 2 Ω to 200k Ω 200 k Ω to 20G Ω	0.02 % to 0.002% 0.002% to 0.005% 0.005% to 0.3%	Using 8 ¹ / ₂ Digit Reference Multimeter, Model 8508A by Direct Method by using Reference Multimeter

* Measurement Capability is expressed as an uncertainty (\pm) at a confidence probability of 95%

^{\$}Only in Permanent Laboratory

^{*}Only for Site Calibration

[#]The laboratory is also capable for site calibration however, the uncertainty at site depends on the prevailing actual environmental conditions and master equipment used.