

Schedule of Accreditation



Organisation Name	Butler Calibration Limited
Trading As	Butler Calibration Limited
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Accreditation Standard	EN ISO/IEC 17025 C
Standard Version	2017
Date of award of accreditation	12/03/2010
Scope Classification	Metrology
Services available to the public ¹	No

¹ Refer to document on interpreting INAB Scopes of Accreditation

Sites from which accredited services are delivered		
(the detail of the accredited services delivered at each site are on the Scope of Accreditation)		
	Name	Address
1	Head Office	G14 Maynooth Business Campus, Maynooth, Kildare

Scope of Accreditation

Head Office

Metrology

Category: A

Metrology field - Calibrated Device Type	Measured quantity	Calibration range	Expanded Measurement Uncertainty	Std. ref/SOP	Products	Remarks
106 Pressure - .01 Aneroid barometers	Pressure	50 kPa to 110 kPa	23 Pa	CTM-6005		
106 Pressure - .02 Barographs			23 Pa	CTM-6005		
106 Pressure - .04 Gauge barometers			23 Pa	CTM-6006		
106 Pressure - .06 Pressure gauges		3.5 kPa to 10 kPa 10 kPa to 20 kPa 20 kPa to 2.5 MPa 2.5 MPa to 12 MPa	0.0088% + 0.9 Pa 0.0068% 0.0048% 0.008%	CTM-6003, CTM-6019		Generation by Deadweight Tester (Gauge Pressure)
		5 kPa to 200 kPa	0.01% + 23 Pa	CTM-6007		Generation by Deadweight Tester (Absolute Pressure)
		0 to 2000 Pa 2 kPa to 200 kPa 200 kPa to 2 MPa	0.15% + 0.1 Pa 0.01% + 50 Pa 0.01% + 500 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators

106 Pressure - .07 Vacuum gauges	-3.5 kPa to -90 kPa 0 to -2000 Pa -2 kPa to -100 kPa	0.0098%+0.9 Pa 0.15% + 0.1 Pa 0.01% + 50 Pa	CTM-6004 CTM-6012, CTM-6015, CTM-6016		Generation by Deadweight Tester Generation by Pressure Calibrators
106 Pressure - .10 Pressure recorders	3.5 kPa to 10 kPa 10 kPa to 20 kPa 20 kPa to 2.5 MPa 2.5 MPa to 12 MPa 5 kPa to 200 kPa 0 to 2000 Pa 2 kPa to 200 kPa 100 kPa to 2 MPa -3.5 kPa to -90 kPa 0 to -2000 Pa -2 kPa to -100 kPa	0.0088% + 0.9 Pa 0.0068% 0.0048% 0.008% 0.01% + 23 Pa 0.15% + 0.1 Pa 0.01% + 50 Pa 0.01% + 500 Pa 0.0098%+0.9 Pa 0.15% + 0.1 Pa 0.01% + 50 Pa	CTM-6003, CTM-6019 CTM-6007 CTM-6012, CTM-6015, CTM-6016 CTM-6004 CTM-6012, CTM-6015, CTM-6016		Generation by Deadweight Tester (Gauge Pressure) Generation by Deadweight Tester (Absolute Pressure) Generation by Pressure Calibrators Generation by Deadweight Tester Generation by Pressure Calibrators
106 Pressure - .13 Digital manometers		0.0088% + 0.9 Pa 0.0068% 0.0048% 0.008% 0.01% + 23 Pa 0.15% + 0.1 Pa 0.01% + 50 Pa 0.01% + 500 Pa 0.0098%+0.9 Pa	CTM-6003, CTM-6019 CTM-6007 CTM-6012, CTM-6015, CTM-6016		Generation by Deadweight Tester (Gauge Pressure) Generation by Deadweight Tester (Absolute Pressure) Generation by Pressure Calibrators Generation by Deadweight Tester

			0.15% + 0.1 Pa 0.01% + 50 Pa	CTM-6004 CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
106 Pressure - .99 Other			0.0088% + 0.9 Pa 0.0068% 0.0048% 0.008% 0.01% + 23 Pa	CTM-6003, CTM-6019 CTM-6007		Generation by Deadweight Tester (Gauge Pressure) Generation by Deadweight Tester (Absolute Pressure)
			0.15% + 0.1 Pa 0.01% + 50 Pa 0.01% + 500 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
			0.0098%+0.9 Pa	CTM-6004		Generation by Deadweight Tester
			0.15% + 0.1 Pa 0.01% + 50 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
107 Temperature measuring equipment - .02 Base metal thermocouples	Temperature	-95 °C to 600 °C	0.3 °C to 1.3 °C	CTM-3027, CTM-3020, CTM-3023		Measurement of thermocouple output at specified temperatures and immersion depths (for thermocouple types E, J, K, N, T)
107 Temperature measuring equipment - .03 Metallic resistance thermometers		-95 °C to 600 °C Water Triple Point (0.01 °C) Gallium Melt Point (29.7646 °C)	0.051 °C to 0.1 °C 0.005 °C 0.005 °C	CTM-3027, CTM-3020, CTM-3023 CTM-3025 CTM-3026		Measurement of RTD output at specified temperatures and immersion depths

107 Temperature measuring equipment - .04 Semiconductor thermometers		-95 to -40 °C -40 to -20 °C -20 to +150 °C +150 to +200 °C +200 to +300 °C +300 to +400 °C +400 to +500 °C +500 to +600 °C	0.1 °C 0.066 °C 0.019 °C 0.05 °C 0.1 °C 0.1 °C 0.1 °C 0.1 °C	CTM-3027, CTM-3020, CTM-3023		
107 Temperature measuring equipment - .09 Digital temperature indicator systems		-95 °C to -40 °C -40 to -20 °C -20 to +150 °C +150 to +200 °C +200 to +300 °C +300 to +400 °C +400 to +500 °C +500 to +600 °C	0.1 °C 0.066 °C 0.019 °C 0.05 °C 0.1 °C 0.1 °C 0.1 °C 0.1 °C	CTM-3027, CTM-3020, CTM-3023		
107 Temperature measuring equipment - .11 Electronic	Temperature/Electrical	-200 °C to +1750 °C	0.06 °C to 0.59 °C	CTM-3010, CTM-110		Calibration of indicators using emf injection (for thermocouple types E, J, K, N, R, T). Calibration of indicators using resistance
108 Temperature controlled enclosures - .01 Ovens, furnaces, baths	Temperature	-95 °C to 600 °C	0.042 °C to 0.65 °C	CTM-3004, CTM-3039		
108 Temperature controlled enclosures - .02 Incubators		0 °C to 70 °C	0.1 °C	CTM-3005		
108 Temperature controlled enclosures - .03 Autoclaves and sterilising ovens		100 °C to 140 °C	0.5 °C	CTM-3004		
108 Temperature controlled enclosures - .04 Industrial freezers		-95 °C to 10 °C	0.05 °C	CTM-3040		
109 Ancillary temperature measuring instruments -		-200 °C to 1750 °C	0.06 °C to 0.59 °C	CTM-3027		

.01 Portable potentiometers						
109 Ancillary temperature measuring instruments - .02 Digital voltmeters			0.06 °C to 0.59 °C	CTM-3027		
109 Ancillary temperature measuring instruments - .03 Resistance bridges			0.06 °C to 0.59 °C	CTM-3027		
109 Ancillary temperature measuring instruments - .04 Indicators, recorders and controllers			0.06 °C to 0.59 °C	CTM-3027		
		-200 °C to 600 °C	0.06 °C to 0.12 °C	CTM-3027		
110 Electrical - .01 Indicating and recording instruments	AC Current 0 to 200 µA 200 µA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 1 kHz 40 Hz to 400 Hz	28 nA to 80 nA 280 nA to 800 nA 2.8 µA to 8 µA 28 µA to 88 µA 0.6 mA to 2 mA 7 mA to 350 mA	Measure & Generate CTM-105,107,108 Generate to 50A		
	AC Voltage 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 20 V to 200 V 20 V to 200 V 20 V to 200 V 20 V to 200 V	. 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz	. 4.8 µV to 28 µV 7µV to 30 µV 80 µV to 160 µV 40 µV to 200 µV 46 µV to 280 µV 38 µV to 180 µV 42 µV to 220 µV 92 µV to 520 µV 360 µV to 1.5 mV 350 µV to 2.6 mV 0.4 mV to 2.2 mV 0.42 mV to 2.4 mV 0.94 mV to 5.2 mV 3.4 mV to 14 mV 3.5 mV to 26 mV 4 mV to 24 mV 4.4 mV to 26 mV 4.9 mV to 54 mV 34 mV to 150 mV	Measure & Generate CTM-101,103, 115,116 . . . Generate to 300 kHz - . . . Generate to 300 kHz . . . Generate to 300 kHz . . .		

200 V to 1000 V 200 V to 1000 V 200 V to 1000 V 200 V to 700 V 1 kV to 6 kV	100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 50 Hz	34 mV to 130 mV 34 mV to 130 mV 72 mV to 270 mV 270 mV to 820 mV 4 V to 24 V	.		
Amplitude Modulation 5% to 95%	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency)	0.4%	CTM-1021, CTM- 1022, CTM-1025		For low distortion modulation waveforms
DC Current	0 to 200 μ A 200 μ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	1.3 nA to 10 nA 11 nA to 75 nA 110 nA to 750 nA 2.4 μ A to 13 μ A 58 μ A to 480 μ A 1 mA to 50 mA	Measure & Generate CTM-105,107,108		
DC Voltage	0 to 200 mV 0.2 V to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V 1 kV to 6 kV	3.5 μ V 3.5 μ V to 15 μ V 15 μ V to 120 μ V 150 μ V to 190 μ V 2.2 mV to 9.7 mV 2.5 V to 15 V	CTM- 101,103,115,116		Measure & Generate
Frequency Modulation 250 Hz to 250 kHz	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency).	0.3 Hz to 300 Hz	CTM-1030, CTM- 1031, CTM-1032		For low distortion modulation waveforms
Frequency	0.03 Hz to 3 kHz 3 kHz to 30 kHz 30 kHz to 300 kHz 300 kHz to 30 MHz 30 MHz to 1.3 GHz 1.3 MHz to 18 GHz	0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		

Horizontal Deflection	1 s to 1 ns	3 ms to 30 ps	CTM-206, CTM-207		
LF Distortion 0 to -40 dB -40 to -60 dB -60 to -80 dB -80 to -90 dB	100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz	0.7 dB 0.8 dB 2.4 dB 5 dB	CTM-154		By rss addition of harmonics
Loop Resistance (@ 50 Hz)	0 to 1.0 Ω 1.0 to 5.0 Ω 5.0 to 10.0 Ω 10.0 to 100.0 Ω 100 to 1000 Ω	0.015 Ω 0.015 to 0.034 Ω 0.034 to 0.063 Ω 0.063 to 0.590 Ω 0.59 to 5.80 Ω	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Oscilloscopes Risetime/Bandwidth	0 to 250 MHz 250 to 350 MHz 350 to 450 MHz 450 to 550 MHz 550 to 650 MHz 650 to 750 MHz 750 MHz to 1 GHz	0.63 MHz to 1.6MHz 1.6 MHz to 2.2 MHz 2.2 MHz to 3 MHz 3 MHz to 3.7 MHz 3.7 MHz to 5 MHz 5 MHz to 6.5 MHz 6.5 MHz to 100 MHz	CTM-217, CTM-218		Measurement in 50 Ohm system Oscilloscope bandwidth calculated using $0.35 = tr.bw$ assuming the oscilloscope input to be Gaussian
Peak to Peak Voltage 0.1 V to 10 V	1 kHz to 5 MHz	300 uV to 30 mV	CTM-167		
Phase	0 to 360° (40 Hz to 100 kHz)	0.95°	CTM-161		For waveforms > 200 mV
RCD Trip Current (@ 50 Hz)	0 to 10 mA 10 mA to 30 mA 30 mA to 90 mA 90 mA to 100 mA 100 mA to 110 mA 110 mA to 300 mA 300 mA to 1000 mA 1000 mA to 2000 mA	0.2 mA 0.2 to 0.5 mA 0.5 to 1.3 mA 1.3 to 1.5 mA 1.5 to 1.6 mA 1.6 to 4.9 mA 4.9 to 15 mA 15 to 29 mA	Method per calibrator manual		Measured using dedicated electrical test equipment calibrator
RCD Trip Time (@ 50 Hz)	20 ms to 1000 ms	1.2 ms	Method per calibrator manual		Generated using dedicated electrical test

					equipment calibrator
Resistance	0 to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 k Ω 2 k Ω to 20 k Ω 20 k Ω to 200 k Ω 200 k Ω to 2 M Ω 2 M Ω to 20 M Ω 20 M Ω to 200 M Ω 200 M Ω to 1 G Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω	20 $\mu\Omega$ to 56 $\mu\Omega$ 54 $\mu\Omega$ to 340 $\mu\Omega$ 300 $\mu\Omega$ to 2.2 m Ω 2.6 m Ω to 18 m Ω 25 m Ω to 180 m Ω 250 m Ω to 1.8 Ω 4.7 Ω to 32 Ω 1 k Ω to 17 k Ω 120 k Ω to 180 k Ω 12 M Ω to 14 M Ω 20 M Ω 200 M Ω 2.5 G Ω 30 G Ω	Measure and Generate CTM-111, CTM-112, CTM-112H		
RF Attenuation 0 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB 1 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB	1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz	0.32 dB 0.45 dB 0.9 dB 1.4 dB 2.6 dB 0.42 dB 0.48 dB 1.3 dB 1.9 dB 2.7 dB	CTM-1006, CTM- 1007, CTM-1008		50 Ohm system Instrument input and output attenuators
RF Power Level 0 dBm to -30 dBm -30 dBm to -40dBm -40 dBm to -50 dBm -50 dBm to -60 dBm -60 dBm to -70 dBm -70 dBm to -80 dBm -80 dBm to -90 dBm -90 dBm to -100 dBm -100 dBm to -110 dBm -110 dBm to -127 dBm	2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz	0.11 dB 0.12 dB 0.15 dB 0.16 dB 0.18 dB 0.20 dB 0.24 dB 0.26 dB 0.28 dB 0.34 dB	CTM- 1004,1005,1007,1008		50 Ohm system Type N connectors Other connectors will increase uncertainty Appropriate to the calibration of sources and receivers

RF Power 0 dBm / 1 mW	At 50 MHz	1.0% or 0.043 dB	CTM-1010,1011,1012		Measure Into 50 Ohms Type 'N' (f) connectors Other connectors will increase uncertainty
-70 dBm to -60 dBm	10 MHz to 4 GHz	0.68 dB to 0.58 dB			
-60 dBm to -50 dBm	10 MHz to 4 GHz	0.50 dB to 0.17 dB			
-50 dBm to -40 dBm	10 MHz to 4 GHz	0.23 dB to 0.13 dB			
-40 dBm to -20 dBm	10 MHz to 4 GHz	0.16 dB to 0.13 dB			
-20 dBm to +10 dBm	10 MHz to 30 MHz	3.4% or 0.15 dB			
-20 dBm to +10 dBm	30 MHz to 1 GHz	2.6% or 0.11 dB			
-20 dBm to +10 dBm	30 MHz to 3 GHz	3% or 0.13 dB			
-30 dBm to +10 dBm	200 kHz to 500 kHz	3.5% or 0.15 dB			
-30 dBm to +10 dBm	500 kHz to 50 MHz	3.3% or 0.14 dB			
-30 dBm to +10 dBm	50 MHz to 3 GHz	3.3% or 0.14 dB			
10 dBm to + 50 dBm	10 MHz to 1 GHz	4% or 0.17 dB			
10 dBm to +40 dBm	10 MHz to 2G Hz	4% or 0.17 dB			
10 dBm to +49.5 dBm	10 MHz to 100 MHz	4% or 0.17 dB			
10 dBm to +47 dBm	101 MHz to 400 MHz	4% or 0.17 dB			
RF Voltage 1V ±10%	1 kHz to 50 kHz	1.2 mV	Measurement in 50 Ohm system		
	50 kHz to 500 kHz	1.3 mV			
	500 kHz to 5 MHz	1.5 mV	CTM-166		
	5 MHz to 20 MHz	2.8 mV			
Risetime	Greater than 25 ps	6% + 10 ps	CTM-211, CTM-214		Measurement in 50 Ohm system
	130 ps	13 ps	CTM-1064		Repetitive waveform generation in a 50 Ohm system
Time	1 µs up	33 ns	CTM-163		
Vertical Deflection	100 µV to 100 V	5.4 µV to 400 mV	CTM-202, CTM-203		
VRC					Type 'N' (f) Other connectors will increase uncertainty
0.7 to 0.18	300 kHz to 1 GHz	0.016	CTM-1053, CTM-1054		
0.18 to 0.0	300 kHz to 1 GHz	0.012			
0.7 to 0.18	1 GHz to 3 GHz	0.018			
0.18 to 0.0	1 GHz to 3 GHz	0.014			

110 Electrical - .02 Inductors and transformers	AC Current			Measure & Generate CTM-105,107,108		
	0 to 200 μ A	10 Hz to 5 kHz	28 nA to 80 nA	Generate to 50A		
	200 μ A to 2 mA	10 Hz to 5 kHz	280 nA to 800 nA			
	2 mA to 20 mA	10 Hz to 5 kHz	2.8 μ A to 8 μ A			
20 mA to 200 mA	10 Hz to 5 kHz	28 μ A to 88 μ A				
200 mA to 2 A	10 Hz to 1 kHz	0.6 mA to 2 mA				
2 A to 100 A	40 Hz to 400 Hz	7 mA to 350 mA				
	AC Voltage			Measure & Generate CTM-101,103, 115,116		
0 to 200 mV	100 Hz to 2 kHz	4.8 μ V to 28 μ V	Generate to 300 kHz			
0 to 200 mV	40 Hz to 10 kHz	7 μ V to 30 μ V				
0 to 200 mV	10 kHz to 30 kHz	80 μ V to 160 μ V				
0 to 200 mV	30 kHz to 100 kHz	40 μ V to 200 μ V				
0 to 200 mV	100 kHz to 300 kHz	46 μ V to 280 μ V				
200 mV to 2 V	100 Hz to 2 kHz	38 μ V to 180 μ V				
200 mV to 2 V	40 Hz to 10 kHz	42 μ V to 220 μ V				
200 mV to 2 V	10 kHz to 30 kHz	92 μ V to 520 μ V				
200 mV to 2 V	30 kHz to 100 kHz	360 μ V to 1.5 mV				
200 mV to 2 V	100 kHz to 300 kHz	350 μ V to 2.6 mV				
2 V to 20 V	100 Hz to 2 kHz	0.4 mV to 2.2 mV	Generate to 300 kHz			
2 V to 20 V	40 Hz to 10 kHz	0.42 mV to 2.4 mV				
2 V to 20 V	10 kHz to 30 kHz	0.94 mV to 5.2 mV				
2 V to 20 V	30 kHz to 100 kHz	3.4 mV to 14 mV				
2 V to 20 V	100 kHz to 300 kHz	3.5 mV to 26 mV				
20 V to 200 V	100 Hz to 2 kHz	4 mV to 24 mV				
20 V to 200 V	40 Hz to 10 kHz	4.4 mV to 26 mV	Generate to 300 kHz			
20 V to 200 V	10 kHz to 30 kHz	4.9 mV to 54 mV				
20 V to 200 V	30 kHz to 100 kHz	34 mV to 150 mV				
200 V to 1000 V	100 Hz to 2 kHz	34 mV to 130 mV				
200 V to 1000 V	40 Hz to 10 kHz	34 mV to 130 mV				
200 V to 1000 V	10 kHz to 30 kHz	72 mV to 270 mV				
200 V to 700 V	30 kHz to 100 kHz	270 mV to 820 mV				
1 kV to 6 kV	50 Hz	4 V to 24 V				
Phase	0 to 360° (40 Hz to 100 kHz)	0.95°	CTM-161			For waveforms > 200 mV
Resistance	0 to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 k Ω 2 k Ω to 20 k Ω 20 k Ω to 200 k Ω	20 $\mu\Omega$ to 56 $\mu\Omega$ 54 $\mu\Omega$ to 340 $\mu\Omega$ 300 $\mu\Omega$ to 2.2 m Ω 2.6 m Ω to 18 m Ω 25 m Ω to 180 m Ω 250 m Ω to 1.8 Ω	Measure and Generate CTM-111, CTM-112, CTM-112H			

		200 kΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 200 MΩ to 1 GΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ			
110 Electrical - .04 Resistors			20 μΩ to 56 μΩ 54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ 25 mΩ to 180 mΩ 250 mΩ to 1.8 Ω 4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ	Measure and Generate CTM-111, CTM-112, CTM-112H		
110 Electrical - .05 Conductors	Resistance		20 μΩ to 56 μΩ 54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ 25 mΩ to 180 mΩ 250 mΩ to 1.8 Ω 4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ	Measure and Generate CTM-111, CTM-112, CTM-112H		
110 Electrical - .06 Potentiometers		0 to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ	20 μΩ to 56 μΩ 54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ	Measure and Generate CTM-111, CTM-112,		

		2 k Ω to 20 k Ω 20 k Ω to 200 k Ω 200 k Ω to 2M Ω 2 M Ω to 20 M Ω 20 M Ω to 200 M Ω 200 M Ω to 1 G Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω	25 m Ω to 180 m Ω 250 m Ω to 1.8 Ω 4.7 Ω to 32 Ω 1 k Ω to 17 k Ω 120 k Ω to 180 k Ω 12 M Ω to 14 M Ω 20 M Ω 200 M Ω 2.5 G Ω 30 G Ω	CTM-112H		
110 Electrical - .07 Transducers	AC Current 0 to 200 μ A 200 μ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 1 kHz 40 Hz to 400 Hz	28 nA to 80 nA 280 nA to 800 nA 2.8 μ A to 8 μ A 28 μ A to 88 μ A 0.6 mA to 2 mA 7 mA to 350 mA	Measure & Generate CTM-105,107,108 Generate to 50A		
	AC Voltage 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 20 V to 200 V 20 V to 200 V 20 V to 200 V 20 V to 200 V 200 V to 1000 V 200 V to 1000 V 200 V to 1000 V 200 V to 700 V	. 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz	. 4.8 μ V to 28 μ V 7 μ V to 30 μ V 80 μ V to 160 μ V 40 μ V to 200 μ V 46 μ V to 280 μ V 38 μ V to 180 μ V 42 μ V to 220 μ V 92 μ V to 520 μ V 360 μ V to 1.5 mV 350 μ V to 2.6 mV 0.4 mV to 2.2 mV 0.42 mV to 2.4 mV 0.94 mV to 5.2 mV 3.4 mV to 14 mV 3.5 mV to 26 mV 4 mV to 24 mV 4.4 mV to 26 mV 4.9 mV to 54 mV 34 mV to 150 mV 34 mV to 130 mV 34 mV to 130 mV 72 mV to 270 mV 270 mV to 820 mV	Measure & Generate CTM-101,103, 115,116 Generate to 300 kHz - Generate to 300 kHz Generate to 300 kHz		

1 kV to 6 kV	50 Hz	4 V to 24 V	.		
Amplitude Modulation 5% to 95%	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency)	0.4%	CTM-1021, CTM- 1022, CTM-1025		For low distortion modulation waveforms
DC Current	0 to 200 μ A 200 μ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	1.3 nA to 10 nA 11 nA to 75 nA 110 nA to 750 nA 2.4 μ A to 13 μ A 58 μ A to 480 μ A 1 mA to 50 mA	Measure & Generate CTM-105,107,108		
DC Voltage	0 to 200 mV 0.2 V to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V 1 kV to 6 kV	3.5 μ V 3.5 μ V to 15 μ V 15 μ V to 120 μ V 150 μ V to 190 μ V 2.2 mV to 9.7 mV 2.5 V to 15 V	CTM- 101,103,115,116		
Frequency Modulation 250 Hz to 250 kHz	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency).	0.3 Hz to 300 Hz	CTM-1030, CTM- 1031, CTM-1032		For low distortion modulation waveforms
Frequency	0.03 Hz to 3 kHz 3 kHz to 30 kHz 30 kHz to 300 kHz 300 kHz to 30 MHz 30 MHz to 1.3 GHz 1.3 MHz to 18 GHz	0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
Horizontal Deflection	1 s to 1 ns	3 ms to 30 ps	CTM-206, CTM-207		
LF Distortion 0 to -40 dB	100 Hz to 100 kHz	0.7 dB	CTM-154		By rss addition of harmonics

-40 to -60 dB -60 to -80 dB -80 to -90 dB	100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz	0.8 dB 2.4 dB 5 dB			
Loop Resistance (@ 50 Hz)	0 to 1.0 Ω 1.0 to 5.0 Ω 5.0 to 10.0 Ω 10.0 to 100.0 Ω 100 to 1000 Ω	0.015 Ω 0.015 to 0.034 Ω 0.034 to 0.063 Ω 0.063 to 0.590 Ω 0.59 to 5.80 Ω	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Oscilloscopes Risetime/Bandwidth	0 to 250 MHz 250 to 350 MHz 350 to 450 MHz 450 to 550 MHz 550 to 650 MHz 650 to 750 MHz 750 MHz to 1 GHz	0.63 MHz to 1.6MHz 1.6 MHz to 2.2 MHz 2.2 MHz to 3 MHz 3 MHz to 3.7 MHz 3.7 MHz to 5 MHz 5 MHz to 6.5 MHz 6.5 MHz to 100 MHz	CTM-217, CTM-218		Measurement in 50 Ohm system Oscilloscope bandwidth calculated using $0.35 = tr.bw$ assuming the oscilloscope input to be Gaussian
Peak to Peak Voltage 0.1 V to 10 V	1 kHz to 5 MHz	300 uV to 30 mV	CTM-167		
Phase	0 to 360° (40 Hz to 100 kHz)	0.95°	CTM-161		For waveforms > 200 mV
RCD Trip Current (@ 50 Hz)	0 to 10 mA 10 mA to 30 mA 30 mA to 90 mA 90 mA to 100 mA 100 mA to 110 mA 110 mA to 300 mA 300 mA to 1000 mA 1000 mA to 2000 mA	0.2 mA 0.2 to 0.5 mA 0.5 to 1.3 mA 1.3 to 1.5 mA 1.5 to 1.6 mA 1.6 to 4.9 mA 4.9 to 15 mA 15 to 29 mA	Method per calibrator manual		Measured using dedicated electrical test equipment calibrator
RCD Trip Time (@ 50 Hz)	20 ms to 1000 ms	1.2 ms	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Resistance	0 to 2 Ω	20 μΩ to 56 μΩ	Measure and		

	2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 200 kΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 200 MΩ to 1 GΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ 25 mΩ to 180 mΩ 250 mΩ to 1.8 Ω 4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ	Generate CTM-111, CTM-112, CTM-112H		
RF Attenuation 0 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB 1 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB	1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz	0.32 dB 0.45 dB 0.9 dB 1.4 dB 2.6 dB 0.42 dB 0.48 dB 1.3 dB 1.9 dB 2.7 dB	CTM-1006, CTM- 1007, CTM-1008		50 Ohm system Instrument input and output attenuators
RF Power Level 0 dBm to –30 dBm –30 dBm to –40dBm –40 dBm to –50 dBm –50 dBm to –60 dBm –60 dBm to –70 dBm –70 dBm to –80 dBm –80 dBm to –90 dBm –90 dBm to –100 dBm –100 dBm to –110 dBm –110 dBm to –127 dBm	2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz	0.11 dB 0.12 dB 0.15 dB 0.16 dB 0.18 dB 0.20 dB 0.24 dB 0.26 dB 0.28 dB 0.34 dB	CTM- 1004,1005,1007,1008		50 Ohm system Type N connectors Other connectors will increase uncertainty Appropriate to the calibration of sources and receivers
RF Power 0 dBm / 1 mW	At 50 MHz	1.0% or 0.043 dB	CTM-1010,1011,1012		Measure Into 50 Ohms Type 'N' (f) connectors

	-70 dBm to -60 dBm -60 dBm to -50 dBm -50 dBm to -40 dBm -40 dBm to -20 dBm -20 dBm to +10 dBm -20 dBm to +10 dBm -20 dBm to +10 dBm -30 dBm to +10 dBm -30 dBm to +10 dBm -30 dBm to +10 dBm 10 dBm to + 50 dBm 10 dBm to +40 dBm 10 dBm to +49.5 dBm 10 dBm to +47 dBm	10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 30 MHz 30 MHz to 1 GHz 30 MHz to 3 GHz 200 kHz to 500 kHz 500 kHz to 50 MHz 50 MHz to 3 GHz 10 MHz to 1 GHz 10 MHz to 2G Hz 10 MHz to 100 MHz 101 MHz to 400 MHz	0.68 dB to 0.58 dB 0.50 dB to 0.17 dB 0.23 dB to 0.13 dB 0.16 dB to 0.13 dB 3.4% or 0.15 dB 2.6% or 0.11 dB 3% or 0.13 dB 3.5% or 0.15 dB 3.3% or 0.14 dB 3.3% or 0.14 dB 4% or 0.17 dB 4% or 0.17 dB 4% or 0.17 dB 4% or 0.17 dB			Other connectors will increase uncertainty
	RF Voltage 1V ±10%	1 kHz to 50 kHz 50 kHz to 500 kHz 500 kHz to 5 MHz 5 MHz to 20 MHz	1.2 mV 1.3 mV 1.5 mV 2.8 mV	Measurement in 50 Ohm system CTM-166		
	Risetime	Greater than 25 ps 130 ps	6% + 10 ps 13 ps	CTM-211, CTM-214 CTM-1064		Measurement in 50 Ohm system Repetitive waveform generation in a 50 Ohm system
	Time	1 µs up	33 ns	CTM-163		
	Vertical Deflection	100 µV to 100 V	5.4 µV to 400 mV	CTM-202, CTM-203		
	VRC 0.7 to 0.18 0.18 to 0.0 0.7 to 0.18 0.18 to 0.0	300 kHz to 1 GHz 300 kHz to 1 GHz 1 GHz to 3 GHz 1 GHz to 3 GHz	0.016 0.012 0.018 0.014	CTM-1053, CTM-1054		Type 'N' (f) Other connectors will increase uncertainty
110 Electrical - .99 Other	AC Current 0 to 200 µA 200 µA to 2 mA	10 Hz to 5 kHz 10 Hz to 5 kHz	28 nA to 80 nA 280 nA to 800 nA	Measure & Generate CTM-105,107,108		

	2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 1 kHz 40 Hz to 400 Hz	2.8 μ A to 8 μ A 28 μ A to 88 μ A 0.6 mA to 2 mA 7 mA to 350 mA	Generate to 50A			
	AC Voltage 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 20 V to 200 V 20 V to 200 V 20 V to 200 V 20 V to 200 V 200 V to 1000 V 200 V to 1000 V 200 V to 1000 V 200 V to 700 V 1 kV to 6 kV	. 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 50 Hz	. 4.8 μ V to 28 μ V 7 μ V to 30 μ V 80 μ V to 160 μ V 40 μ V to 200 μ V 46 μ V to 280 μ V 38 μ V to 180 μ V 42 μ V to 220 μ V 92 μ V to 520 μ V 360 μ V to 1.5 mV 350 μ V to 2.6 mV 0.4 mV to 2.2 mV 0.42 mV to 2.4 mV 0.94 mV to 5.2 mV 3.4 mV to 14 mV 3.5 mV to 26 mV 4 mV to 24 mV 4.4 mV to 26 mV 4.9 mV to 54 mV 34 mV to 150 mV 34 mV to 130 mV 34 mV to 130 mV 72 mV to 270 mV 270 mV to 820 mV 4 V to 24 V	Measure & Generate CTM-101,103, 115,116 Generate to 300 kHz - . . . Generate to 300 kHz Generate to 300 kHz Generate to 300 kHz			
	Amplitude Modulation 5% to 95%	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency)	0.4%	CTM-1021, CTM- 1022, CTM-1025		For low distortion modulation waveforms	
	DC Current	0 to 200 μ A 200 μ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA	1.3 nA to 10 nA 11 nA to 75 nA 110 nA to 750 nA 2.4 μ A to 13 μ A	Measure & Generate CTM-105,107,108			

	200 mA to 2 A 2 A to 100 A	58 μ A to 480 μ A 1 mA to 50 mA			
DC Voltage	0 to 200 mV 0.2 V to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V 1 kV to 6 kV	3.5 μ V 3.5 μ V to 15 μ V 15 μ V to 120 μ V 150 μ V to 190 μ V 2.2 mV to 9.7 mV 2.5 V to 15 V	CTM-101,103,115,116		
Frequency Modulation 250 Hz to 250 kHz	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency).	0.3 Hz to 300 Hz	CTM-1030, CTM-1031, CTM-1032		For low distortion modulation waveforms
Frequency	0.03 Hz to 3 kHz 3 kHz to 30 kHz 30 kHz to 300 kHz 300 kHz to 30 MHz 30 MHz to 1.3 GHz 1.3 MHz to 18 GHz	0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
Horizontal Deflection	1 s to 1 ns	3 ms to 30 ps	CTM-206, CTM-207		
LF Distortion 0 to -40 dB -40 to -60 dB -60 to -80 dB -80 to -90 dB	100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz	0.7 dB 0.8 dB 2.4 dB 5 dB	CTM-154		By rss addition of harmonics
Loop Resistance (@ 50 Hz)	0 to 1.0 Ω 1.0 to 5.0 Ω 5.0 to 10.0 Ω 10.0 to 100.0 Ω 100 to 1000 Ω	0.015 Ω 0.015 to 0.034 Ω 0.034 to 0.063 Ω 0.063 to 0.590 Ω 0.59 to 5.80 Ω	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Oscilloscopes Risetime/Bandwidth	0 to 250 MHz 250 to 350 MHz 350 to 450 MHz	0.63 MHz to 1.6MHz 1.6 MHz to 2.2 MHz 2.2 MHz to 3 MHz	CTM-217, CTM-218		Measurement in 50 Ohm system Oscilloscope

	450 to 550 MHz 550 to 650 MHz 650 to 750 MHz 750 MHz to 1 GHz	3 MHz to 3.7 MHz 3.7 MHz to 5 MHz 5 MHz to 6.5 MHz 6.5 MHz to 100 MHz			bandwidth calculated using $0.35 = tr.bw$ assuming the oscilloscope input to be Gaussian
Peak to Peak Voltage 0.1 V to 10 V	1 kHz to 5 MHz	300 uV to 30 mV	CTM-167		
Phase	0 to 360° (40 Hz to 100 kHz)	0.95°	CTM-161		For waveforms > 200 mV
RCD Trip Current (@ 50 Hz)	0 to 10 mA 10 mA to 30 mA 30 mA to 90 mA 90 mA to 100 mA 100 mA to 110 mA 110 mA to 300 mA 300 mA to 1000 mA 1000 mA to 2000 mA	0.2 mA 0.2 to 0.5 mA 0.5 to 1.3 mA 1.3 to 1.5 mA 1.5 to 1.6 mA 1.6 to 4.9 mA 4.9 to 15 mA 15 to 29 mA	Method per calibrator manual		Measured using dedicated electrical test equipment calibrator
RCD Trip Time (@ 50 Hz)	20 ms to 1000 ms	1.2 ms	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Resistance	0 to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 200 kΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 200 MΩ to 1 GΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	20 μΩ to 56 μΩ 54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ 25 mΩ to 180 mΩ 250 mΩ to 1.8 Ω 4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ	Measure and Generate CTM-111, CTM-112, CTM-112H		
RF Attenuation					50 Ohm system

0 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB 1 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB	1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz	0.32 dB 0.45 dB 0.9 dB 1.4 dB 2.6 dB 0.42 dB 0.48 dB 1.3 dB 1.9 dB 2.7 dB	CTM-1006, CTM-1007, CTM-1008		Instrument input and output attenuators
RF Power Level 0 dBm to -30 dBm -30 dBm to -40dBm -40 dBm to -50 dBm -50 dBm to -60 dBm -60 dBm to -70 dBm -70 dBm to -80 dBm -80 dBm to -90 dBm -90 dBm to -100 dBm -100 dBm to -110 dBm -110 dBm to -127 dBm	2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz	0.11 dB 0.12 dB 0.15 dB 0.16 dB 0.18 dB 0.20 dB 0.24 dB 0.26 dB 0.28 dB 0.34 dB	CTM-1004,1005,1007,1008		50 Ohm system Type N connectors Other connectors will increase uncertainty Appropriate to the calibration of sources and receivers
RF Power 0 dBm / 1 mW -70 dBm to -60 dBm -60 dBm to -50 dBm -50 dBm to -40 dBm -40 dBm to -20 dBm -20 dBm to +10 dBm -20 dBm to +10 dBm -20 dBm to +10 dBm -30 dBm to +10 dBm -30 dBm to +10 dBm -30 dBm to +10 dBm 10 dBm to + 50 dBm 10 dBm to +40 dBm 10 dBm to +49.5 dBm 10 dBm to +47 dBm	At 50 MHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 30 MHz 30 MHz to 1 GHz 30 MHz to 3 GHz 200 kHz to 500 kHz 500 kHz to 50 MHz 50 MHz to 3 GHz 10 MHz to 1 GHz 10 MHz to 2G Hz 10 MHz to 100 MHz 101 MHz to 400 MHz	1.0% or 0.043 dB 0.68 dB to 0.58 dB 0.50 dB to 0.17 dB 0.23 dB to 0.13 dB 0.16 dB to 0.13 dB 3.4% or 0.15 dB 2.6% or 0.11 dB 3% or 0.13 dB 3.5% or 0.15 dB 3.3% or 0.14 dB 3.3% or 0.14 dB 4% or 0.17 dB 4% or 0.17 dB 4% or 0.17 dB 4% or 0.17 dB	CTM-1010,1011,1012		

	RF Voltage 1V ±10%	1 kHz to 50 kHz 50 kHz to 500 kHz 500 kHz to 5 MHz 5 MHz to 20 MHz	1.2 mV 1.3 mV 1.5 mV 2.8 mV	Measurement in 50 Ohm system CTM-166		
	Risetime	Greater than 25 ps 130 ps	6% + 10 ps 13 ps	CTM-211, CTM-214 CTM-1064		Measurement in 50 Ohm system Repetitive waveform generation in a 50 Ohm system
	Time	1 µs up	33 ns	CTM-163		
	Vertical Deflection	100 µV to 100 V	5.4 µV to 400 mV	CTM-202, CTM-203		
	VRC 0.7 to 0.18 0.18 to 0.0 0.7 to 0.18 0.18 to 0.0	300 kHz to 1 GHz 300 kHz to 1 GHz 1 GHz to 3 GHz 1 GHz to 3 GHz	0.016 0.012 0.018 0.014	CTM-1053, CTM-1054		Type 'N' (f) Other connectors will increase uncertainty
111 Frequency - .01 Frequency meters	Frequency	0.03 Hz to 3 kHz 3 kHz to 30 kHz 30 kHz to 300 kHz 300 kHz to 30 MHz 30 MHz to 1.3 GHz 1.3 MHz to 18 GHz	0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
111 Frequency - .02 Wavemeters	Frequency		0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
111 Frequency - .03 Counters	Frequency		0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		

			42 mHz to 1.8 Hz 1.8 Hz to 25 Hz			
111 Frequency - .99 Other			0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
112 Speed - .01 Centrifuges			0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		Rotational speed (Frequency measurement)
112 Speed - .02 Tachometers			0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311, CTM-314		Rotational speed (Frequency measurement)
112 Speed - .03 Speedometers			0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		Rotational speed (Frequency measurement)
113 Time - .01 Oscilloscopes	Time	1 μ s up	33 ns	CTM-163		
113 Time - .02 Clocks and stopwatches			33 ns	CTM-163, CTM-313, CTM-315		
113 Time - .03 Tachometers			33 ns	CTM-163		
113 Time - .99 Other			33 ns	CTM-163		

Metrology field - Calibrated Device Type	Measured quantity	Calibration range	Expanded Measurement Uncertainty	Std. ref/SOP	Products	Remarks
106 Pressure - .06 Pressure gauges	Pressure	9 kPa to 2.5 MPa	0.018%	CTM-6001		Generation by Deadweight Tester (Gauge Pressure)
		0 to 2000 Pa 2 kPa to 200 kPa 100 kPa to 2 MPa	0.15% + 0.1 Pa 0.01% + 50 Pa 0.01% + 500 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
106 Pressure - .07 Vacuum gauges	Pressure	-4 kPa to -100 kPa	0.018%	CTM-6002		Generation by Deadweight Tester
		0 to -2000 Pa -2 kPa to -100 kPa	0.15% + 0.1 Pa 0.01% + 50 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
106 Pressure - .10 Pressure recorders	Pressure	9 kPa to 2.5 MPa	0.018%	CTM-6001		Generation by Deadweight Tester (Gauge Pressure)
		0 to 2000 Pa 2 kPa to 200 kPa 200 kPa to 2 MPa	0.15% + 0.1 Pa 0.01% + 50 Pa 0.01% + 500 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
		-4 kPa to -100 kPa	0.018%	CTM-6002		Generation by Deadweight Tester
		0 to -2000 Pa -2 kPa to -100 kPa	0.15% + 0.1 Pa 0.01% + 50 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
106 Pressure - .13 Digital manometers			0.018%	CTM-6001		Generation by Deadweight Tester

			0.15% + 0.1 Pa 0.01% + 50 Pa 0.01% + 500 Pa	CTM-6012, CTM-6015, CTM-6016		(Gauge Pressure) Generation by Pressure Calibrators
			0.018%	CTM-6002		Generation by Deadweight Tester
			0.15% + 0.1 Pa 0.01% + 50 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
106 Pressure - .99 Other			0.018%	CTM-6001		Generation by Deadweight Tester (Gauge Pressure)
			0.15% + 0.1 Pa 0.01% + 50 Pa 0.01% + 500 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
			0.018%	CTM-6002		Generation by Deadweight Tester
			0.15% + 0.1 Pa 0.01% + 50 Pa	CTM-6012, CTM-6015, CTM-6016		Generation by Pressure Calibrators
107 Temperature measuring equipment - .02 Base metal thermocouples	Temperature	-45 °C to 600 °C	0.3 °C to 1.3 °C	CTM-3027, CTM-3020, CTM-3023		Measurement of thermocouple output at specified temperatures and immersion depths (for thermocouple types E, J, K, N, T)
107 Temperature measuring equipment - .03 Metallic resistance thermometers			0.051 °C to 1.2 °C	CTM-3027, CTM-3020, CTM-3023		Measurement of RTD output at specified temperatures and immersion depths
107 Temperature measuring equipment - .04			0.051 °C to 1.2 °C	CTM-3027, CTM-3020, CTM-3023		

Semiconductor thermometers						
107 Temperature measuring equipment - .09 Digital temperature indicator systems		-40 to -20 °C -20 to +150 °C +150 to +200 °C +200 to +300 °C +300 to +400 °C +400 to +500 °C +500 to +600 °C	0.051 °C 0.066 °C 0.05 °C 0.1 °C 0.1 °C 0.1 °C 0.1 °C	CTM-3027, CTM-3020, CTM-3023		
107 Temperature measuring equipment - .11 Electronic	Temperature/Electrical	-200 °C to +1750 °C	0.06 °C to 0.59 °C	CTM-3010, CTM-110		Calibration of indicators using emf injection (for thermocouple types E, J, K, N, R, T). Calibration of indicators using resistance
108 Temperature controlled enclosures - .01 Ovens, furnaces, baths	Temperature	-95 °C to 600 °C	0.042 °C to 0.65 °C	CTM-3004, CTM-3039		
108 Temperature controlled enclosures - .02 Incubators		0 °C to 70 °C	0.1 °C	CTM-3005		
108 Temperature controlled enclosures - .03 Autoclaves and sterilising ovens		100 °C to 140 °C	0.5 °C	CTM-3004		
108 Temperature controlled enclosures - .04 Industrial freezers		-95 °C to 10 °C	0.1 °C	CTM-3040		
109 Ancillary temperature measuring instruments - .01 Portable potentiometers		-200 °C to 1750 °C	0.06 °C to 0.59 °C	CTM-3027		
109 Ancillary temperature measuring instruments - .02 Digital voltmeters			0.06 °C to 0.59 °C	CTM-3027		
109 Ancillary temperature measuring instruments - .03 Resistance bridges			0.06 °C to 0.59 °C	CTM-3027		

	2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	110 nA to 750 nA 2.4 μ A to 13 μ A 58 μ A to 480 μ A 1 mA to 50 mA			
DC Voltage	0 to 200 mV 0.2 V to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V 1 kV to 6 kV	3.5 μ V 3.5 μ V to 15 μ V 15 μ V to 120 μ V 150 μ V to 190 μ V 2.2 mV to 9.7 mV 2.5 V to 15 V	Measure & Generate CTM-101,103,115,116		
Frequency	0.03 Hz to 3 kHz 3 kHz to 30 kHz 30 kHz to 300 kHz 300 kHz to 30 MHz 30 MHz to 1.3 GHz 1.3 MHz to 18 GHz	0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
Frequency Modulation 250 Hz to 250 kHz	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency)	0.3 Hz to 300 Hz	CTM-1030, CTM-1031, CTM-1032		For low distortion modulation waveforms
Horizontal Deflection	1 s to 1 ns	3 ms to 30 ps	CTM-206, CTM-207		
LF Distortion 0 to -40 dB -40 to -60 dB -60 to -80 dB -80 to -90 dB	100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz	0.7 dB 8 dB 2.4 dB 5 dB	CTM-154		By rss addition of harmonics
Loop Resistance (@ 50 Hz)	0 to 1.0 Ω 1.0 to 5.0 Ω 5.0 to 10.0 Ω 10.0 to 100.0 Ω 100 to 1000 Ω	0.015 Ω 0.015 to 0.034 Ω 0.034 to 0.063 Ω 0.063 to 0.590 Ω 0.59 to 5.80 Ω	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Oscilloscopes Risetime/ Bandwidth	Oscilloscope bandwidth 0 to 250 MHz	0.63 MHz to 1.6 MHz	CTM-217, CTM-218		Measurement in 50 Ohm system Oscilloscope

	250 to 350 MHz 350 to 450 MHz 450 to 550 MHz 550 to 650 MHz 650 to 750 MHz 750 MHz to 1 GHz	1.6 MHz to 2.2 MHz 2.2 MHz to 3 MHz 3 MHz to 3.7 MHz 3.7 MHz to 5 MHz 5 MHz to 6.5 MHz 6.5 MHz to 100 MHz			bandwidth calculated using $0.35 = \text{tr.bw}$ assuming the oscilloscope input to be Gaussian
Peak to Peak Voltage 0.1 V to 10 V	1 kHz to 5 MHz	300 μ V to 30 mV	CTM-167		
Phase	0 to 360° (40 Hz to 100 kHz)	0.95°	CTM-161		For waveforms > 200 mV
RCD Trip Current (@ 50 Hz)	0 to 10 mA 10 mA to 30 mA 30 mA to 90 mA 90 mA to 100 mA 100 mA to 110 mA 110 mA to 300 mA 300 mA to 1000 mA 1000 mA to 2000 mA	0.2 mA 0.2 to 0.5 mA 0.5 to 1.3 mA 1.3 to 1.5 mA 1.5 to 1.6 mA 1.6 to 4.9 mA 4.9 to 15 mA 15 to 29 mA	Method per calibrator manual		Measured using dedicated electrical test equipment calibrator
RCD Trip Time (@ 50 Hz)	20 ms to 1000 ms	1.2 ms	Method per calibrator manual		Measured using dedicated electrical test equipment calibrator
Resistance	0 to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 k Ω 2 k Ω to 20 k Ω 20 k Ω to 200 k Ω 200 k Ω to 2 M Ω 2 M Ω to 20 M Ω 20 M Ω to 200 M Ω 200 M Ω to 1 G Ω 1 G Ω 10 G Ω 100 G Ω 1 T Ω	20 $\mu\Omega$ to 56 $\mu\Omega$ 54 $\mu\Omega$ to 340 $\mu\Omega$ 300 $\mu\Omega$ to 2.2 m Ω 2.6 m Ω to 18 m Ω 25 m Ω to 180 m Ω 250 m Ω to 1.8 Ω 4.7 Ω to 32 Ω 1 k Ω to 17 k Ω 120 k Ω to 180 k Ω 12 M Ω to 14 M Ω 20 M Ω 200 M Ω 2.5 G Ω 30 G Ω	Measure and Generate CTM-111, CTM-112, CTM-112H		

RF Attenuation 0 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB 1 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB	1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz	0.32 dB 0.45 dB 0.9 dB 1.4 dB 2.6 dB 0.42 dB 0.48 dB 1.3 dB 1.9 dB 2.7 dB	CTM-1006, CTM-1007, CTM-1008		50 Ohm system Instrument input and output attenuators
RF Power Level 0 dBm to -30 dBm -30 dBm to -40dBm -40 dBm to -50 dBm -50 dBm to -60 dBm -60 dBm to -70 dBm -70 dBm to -80 dBm -80 dBm to -90 dBm -90 dBm to -100 dBm -100 dBm to -110 dBm -110 dBm to -127 dBm	2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz	0.11 dB 0.12 dB 0.15 dB 0.16 dB 0.18 dB 0.20 dB 0.24 dB 0.26 dB 0.28 dB 0.34 dB	CTM-1004,1005,1007,1008		50 Ohm system Type N connectors Other connectors will increase uncertainty Appropriate to the calibration of sources and receivers
RF Power 0 dBm / 1 mW -70 dBm to -60 dBm -60 dBm to -50 dBm -50 dBm to -40 dBm -40 dBm to -20 dBm -20 dBm to +10 dBm -20 dBm to +10 dBm -20 dBm to +10 dBm -30 dBm to +10 dBm -30 dBm to +10 dBm	At 50 MHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 30 MHz 30 MHz to 1 GHz 30 MHz to 3 GHz 200 kHz to 500 kHz 500 kHz to 50 MHz	1.0% or 0.043 dB 0.68 dB to 0.58 dB 0.50 dB to 0.17 dB 0.23 dB to 0.13 dB 0.16 dB to 0.13 dB 3.4% or 0.15 dB 2.6% or 0.11 dB 3% or 0.13 dB 3.5% or 0.15 dB 3.3% or 0.14 dB	CTM-1010,1011,1012		Measure Into 50 Ohms Type 'N' (f) connectors Other connectors will increase uncertainty
RF Voltage 1V ±10%	1 kHz to 50 kHz	1.2 mV	Measurement in 50 Ohm system		

		50 kHz to 500 kHz 500 kHz to 5 MHz 5 MHz to 20 MHz	1.3 mV 1.5 mV 2.8 mV	CTM-166		
	Risetime	Greater than 25 ps 130 ps	6% + 10 ps 13 ps	CTM-211, CTM-214, CTM-1064		Measurement in 50 Ohm system Repetitive waveform generation in a 50 Ohm system
	Time	1 μ s up	33 ns	CTM-163		
	Vertical Deflection	100 μ V to 100 V	5.4 μ V to 400 mV	CTM-202, CTM-203		
	VRC 0.7 to 0.18 0.18 to 0.0 0.7 to 0.18 0.18 to 0.0	300 kHz to 1 GHz 300 kHz to 1 GHz 1 GHz to 3 GHz 1 GHz to 3 GHz	0.016 0.012 0.018 0.014	CTM-1053/1054		Type 'N' (f) Other connectors will increase uncertainty
110 Electrical - .02 Inductors and transformers	AC Current 0 to 200 μ A 200 μ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 1 kHz 40 Hz to 400 Hz	28 nA to 80 nA 280 nA to 800 nA 2.8 μ A to 8 μ A 28 μ A to 88 μ A 0.6 mA to 2 mA 7 mA to 350 mA	Measure & Generate CTM-105,107,108 Generate to 50A		
	AC Voltage 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 2 V to 20 V	. 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz	. 4.8 μ V to 28 μ V 7 μ V to 30 μ V 80 μ V to 160 μ V 40 μ V to 200 μ V 46 μ V to 280 μ V 38 μ V to 180 μ V 42 μ V to 220 μ V 92 μ V to 520 μ V 360 μ V to 1.5 mV 350 μ V to 2.6 mV 0.4 mV to 2.2 mV	Measure & Generate CTM-101,103, 115,116 . . . Generate to 300 kHz - . . .		

		10 GΩ 100 GΩ 1 TΩ	200 MΩ 2.5 GΩ 30 GΩ			
110 Electrical - .04 Resistors			20 μΩ to 56 μΩ 54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ 25 mΩ to 180 mΩ 250 mΩ to 1.8 Ω 4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ	Measure and Generate CTM-111, CTM-112, CTM-112H		
110 Electrical - .06 Potentiometers		0 to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 200 kΩ to 2MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 200 MΩ to 1 GΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	20 μΩ to 56 μΩ 54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ 25 mΩ to 180 mΩ 250 mΩ to 1.8 Ω 4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ	Measure and Generate CTM-111, CTM-112, CTM-112H		
110 Electrical - .07 Transducers	AC Current 0 to 200 μA 200 μA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 1 kHz 40 Hz to 400 Hz	28 nA to 80 nA 280 nA to 800 nA 2.8 μA to 8 μA 28 μA to 88 μA 0.6 mA to 2 mA 7 mA to 350 mA	Measure & Generate CTM-105,107,108 Generate to 50A		

	20 V to 200 V 200 V to 1000 V 1 kV to 6 kV	150 μ V to 190 μ V 2.2 mV to 9.7 mV 2.5 V to 15 V	101,103,115,116		
Frequency	0.03 Hz to 3 kHz 3 kHz to 30 kHz 30 kHz to 300 kHz 300 kHz to 30 MHz 30 MHz to 1.3 GHz 1.3 MHz to 18 GHz	0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
Frequency Modulation 250 Hz to 250 kHz	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency)	0.3 Hz to 300 Hz	CTM-1030, CTM- 1031, CTM-1032		For low distortion modulation waveforms
Horizontal Deflection	1 s to 1 ns	3 ms to 30 ps	CTM-206, CTM-207		
LF Distortion 0 to -40 dB -40 to -60 dB -60 to -80 dB -80 to -90 dB	100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz	0.7 dB 8 dB 2.4 dB 5 dB	CTM-154		By rss addition of harmonics
Loop Resistance (@ 50 Hz)	0 to 1.0 Ω 1.0 to 5.0 Ω 5.0 to 10.0 Ω 10.0 to 100.0 Ω 100 to 1000 Ω	0.015 Ω 0.015 to 0.034 Ω 0.034 to 0.063 Ω 0.063 to 0.590 Ω 0.59 to 5.80 Ω	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Oscilloscopes Risetime/ Bandwidth	Oscilloscope bandwidth 0 to 250 MHz 250 to 350 MHz 350 to 450 MHz 450 to 550 MHz 550 to 650 MHz 650 to 750 MHz 750 MHz to 1 GHz	0.63 MHz to 1.6 MHz 1.6 MHz to 2.2 MHz 2.2 MHz to 3 MHz 3 MHz to 3.7 MHz 3.7 MHz to 5 MHz 5 MHz to 6.5 MHz 6.5 MHz to 100 MHz	CTM-217, CTM-218		Measurement in 50 Ohm system Oscilloscope bandwidth calculated using 0.35 = tr.bw assuming the oscilloscope input to be Gaussian

Peak to Peak Voltage 0.1 V to 10 V	1 kHz to 5 MHz	300 uV to 30 mV	CTM-167		
Phase	0 to 360° (40 Hz to 100 kHz)	0.95°	CTM-161		For waveforms > 200 mV
RCD Trip Current (@ 50 Hz)	0 to 10 mA 10 mA to 30 mA 30 mA to 90 mA 90 mA to 100 mA 100 mA to 110 mA 110 mA to 300 mA 300 mA to 1000 mA 1000 mA to 2000 mA	0.2 mA 0.2 to 0.5 mA 0.5 to 1.3 mA 1.3 to 1.5 mA 1.5 to 1.6 mA 1.6 to 4.9 mA 4.9 to 15 mA 15 to 29 mA	Method per calibrator manual		Measured using dedicated electrical test equipment calibrator
RCD Trip Time (@ 50 Hz)	20 ms to 1000 ms	1.2 ms	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Resistance	0 to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 200 kΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 200 MΩ to 1 GΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	20 μΩ to 56 μΩ 54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ 25 mΩ to 180 mΩ 250 mΩ to 1.8 Ω 4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ	Measure and Generate CTM-111, CTM-112, CTM-112H		
RF Attenuation 0 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB 1 dB to 49 dB	1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz	0.32 dB 0.45 dB 0.9 dB 1.4 dB 2.6 dB 0.42 dB	CTM-1006, CTM-1007, CTM-1008		50 Ohm system Instrument input and output attenuators

50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB	1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz	0.48 dB 1.3 dB 1.9 dB 2.7 dB			
RF Power Level 0 dBm to -30 dBm -30 dBm to -40dBm -40 dBm to -50 dBm -50 dBm to -60 dBm -60 dBm to -70 dBm -70 dBm to -80 dBm -80 dBm to -90 dBm -90 dBm to -100 dBm -100 dBm to -110 dBm -110 dBm to -127 dBm	2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz	0.11 dB 0.12 dB 0.15 dB 0.16 dB 0.18 dB 0.20 dB 0.24 dB 0.26 dB 0.28 dB 0.34 dB	CTM-1004,1005,1007,1008		50 Ohm system Type N connectors Other connectors will increase uncertainty Appropriate to the calibration of sources and receivers
RF Power 0 dBm / 1 mW -70 dBm to -60 dBm -60 dBm to -50 dBm -50 dBm to -40 dBm -40 dBm to -20 dBm -20 dBm to +10 dBm -20 dBm to +10 dBm -20 dBm to +10 dBm -30 dBm to +10 dBm -30 dBm to +10 dBm	At 50 MHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 4 GHz 10 MHz to 30 MHz 30 MHz to 1 GHz 30 MHz to 3 GHz 200 kHz to 500 kHz 500 kHz to 50 MHz	1.0% or 0.043 dB 0.68 dB to 0.58 dB 0.50 dB to 0.17 dB 0.23 dB to 0.13 dB 0.16 dB to 0.13 dB 3.4% or 0.15 dB 2.6% or 0.11 dB 3% or 0.13 dB 3.5% or 0.15 dB 3.3% or 0.14 dB	CTM-1010,1011,1012		Measure Into 50 Ohms Type 'N' (f) connectors Other connectors will increase uncertainty
RF Voltage 1V ±10%	1 kHz to 50 kHz 50 kHz to 500 kHz 500 kHz to 5 MHz 5 MHz to 20 MHz	1.2 mV 1.3 mV 1.5 mV 2.8 mV	Measurement in 50 Ohm system CTM-166		
Risetime	Greater than 25 ps 130 ps	6% + 10 ps 13 ps	CTM-211, CTM-214, CTM-1064		Measurement in 50 Ohm system Repetitive waveform

						generation in a 50 Ohm system
	Time	1 μ s up	33 ns	CTM-163		
	Vertical Deflection	100 μ V to 100 V	5.4 μ V to 400 mV	CTM-202, CTM-203		
	VRC 0.7 to 0.18 0.18 to 0.0 0.7 to 0.18 0.18 to 0.0	300 kHz to 1 GHz 300 kHz to 1 GHz 1 GHz to 3 GHz 1 GHz to 3 GHz	0.016 0.012 0.018 0.014	CTM-1053/1054		Type 'N' (f) Other connectors will increase uncertainty
110 Electrical - .99 Other	AC Current 0 to 200 μ A 200 μ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 5 kHz 10 Hz to 1 kHz 40 Hz to 400 Hz	28 nA to 80 nA 280 nA to 800 nA 2.8 μ A to 8 μ A 28 μ A to 88 μ A 0.6 mA to 2 mA 7 mA to 350 mA	Measure & Generate CTM-105,107,108 Generate to 50A		
	AC Voltage 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 0 to 200 mV 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 200 mV to 2 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 2 V to 20 V 20 V to 200 V 20 V to 200 V 20 V to 200 V 20 V to 200 V 200 V to 1000 V	. 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 kHz to 300 kHz 100 Hz to 2 kHz 40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 100 Hz to 2 kHz	. 4.8 μ V to 28 μ V 7 μ V to 30 μ V 80 μ V to 160 μ V 40 μ V to 200 μ V 46 μ V to 280 μ V 38 μ V to 180 μ V 42 μ V to 220 μ V 92 μ V to 520 μ V 360 μ V to 1.5 mV 350 μ V to 2.6 mV 0.4 mV to 2.2 mV 0.42 mV to 2.4 mV 0.94 mV to 5.2 mV 3.4 mV to 14 mV 3.5 mV to 26 mV 4 mV to 24 mV 4.4 mV to 26 mV 4.9 mV to 54 mV 34 mV to 150 mV 34 mV to 130 mV	Measure & Generate CTM-101,103, 115,116 . . . Generate to 300 kHz - . . . Generate to 300 kHz . . . Generate to 300 kHz . . . Generate to 300 kHz . . .		

200 V to 1000 V 200 V to 1000 V 200 V to 700 V 1 kV to 6 kV	40 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz 50 Hz	34 mV to 130 mV 72 mV to 270 mV 270 mV to 820 mV 4 V to 24 V	.		
Amplitude Modulation 5% to 95%	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency)	0.4%	CTM-1021, CTM- 1022, CTM-1025		For low distortion modulation waveforms
DC Current	0 to 200 μ A 200 μ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 100 A	1.3 nA to 10 nA 11 nA to 75 nA 110 nA to 750 nA 2.4 μ A to 13 μ A 58 μ A to 480 μ A 1 mA to 50 mA	Measure & Generate CTM-105,107,108		
DC Voltage	0 to 200 mV 0.2 V to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V 1 kV to 6 kV	3.5 μ V 3.5 μ V to 15 μ V 15 μ V to 120 μ V 150 μ V to 190 μ V 2.2 mV to 9.7 mV 2.5 V to 15 V	Measure & Generate CTM- 101,103,115,116		
Frequency	0.03 Hz to 3 kHz 3 kHz to 30 kHz 30 kHz to 300 kHz 300 kHz to 30 MHz 30 MHz to 1.3 GHz 1.3 MHz to 18 GHz	0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
Frequency Modulation 250 Hz to 250 kHz	10 MHz to 2.4 GHz (Carrier Frequency) 300 Hz to 20 kHz (Modulation Frequency)	0.3 Hz to 300 Hz	CTM-1030, CTM- 1031, CTM-1032		For low distortion modulation waveforms
Horizontal Deflection	1 s to 1 ns	3 ms to 30 ps	CTM-206, CTM-207		

LF Distortion 0 to -40 dB -40 to -60 dB -60 to -80 dB -80 to -90 dB	100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz 100 Hz to 100 kHz	0.7 dB 8 dB 2.4 dB 5 dB	CTM-154		By rss addition of harmonics
Loop Resistance (@ 50 Hz)	0 to 1.0 Ω 1.0 to 5.0 Ω 5.0 to 10.0 Ω 10.0 to 100.0 Ω 100 to 1000 Ω	0.015 Ω 0.015 to 0.034 Ω 0.034 to 0.063 Ω 0.063 to 0.590 Ω 0.59 to 5.80 Ω	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator
Oscilloscopes Risetime/ Bandwidth	Oscilloscope bandwidth 0 to 250 MHz 250 to 350 MHz 350 to 450 MHz 450 to 550 MHz 550 to 650 MHz 650 to 750 MHz 750 MHz to 1 GHz	0.63 MHz to 1.6 MHz 1.6 MHz to 2.2 MHz 2.2 MHz to 3 MHz 3 MHz to 3.7 MHz 3.7 MHz to 5 MHz 5 MHz to 6.5 MHz 6.5 MHz to 100 MHz	CTM-217, CTM-218		Measurement in 50 Ohm system Oscilloscope bandwidth calculated using $0.35 = tr.bw$ assuming the oscilloscope input to be Gaussian
Peak to Peak Voltage 0.1 V to 10 V	1 kHz to 5 MHz	300 uV to 30 mV	CTM-167		
Phase	0 to 360° (40 Hz to 100 kHz)	0.95°	CTM-161		For waveforms > 200 mV
RCD Trip Current (@ 50 Hz)	0 to 10 mA 10 mA to 30 mA 30 mA to 90 mA 90 mA to 100 mA 100 mA to 110 mA 110 mA to 300 mA 300 mA to 1000 mA 1000 mA to 2000 mA	0.2 mA 0.2 to 0.5 mA 0.5 to 1.3 mA 1.3 to 1.5 mA 1.5 to 1.6 mA 1.6 to 4.9 mA 4.9 to 15 mA 15 to 29 mA	Method per calibrator manual		Measured using dedicated electrical test equipment calibrator
RCD Trip Time (@ 50 Hz)	20 ms to 1000 ms	1.2 ms	Method per calibrator manual		Generated using dedicated electrical test equipment calibrator

Resistance	0 to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 200 kΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 200 MΩ to 1 GΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	20 μΩ to 56 μΩ 54 μΩ to 340 μΩ 300 μΩ to 2.2 mΩ 2.6 mΩ to 18 mΩ 25 mΩ to 180 mΩ 250 mΩ to 1.8 Ω 4.7 Ω to 32 Ω 1 kΩ to 17 kΩ 120 kΩ to 180 kΩ 12 MΩ to 14 MΩ 20 MΩ 200 MΩ 2.5 GΩ 30 GΩ	Measure and Generate CTM-111, CTM-112, CTM-112H		
RF Attenuation	0 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB 1 dB to 49 dB 50 dB to 79 dB 80 dB to 90 dB 90 dB to 95 dB 95 dB to 100 dB	1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz 1 kHz to 1 GHz	0.32 dB 0.45 dB 0.9 dB 1.4 dB 2.6 dB 0.42 dB 0.48 dB 1.3 dB 1.9 dB 2.7 dB	CTM-1006, CTM-1007, CTM-1008	50 Ohm system Instrument input and output attenuators
RF Power Level	0 dBm to -30 dBm -30 dBm to -40dBm -40 dBm to -50 dBm -50 dBm to -60 dBm -60 dBm to -70 dBm -70 dBm to -80 dBm -80 dBm to -90 dBm -90 dBm to -100 dBm -100 dBm to -110 dBm -110 dBm to -127 dBm	2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz 2.5 MHz to 1.3 GHz	0.11 dB 0.12 dB 0.15 dB 0.16 dB 0.18 dB 0.20 dB 0.24 dB 0.26 dB 0.28 dB 0.34 dB	CTM-1004,1005,1007,1008	50 Ohm system Type N connectors Other connectors will increase uncertainty Appropriate to the calibration of sources and receivers
RF Power					

	<p>0 dBm / 1 mW</p> <p>-70 dBm to -60 dBm</p> <p>-60 dBm to -50 dBm</p> <p>-50 dBm to -40 dBm</p> <p>-40 dBm to -20 dBm</p> <p>-20 dBm to +10 dBm</p> <p>-20 dBm to +10 dBm</p> <p>-20 dBm to +10 dBm</p> <p>-30 dBm to +10 dBm</p> <p>-30 dBm to +10 dBm</p>	<p>At 50 MHz</p> <p>10 MHz to 4 GHz</p> <p>10 MHz to 4 GHz</p> <p>10 MHz to 4 GHz</p> <p>10 MHz to 4 GHz</p> <p>10 MHz to 30 MHz</p> <p>30 MHz to 1 GHz</p> <p>30 MHz to 3 GHz</p> <p>200 kHz to 500 kHz</p> <p>500 kHz to 50 MHz</p>	<p>1.0% or 0.043 dB</p> <p>0.68 dB to 0.58 dB</p> <p>0.50 dB to 0.17 dB</p> <p>0.23 dB to 0.13 dB</p> <p>0.16 dB to 0.13 dB</p> <p>3.4% or 0.15 dB</p> <p>2.6% or 0.11 dB</p> <p>3% or 0.13 dB</p> <p>3.5% or 0.15 dB</p> <p>3.3% or 0.14 dB</p>	<p>CTM-1010,1011,1012</p>		
	<p>RF Voltage</p> <p>1V ±10%</p>	<p>1 kHz to 50 kHz</p> <p>50 kHz to 500 kHz</p> <p>500 kHz to 5 MHz</p> <p>5 MHz to 20 MHz</p>	<p>1.2 mV</p> <p>1.3 mV</p> <p>1.5 mV</p> <p>2.8 mV</p>	<p>Measurement in 50 Ohm system</p> <p>CTM-166</p>		
	<p>Risetime</p>	<p>Greater than 25 ps</p> <p>130 ps</p>	<p>6% + 10 ps</p> <p>13 ps</p>	<p>CTM-211, CTM-214,</p> <p>CTM-1064</p>		<p>Measurement in 50 Ohm system</p> <p>Repetitive waveform generation in a 50 Ohm system</p>
	<p>Time</p>	<p>1 µs up</p>	<p>33 ns</p>	<p>CTM-163</p>		
	<p>Vertical Deflection</p>	<p>100 µV to 100 V</p>	<p>5.4 µV to 400 mV</p>	<p>CTM-202, CTM-203</p>		
	<p>VRC</p> <p>0.7 to 0.18</p> <p>0.18 to 0.0</p> <p>0.7 to 0.18</p> <p>0.18 to 0.0</p>	<p>300 kHz to 1 GHz</p> <p>300 kHz to 1 GHz</p> <p>1 GHz to 3 GHz</p> <p>1 GHz to 3 GHz</p>	<p>0.016</p> <p>0.012</p> <p>0.018</p> <p>0.014</p>	<p>CTM-1053/1054</p>		<p>Type 'N' (f)</p> <p>Other connectors will increase uncertainty</p>
<p>111 Frequency - .01 Frequency meters</p>	<p>Frequency</p>	<p>0.03 Hz to 3 kHz</p> <p>3 kHz to 30 kHz</p> <p>30 kHz to 300 kHz</p> <p>300 kHz to 30 MHz</p> <p>30 MHz to 1.3 GHz</p>	<p>0.45 mHz to 4.5 mHz</p> <p>0.48 mHz to 4.8 mHz</p> <p>0.45 mHz to 51 mHz</p> <p>0.6 mHz to 60 mHz</p> <p>42 mHz to 1.8 Hz</p>	<p>CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311</p>		

		1.3 MHz to 18 GHz	1.8 Hz to 25 Hz			
111 Frequency - .02 Wavemeters			0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
111 Frequency - .03 Counters	Frequency		0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
111 Frequency - .99 Other	Frequency		0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		
112 Speed - .01 Centrifuges	Frequency		0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		Rotational speed (Frequency measurement)
112 Speed - .02 Tachometers	Frequency		0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz 42 mHz to 1.8 Hz 1.8 Hz to 25 Hz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311, CTM-314		Rotational speed (Frequency measurement)
112 Speed - .03 Speedometers			0.45 mHz to 4.5 mHz 0.48 mHz to 4.8 mHz 0.45 mHz to 51 mHz 0.6 mHz to 60 mHz	CTM-114, CTM-301, CTM-302, CTM-303, CTM-310, CTM-311		Rotational speed (Frequency measurement)

			42 mHz to 1.8 Hz 1.8 Hz to 25 Hz			
113 Time - .01 Oscilloscopes	Time	1 μ s up	33 ns	CTM-163		
113 Time - .02 Clocks and stopwatches			33 ns	CTM-163, CTM-313, CTM-315		
113 Time - .03 Tachometers			33 ns	CTM-163		
113 Time - .99 Other			33 ns	CTM-163		