



TRANSMILLE 4610M ADVANCED MULTIPRODUCT CALIBRATOR

EXTENDED SPECIFICATIONS

V1.5

Warm Up Time	Double the time since last used, up to 20 minutes maximum	
Standard Interfaces	USB, GPIB (IEEE-488)	
Optional Interfaces	RS232	
Temperature Performance	Storage : -5°C to +60°C Operation : 0°C to +50°C	
Relative Humidity	Operation : <80% to 30°C, <70% to 40°C, <40% to 50°C Storage : <95%, non-condensing	
Altitude	Operation : 3000m (10,000ft) Maximum Transit : 12000m (40,000ft) Maximum	
EMC & Safety	The calibrator line input plug must be earthed See D.O.C for full details	
Line Power	Line Voltage Selectable : 100V/120V/230V/240V Line Frequency : 50Hz to 60Hz Line Voltage Variation : -6% +10%	
Power Consumption	28 Watts (Standby)	450 Watts (Maximum)
Low Analogue Isolation	100V	
Front Panel Connections	Voltage / 2 Wire Resistance / Capacitance Low Current (<=2A) / Resistance Compensation High current (>2A) Earth Connection	1x Black : 1x Red 4mm Binding Posts 1x Black : 1x Red 4mm Binding Posts 1x Blue : 1x Yellow 4mm Binding Posts 1x Green 4mm Binding Posts
Display Information	Type Viewing Area Resolution Backlight Type	Touchscreen LCD 7" 800 * 480 LED
Indicators	Voltage / Current / High Current Negative to ground Standby Indicator Output Indicator	Red LED (left of terminals) Green LED (left of Earth terminal) Red LED (left of Standby Key) Green LED (left of Operate Key)
Keyboard	Rubber key	
Fuses	Mains Inlet	3.15A A/S (230/240 Volt) (E006)
Transmille P/N's Exxx		5A A/S (100/120 Volt operation) (E007)
	Internal	2A FF, 250V x 2 (E035) 25A, 32V x 2 Blade Fuse (E044) 630mA A/S, 250V x 2 (E002)
Isolation	Outputs are opto-isolated from mains earth and remote interfaces Maximum common mode voltage between earth and the low terminals - 50 Volts ac/dc.	
Dimensions & Weights (Length x Width x Height)	Calibrator Only Calibrator in Shipping Box Calibrator in Hard Transit case	46cm x 43cm x 19cm : 20.5 kg 60cm x 65cm x 45cm : 28 kg 70cm x 44cm x 74cm : 42 kg
Warranty Period	1 Years (Parts & Labour)	
Recommended Service Interval	1 Year	
Supplied Connections	1x Mains Lead 1 x Fuse Kit 1 x Type J Mini Plug to Mini Plug 1 x Type K Mini Plug to Mini Plug	1 x Type J Mini Plug to 4mm Banana Jack 1 x Type K Mini Plug to 4mm Banana Jack
Optional Lead Set Kit	1x Voltage connection lead set 1x Low Current connection lead set 1x High current connection lead set 1x AC connection lead set	
Mounting Kit (optional)	4U rack mount kit	
Case Colour	Grey	

Due to continuous development specifications may be subject to change.

4610M Extended Specifications

General Specifications : V1.5

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Interpreting Specifications

Transmille have taken great care over presenting the extended specifications in a manner that is easy to read while including high levels of details

Transmille specify specifications as both Total Accuracy and Relative Specification, with varying calibration intervals, from 24 Hours to 2 Years

By 'Total Accuracy', this means that all internal components of the calibrator have been compensated for. This includes stability, line voltage variations, temperature, humidity as well as the uncertainty of calibration as performed by Transmille Ltd.

This does NOT include external sources of uncertainty, such as the leads that are used to connect to the calibrator, and resolution of the UUT

'Relative Accuracy' refers to the stability of the instrument itself, without any external factors except temperature variation.

During re-calibration, the 'Total Accuracy' should be used for verification of the instrument. If the calibration laboratory offers better uncertainties than those offered by Transmille, new uncertainties can be calculated by combining the relative specification and the new imported uncertainties.

All of Transmilles Total Accuracies are presented to 95% confidence, $k=2$.

This is for ease of use in a 17025 accredited laboratory, where other contributions will likely also be calculated for $k=2$, minimising the need for re-calibration of uncertainties.

1 year Total Accuracy Specifications at Tcal $\pm 5^{\circ}\text{C}$

Range	Resolution	Max. Burden Current	Typical Output Resistance ¹	Overload Protection	1 Year Total	
					ppm set	μV
0-202mV	0.01 μV	1mA ²	50 Ohms	20 V	15 +	2
0.2-2.02V	0.1 μV	50mA	0.2 Ohms	150V	9 +	2.5
2-20.2V	1 μV	50mA	0.2 Ohms	150V	8 +	24
20-202V	10 μV	20mA ³	0.5 Ohms	1200V	12 +	200
200-1025V	100 μV	20mA ³	0.7 Ohms	1200V	12 +	2000

Stability (Accuracy relative to calibration Standards)

Range	24 Hour Stability		Noise ⁴ μV	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
	ppm Set	μV		ppm Set	μV	ppm Set	μV	ppm Set	μV	ppm Set	μV
0-202mV	2 +	1	0.3	9.6 +	2	10.8 +	2	12 +	2	16.8 +	2.8
0.2-2.02V	2 +	1.2	0.4	5.6 +	2.5	6.3 +	2.5	7 +	2.5	9.8 +	3.5
2-20.2V	2 +	9	3	4.8 +	24	5.4 +	24	6 +	24	8.4 +	33.6
20-202V	3.5 +	120	40	8 +	200	9 +	200	10 +	200	14 +	280
200-1020V	5 +	1100	363	8 +	2000	9 +	2000	10 +	2000	14 +	2800

Notes

Note 1: Allowance must be made for output resistance when driving into a load.

Note 2: Limited by 50 Ohm output impedance.

Note 3: Internally adjustable from 2mA to 30mA - Factory set to 20mA as standard.

For safety the trip is controlled by a fail-safe circuit independent of the processor which shuts the high voltage output off in the event of an overload.

Note 4: Typical RMS noise figures at 50% of full scale, bandwidth 1Hz to 10Hz.

High Voltage Safety

High voltage output is ramped to allow instrument under test to auto range.

Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage

Standby is automatically selected for high voltage (>20V) after 20 minutes on the same setting. This function can be disabled

High voltage (> 20V) output is indicated to user through an audible warning beep.

An external high voltage output/standby control switch is available as an option.

2 Wire output / Remote sensing not available.

Isolation : Floating or grounded selection available as standard.

Maximum floating voltage : 100V

Specifications apply at TCal $\pm 5^{\circ}\text{C}$

Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.

1 year Total Accuracy Specifications at TCal $\pm 5^{\circ}\text{C}$

Range	Resolution	Max. Inductive Load	Compliance Voltage	Overload Protection	1 Year Total ppm set	uA
0-202uA	10pA	10mH	4.2 Volts	150V	100	+ 0.01
0.2-2.02mA	100pA	10mH	4.2 Volts	150V	50	+ 0.03
2-20.2mA	1nA	10mH	4.2 Volts	150V	50	+ 0.2
20-202mA	10nA	10mH	4.2 Volts	150V	50	+ 2
0.2-2.02A	100nA	10mH	4.2 Volts	150V	130	+ 30
2-20.2A	1uA	10mH	3.9 Volts	150V	300	+ 300
20.2-30A	10uA	10mH	3.9 Volts	150V	700	+ 450

Stability (Accuracy relative to calibration Standards)

Range	Noise ¹ 0.1-1Hz	90 Day Rel %Set uA	180 Day Rel %Set uA	1 Year Rel %Set uA	2 Year Rel %Set uA
0-202uA	180pA	0.006 + 0.01	0.007 + 0.01	0.008 + 0.01	0.0112 + 0.014
0.2-2.02mA	500pA	0.0032 + 0.03	0.0036 + 0.03	0.004 + 0.03	0.0056 + 0.042
2-20.2mA	4nA	0.0032 + 0.2	0.0036 + 0.2	0.004 + 0.2	0.0056 + 0.28
20-202mA	40nA	0.0032 + 2	0.0036 + 2	0.004 + 2	0.0056 + 2.8
0.2-2.02A	1uA	0.0056 + 30	0.006 + 30	0.007 + 30	0.0098 + 42
2-20.2A ²	20uA	0.016 + 300	0.018 + 300	0.02 + 300	0.028 + 420
20.2-30A ²	20uA	0.040 + 450	0.045 + 450	0.05 + 450	0.07 + 630

Notes

Note 1 : Typical RMS noise figures at 50% of full scale.

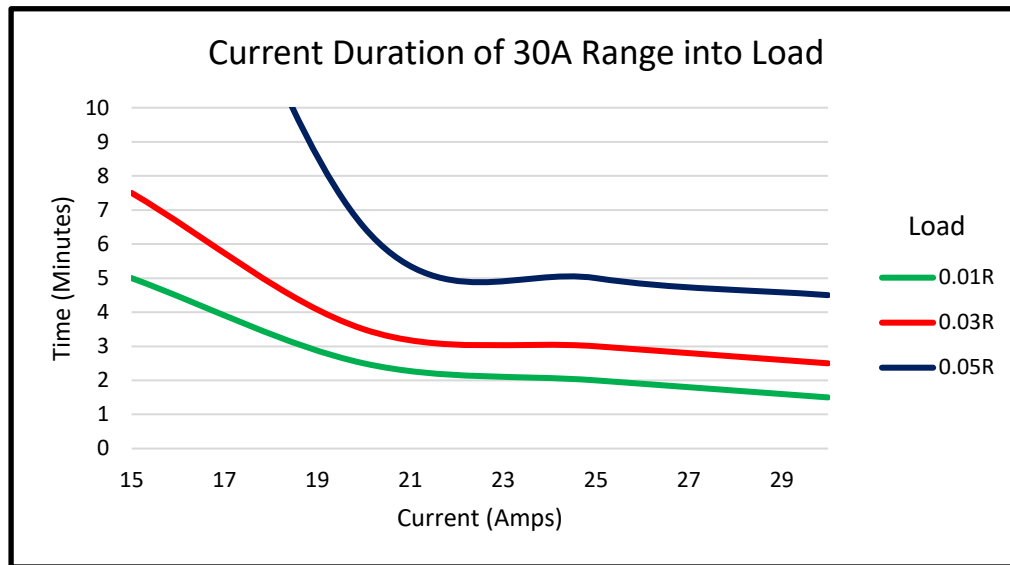
Note 2 : Power & temperature sensor on 30A range - microprocessor monitors & protects from overheating.
Higher resistance loads allow a longer ON period. See graphs 1 and 2 for details.

Note 3 : Specifications apply to loads of less than 10% of the maximum burden voltage.

Note 4: Zero or floor allowance.

Specifications apply at TCal $\pm 5^{\circ}\text{C}$

Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.



Measurement Conditions : Ambient Temperature 20°C, Mains Voltage 230V, Mains Frequency 50Hz
Allow at least 7 minutes 'off' period between current output

Shorter periods will reduce the output time available.

A higher ohmic value load (for example, a 0.1R Shunt) allows greater output time as more heat is dissipated within the shunt / load. With lower loads more heat is dissipated within the instrument, reducing output time

Into a 0.1R Load outputs of up to 20A are available for periods of greater than 30 minutes continuously, considerations of self heating of the external load/Uut should be considered due to the power being dissipated

1 year Total Accuracy Specifications at TCal $\pm 5^{\circ}\text{C}$

Range	Frequency	Resolution	Max. Burden Current	Typical Output Resistance	Overload Protection	1 Year Accuracy	
						ppm set	μV
1-20.2mV	10 to 45Hz	1 μV	1mA ¹	50 Ohms	20 V	800 +	10
	45Hz to 1kHz	1 μV	1mA ¹	50 Ohms	20 V	220 +	10
	1 to 20kHz	1 μV	1mA ¹	50 Ohms	20 V	180 +	10
	20 to 50kHz	1 μV	1mA ¹	50 Ohms	20 V	1200 +	10
	50 to 100kHz	1 μV	1mA ¹	50 Ohms	20 V	3500 +	12
	100 to 500kHz	1 μV	1mA ¹	50 Ohms	20 V	8000 +	50
20-202mV	10 to 45Hz	1 μV	1mA ¹	50 Ohms	20 V	280 +	12
	45Hz to 1kHz	1 μV	1mA ¹	50 Ohms	20 V	160 +	10
	1 to 20kHz	1 μV	1mA ¹	50 Ohms	20 V	200 +	15
	20 to 50kHz	1 μV	1mA ¹	50 Ohms	20 V	800 +	20
	50 to 100kHz	1 μV	1mA ¹	50 Ohms	20 V	1000 +	40
	100 to 500kHz	1 μV	1mA ¹	50 Ohms	20 V	3000 +	50
0.2-2.02V ⁶	10 to 45Hz	10 μV	50mA	0.2 Ohms	1200V	320 +	12
	45Hz to 1kHz	10 μV	50mA	0.2 Ohms	1200V	200 +	20
	1 to 20kHz	10 μV	50mA	0.2 Ohms	1200V	200 +	50
	20 to 50kHz	10 μV	50mA	0.2 Ohms	1200V	650 +	50
	50 to 100kHz	10 μV	50mA	0.2 Ohms	1200V	650 +	170
	100kHz to 500kHz	10 μV	50mA	0.2 Ohms	1200V	2500 +	300
	500kHz to 1MHz	10 μV	50mA	0.2 Ohms	1200V	3000 +	450
2-20.2V	10 to 45Hz	100 μV	50mA	0.2 Ohms	1200V	400 +	250
	45Hz to 1kHz	100 μV	50mA	0.2 Ohms	1200V	180 +	200
	1 to 20kHz	100 μV	50mA	0.2 Ohms	1200V	220 +	320
	20 to 50kHz	100 μV	50mA	0.2 Ohms	1200V	350 +	500
	50 to 100kHz	100 μV	50mA	0.2 Ohms	1200V	750 +	300
20V - 202V	10Hz to 45Hz	1mV	20mA ²	0.5 Ohms	1200V	400 +	5000
	45Hz to 1kHz	1mV	15mA ²	0.5 Ohms	1200V	190 +	1800
	1 to 20kHz	1mV	15mA ²	0.5 Ohms	1200V	250 +	2500
	20 to 50kHz	1mV	15mA ³	0.5 Ohms	1200V	350 +	1000
	50 to 100kHz	1mV	2mA ²	0.5 Ohms	1200V	800 +	5000
200-1020V ^{3,9}	30 to 45Hz	10mV	20mA ²	0.7 Ohms	1200V	600 +	15000
	45Hz to 1kHz	10mV	15mA ²	0.7 Ohms	1200V	240 +	8000
	1kHz to 10kHz	10mV	2mA ²	0.7 Ohms	1200V	300 +	12000
	10kHz to 20kHz	10mV	2mA ²	0.7 Ohms	1200V	300 +	200000

AC Frequency Accuracy : 1ppm

Stability (Accuracy relative to calibration Standards)

Range	Frequency	Frequency Resolution	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
			ppm set	uV	ppm set	uV	ppm set	uV	ppm set	uV
1-20.2mV	10 to 45Hz	1Hz	600	+ 8	675	+ 9	750	+ 10	1050	+ 14
	45Hz to 1kHz	1Hz	160	+ 8	180	+ 9	200	+ 10	280	+ 14
	1 to 20kHz	1Hz	128	+ 8	144	+ 9	160	+ 10	224	+ 14
	20 to 50kHz	1Hz	904	+ 8	1017	+ 9	1130	+ 10	1582	+ 14
	50 to 100kHz	1Hz	2640	+ 9.6	2970	+ 10.8	3300	+ 12	4620	+ 17
	100 to 500kHz	1Hz	5600	+ 40	6300	+ 45	7000	+ 50	9800	+ 70
20-202mV	10 to 45Hz	1Hz	184	+ 9.6	207	+ 10.8	230	+ 12	322	+ 17
	45Hz to 1kHz	1Hz	112	+ 8	126	+ 9	140	+ 10	196	+ 14
	1 to 20kHz	1Hz	144	+ 12	162	+ 13.5	180	+ 15	252	+ 21
	20 to 50kHz	1Hz	584	+ 16	657	+ 18	730	+ 20	1022	+ 28
	50 to 100kHz	1Hz	640	+ 32	720	+ 36	800	+ 40	1120	+ 56
	100 to 500kHz	1Hz	1600	+ 40	1800	+ 45	2000	+ 50	2800	+ 70
0.2-2.02V ⁶	10 to 45Hz	1Hz	216	+ 9.6	243	+ 10.8	270	+ 12	378	+ 17
	45Hz to 1kHz	1Hz	144	+ 16	162	+ 18	180	+ 20	252	+ 28
	1 to 20kHz	1Hz	144	+ 40	162	+ 45	180	+ 50	252	+ 70
	20 to 50kHz	1Hz	464	+ 40	522	+ 45	580	+ 50	812	+ 70
	50 to 100kHz	1Hz	360	+ 136	405	+ 153	450	+ 170	630	+ 238
	100kHz to 500kHz	1Hz	1200	+ 240	1350	+ 270	1500	+ 300	2100	+ 420
	500kHz to 1MHz	1Hz	800	+ 360	900	+ 405	1000	+ 450	1400	+ 630
2-20.2V	10 to 45Hz	1Hz	280	+ 200	315	+ 225	350	+ 250	490	+ 350
	45Hz to 1kHz	1Hz	128	+ 160	144	+ 180	160	+ 200	224	+ 280
	1 to 20kHz	1Hz	160	+ 256	180	+ 288	200	+ 320	280	+ 448
	20 to 50kHz	1Hz	224	+ 400	252	+ 450	280	+ 500	392	+ 700
	50 to 100kHz	1Hz	440	+ 240	495	+ 270	550	+ 300	770	+ 420
20V - 202V	10Hz to 45Hz	1Hz	280	+ 5000	315	+ 4500	350	+ 5000	490	+ 7000
	45Hz to 1kHz	1Hz	136	+ 1800	153	+ 1620	170	+ 1800	238	+ 2520
	1 to 20kHz	1Hz	184	+ 2500	207	+ 2250	230	+ 2500	322	+ 3500
	20 to 50kHz	1Hz	224	+ 1000	252	+ 900	280	+ 1000	392	+ 1400
	50 to 100kHz	1Hz	480	+ 5000	540	+ 4500	600	+ 5000	840	+ 7000
200-1020V ^{3,9}	30 to 45Hz	1Hz	440	+ 15000	495	+ 13500	550	+ 15000	770	+ 21000
	45Hz to 1kHz	1Hz	176	+ 8000	198	+ 7200	220	+ 8000	308	+ 11200
	1kHz to 10kHz	1Hz	224	+ 12000	252	+ 10800	280	+ 12000	392	+ 16800
	10kHz to 20kHz	1Hz	184	+ 2E+05	207	+ 180000	230	+ 200000	322	+ 280000

AC Frequency Accuracy : 1ppm

Notes	
Note 1:	Current limited by 50 ohms output resistance.
Note 2:	Internally adjustable from 2mA to 30mA - Factory set to 20mA as standard For safety the trip is controlled by a fail-safe circuit independent of the processor which shuts the high voltage output off in the event of an overload.
Note 3:	Frequency and voltage combinations are limited.
Note 4:	Specifications apply up to 10% of maximum load current. Above this level, allowance must be made for output resistance.
Note 5:	Zero or floor allowance.
Note 7:	THD less than 0.39% of output - 10Hz to 1MHz bandwidth at frequencies up to 50kHz
Note 9:	Maximum frequency 10kHz above 330V

2 Wire output / Remote sensing not available.

Maximum floating voltage : 100V.

Isolation : Floating or grounded selection available as standard.

Specifications apply at TCal $\pm 5^{\circ}\text{C}$. Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.

High Voltage Safety	
High voltage output is ramped to allow instruments under test to auto-range.	
Standby is automatically activated when setting voltages greater than 20V or 200V from a lower voltage.	
Standby is automatically selected for high voltage (>20V) after 20 minutes on the same setting for frequencies	
This function can be disabled by the user	
High voltage (> 20V) output is indicated to user through an audible warning beep. This can be disabled by the user	

Due to continuous development specifications may be subject to change.

4610M Extended Specifications

ACV Specifications : V1.5

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1 Year Total Accuracy Specifications at TCal $\pm 5^{\circ}\text{C}$

Range	Frequency	Resolution	Max. Burden Voltage (peak)	Overload Protection	1 year Accuracy		
					%Set		μA
20-202 μA	10Hz to 45Hz	1nA	3 Volts	150V	0.20	+	0.1
	45Hz to 1kHz				0.10	+	0.1
	1kHz to 5kHz				0.80	+	0.25
	5kHz to 10kHz				0.80	+	0.25
	10kHz to 30kHz				1.60	+	0.4
0.2-2.02mA	10Hz to 45Hz	10nA	3 Volts	150V	0.15	+	0.1
	45Hz to 1kHz				0.10	+	0.15
	1kHz to 5kHz				0.50	+	0.3
	5kHz to 10kHz				0.50	+	0.3
	10kHz to 30kHz				1.00	+	0.6
2-20.2mA	10Hz to 45Hz	100nA	3 Volts	150V	0.17	+	1
	45Hz to 1kHz				0.04	+	1.5
	1kHz to 5kHz				0.25	+	3
	5kHz to 10kHz				0.25	+	3
	10kHz to 30kHz				0.50	+	4
20-202mA	10Hz to 45Hz	1 μA	3 Volts	150V	0.15	+	20
	45Hz to 1kHz				0.04	+	8
	1kHz to 5kHz				0.30	+	40
	1kHz to 10kHz				0.50	+	40
	10kHz to 30kHz				0.70	+	200
0.2-2.02A	10Hz to 45Hz	10 μA	3 Volts	150V	0.14	+	200
	45Hz to 1kHz				0.05	+	100
	1kHz to 5kHz				0.40	+	400
	5kHz to 10kHz				0.60	+	1000
	10kHz to 30kHz				2.50	+	5000
2-20.0A ^{1,4}	10Hz to 45Hz	100 μA	2.8 Volts	150V	0.14	+	2000
	45Hz to 1kHz				0.13	+	2000
	1kHz to 5kHz				0.60	+	4000
	5kHz to 10kHz				3.00	+	5000
20-30.0A ^{1,4}	30Hz to 45Hz	100 μA	2.8 Volts	150V	0.20	+	3000
	45Hz to 1kHz				0.30	+	4000
	1kHz to 5kHz				0.60	+	4000
	5kHz to 10kHz				3.00	+	5000

Settling Time: For 50% change in output: Less than 3 second from standby to within spec

Inductive Loads : Up to 1H may be connected without additional protection providing the frequency/inductance combination does not exceed the maximum burden voltage.

Stability (Accuracy relative to calibration Standards)

Range	Frequency	Frequency Resolution	90 Day Rel		180 Day Rel		1 Year Rel		2 Year Rel	
			%Set	uA	%Set	uA	%Set	uA	%Set	uA
20-202uA	10Hz to 45Hz	1Hz	0.136	+ 0.08	0.153	+ 0.09	0.170	+ 0.1	0.238	+ 0.14
	45Hz to 1kHz		0.056	+ 0.08	0.063	+ 0.09	0.070	+ 0.1	0.098	+ 0.14
	1kHz to 5kHz		0.616	+ 0.2	0.693	+ 0.23	0.770	+ 0.25	1.078	+ 0.35
	5kHz to 10kHz		0.616	+ 0.2	0.693	+ 0.23	0.770	+ 0.25	1.078	+ 0.35
	10kHz to 30kHz		1.256	+ 0.32	1.413	+ 0.36	1.570	+ 0.4	2.198	+ 0.56
0.2-2.02mA	10Hz to 45Hz	1Hz	0.096	+ 0.1	0.108	+ 0.1	0.120	+ 0.1	0.168	+ 0.14
	45Hz to 1kHz		0.056	+ 0.15	0.063	+ 0.15	0.070	+ 0.15	0.098	+ 0.21
	1kHz to 5kHz		0.376	+ 0.3	0.423	+ 0.3	0.470	+ 0.3	0.658	+ 0.42
	5kHz to 10kHz		0.376	+ 0.3	0.423	+ 0.3	0.470	+ 0.3	0.658	+ 0.42
	10kHz to 30kHz		0.776	+ 0.6	0.873	+ 0.6	0.970	+ 0.6	1.358	+ 0.84
2mA-20.2mA	10Hz to 45Hz	1Hz	0.112	+ 1	0.126	+ 1	0.140	+ 1	0.196	+ 1.4
	45Hz to 1kHz		0.008	+ 1.5	0.009	+ 1.5	0.010	+ 1.5	0.014	+ 2.1
	1kHz to 5kHz		0.176	+ 3	0.198	+ 3	0.220	+ 3	0.308	+ 4.2
	5kHz to 10kHz		0.176	+ 3	0.198	+ 3	0.220	+ 3	0.308	+ 4.2
	10kHz to 30kHz		0.376	+ 4	0.423	+ 4	0.470	+ 4	0.658	+ 5.6
20-202mA	10Hz to 45Hz	1Hz	0.096	+ 20	0.108	+ 20	0.120	+ 20	0.168	+ 28
	45Hz to 1kHz		0.008	+ 8	0.009	+ 8	0.010	+ 8	0.014	+ 11.2
	1kHz to 5kHz		0.216	+ 40	0.243	+ 40	0.270	+ 40	0.378	+ 56
	5kHz to 10kHz		0.376	+ 40	0.423	+ 40	0.470	+ 40	0.658	+ 56
	10kHz to 30kHz		0.536	+ 200	0.603	+ 200	0.670	+ 200	0.938	+ 280
0.2-2.02A ³	10Hz to 45Hz	1Hz	0.088	+ 200	0.099	+ 200	0.110	+ 200	0.154	+ 280
	45Hz to 1kHz		0.016	+ 100	0.018	+ 100	0.020	+ 100	0.028	+ 140
	1kHz to 5kHz		0.296	+ 400	0.333	+ 400	0.370	+ 400	0.518	+ 560
	5kHz to 10kHz		0.456	+ 1000	0.513	+ 1000	0.570	+ 1000	0.798	+ 1400
	10kHz to 30kHz		1.976	+ 5000	2.223	+ 5000	2.470	+ 5000	3.458	+ 7000
2-20.0A ^{1,4}	10Hz to 45Hz	1Hz	0.088	+ 2000	0.099	+ 2000	0.110	+ 2000	0.154	+ 2800
	45Hz to 1kHz		0.080	+ 2000	0.090	+ 2000	0.100	+ 2000	0.140	+ 2800
	1kHz to 5kHz		0.456	+ 4000	0.513	+ 4000	0.570	+ 4000	0.798	+ 5600
	5kHz to 10kHz		2.376	+ 5000	2.673	+ 5000	2.970	+ 5000	4.158	+ 7000
20-30.0A ^{1,4}	30Hz to 45Hz	1Hz	0.136	+ 3000	0.153	+ 3000	0.170	+ 3000	0.238	+ 4200
	45Hz to 100Hz		0.216	+ 4000	0.243	+ 4000	0.270	+ 4000	0.378	+ 5600
	100Hz to 1kHz		0.456	+ 4000	0.513	+ 4000	0.570	+ 4000	0.798	+ 5600
	1kHz to 5kHz		2.376	+ 5000	2.673	+ 5000	2.970	+ 5000	4.158	+ 7000

Notes

Note 1 : Temperature sensor on 30A range - microprocessor monitors & protects from overheating.

Higher resistance loads allow a longer ON period. See graph 5 for details.

Note 2 : Specifications apply to loads of less than 10% of the maximum burden voltage.

Note 3 : Frequency limited to 10kHz above 1A

Note 4 : Frequency limited to 5kHz above 10A

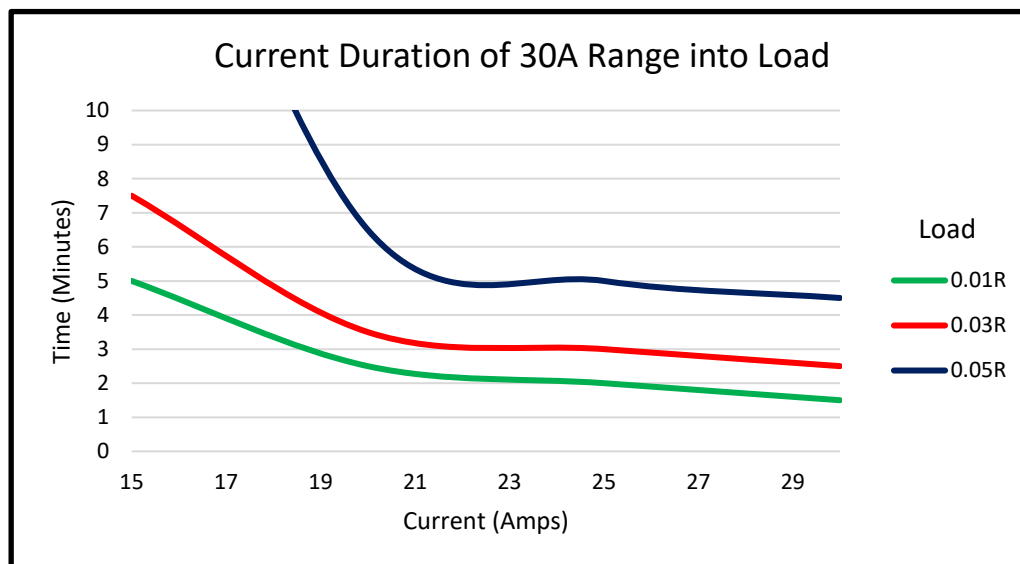
Driving Coils and Inductive Loads

When driving any load exceeding the maximum compliance voltage will cause the calibrator to trip into standby

The maximum compliance voltage on the 30Amp range is specified at a max 2.8V RMS, 7.8V Peak to Peak at 220V supply
Slightly higher compliances are available when powered from a 240V supply.

When using EA002 with leads supplied it is possible to drive 30Amps/50Hz from a 230V supply, falling to 10Amps at 400Hz
Specifications apply at TCal $\pm 5^{\circ}\text{C}$

Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.



Measurement Conditions : Ambient Temperature 20°C, Mains Voltage 230V, Mains Frequency 50Hz
Allow at least 7 minutes 'off' period between current output

Shorter periods will reduce the output time available.

A higher ohmic value load (for example, a 0.1R Shunt) allows greater output time as more heat is dissipated within the shunt / load. With lower loads more heat is dissipated within the instrument, reducing output time

Into a 0.1R Load outputs of up to 20A are available for periods of greater than 30 minutes continuously, considerations of self heating of the external load/Uut should be considered due to the power being dissipated

Total Accuracy Specifications at TCal $\pm 5^{\circ}\text{C}$

Range	Resolution	90 day ppm	180 Day ppm	1 year ppm	2 year ppm
1Hz - 1.2MHz*	1Hz	0.8	0.9	1	1.4

* Frequency continuously variable. Maximum frequency range available on the 2V AC Range

Specifications apply at TCal $\pm 5^{\circ}\text{C}$

Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.

PWM (%) - Frequency Range 5Hz to 50kHz	Duty Cycle Accuracy
5% to 95%	Better than 0.1% Setting

PWM (Level)	Level Accuracy
2V to 10V	Better than 0.05V

PWM (DC Offset)	Level Accuracy
+0V to +5V	Better than 0.1V

PWM Output provides a square wave output with variable level, duty cycle and DC offset

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 4000 Series calibrators use passive standard resistors, the calibrated value of which is displayed when selected.

1 year Total Accuracy Specifications at TCal $\pm 5^{\circ}\text{C}$ & Range Parameters

Range	Maximum Current	Maximum Voltage	Display Resolution	1 Year Total Accuracy	
				ppm set	Ohms
0 Ω	0.5A	-	1 $\mu\Omega$	0	0.005
0.1 Ω	0.5A	-	1 $\mu\Omega$	25 +	0.005
1 Ω	0.4A	-	1 $\mu\Omega$	25 +	0.005
10 Ω	0.3A	-	1 $\mu\Omega$	25 +	0.005
100 Ω	0.1A	-	10 $\mu\Omega$	18 +	0.005
1k Ω	-	10V	100 $\mu\Omega$	18 +	0.005
10k Ω	-	50V	1m Ω	8 +	0.05
100k Ω	-	100V	10m Ω	18 +	0.5
1M Ω	-	100V	100m Ω	25 +	5
10M Ω	-	100V	1 Ω	90 +	100
100M Ω	-	100V	1k Ω	1800 +	2000
1G Ω *		100V	10k Ω	10000 +	30000

*** 2-Wire only**

Stability (Accuracy relative to calibration Standards)

Range	90 Day Rel		180 Day Rel		1 Year Rel		2 Year Rel	
	%	Ohms	%	Ohms	%	Ohms	%	Ohms
0 Ω	-	0.005	-	0.005	-	0.005	-	0.005
0.1 Ω	0 +	0.005	0 +	0.005	0 +	0.005	0 +	0.005
1 Ω	0 +	0.005	0 +	0.005	0 +	0.005	0 +	0.005
10 Ω	0 +	0.005	0 +	0.005	0 +	0.005	0 +	0.005
100 Ω	0.0012 +	0.005	0.00135 +	0.005	0.0015 +	0.005	0.0021 +	0.005
1k Ω	0.00128 +	0.005	0.00144 +	0.005	0.0016 +	0.005	0.0022 +	0.005
10k Ω	0.00048 +	0.05	0.00054 +	0.05	0.0006 +	0.05	0.0008 +	0.05
100k Ω	0.00096 +	0.5	0.00108 +	0.5	0.0012 +	0.5	0.0017 +	0.5
1M Ω	0.00144 +	5	0.00162 +	5	0.0018 +	5	0.0025 +	5
10M Ω	0.0064 +	100	0.0072 +	100	0.008 +	100	0.0112 +	100
100M Ω	0.136 +	2000	0.153 +	2000	0.17 +	2000	0.238 +	2000
1G Ω	0.72 +	30000	0.81 +	30000	0.9 +	30000	1.26 +	30000

For 2-Wire connection allow 35mW on all resistance specifications.

The 2 and 4 Wire value for each resistor is calibrated. The 2-Wire value is measured at the terminals

The 4-Wire values are taken using the zero position to NULL the measuring system.

Specifications apply at TCal $\pm 5^{\circ}\text{C}$.

Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.

1 year Total Accuracy Specifications at TCal $\pm 5^{\circ}\text{C}$

Range	Display Resolution	Measurement Current (Max.)	1 year	
			ppm Set	Zero
0 Ω to 10 Ω	1m Ω	100mA	150	6m Ω
10 Ω to 33 Ω	1m Ω	100mA	90	3m Ω
33 Ω to 100 Ω	10m Ω	50mA	80	9m Ω
100 Ω to 330 Ω	10m Ω	30mA	30	18m Ω
330 Ω to 1k Ω	100m Ω	10mA	50	26m Ω
1k Ω to 3.3k Ω	100m Ω	3mA	60	60m Ω
3.3k Ω to 10k Ω	1 Ω	1mA	60	220m Ω
10k Ω to 33k Ω	1 Ω	300uA	60	620m Ω
33k Ω to 100k Ω	10 Ω	100uA	60	2.2 Ω
100k Ω to 330k Ω	10 Ω	30uA	60	6.2 Ω
330k Ω to 1M Ω	100 Ω	10uA	100	9 Ω
1M Ω to 3.3M Ω	100 Ω	3uA	200	150 Ω
3.3M Ω to 10M Ω	1k Ω	1uA	250	300 Ω
10M Ω to 33M Ω	1k Ω	300nA	800	15k Ω
33M Ω to 100M Ω	10k Ω	100nA	1500	25k Ω
110M Ω to 330M Ω	10k Ω	30nA	1700	80k Ω
330M Ω to 1G Ω	100k Ω	10nA	10000	800k Ω

Simulated resistance is available as 2 Wire, 2 Wire Compensated and 4 Wire

Specifications apply for 4 Wire mode up to 100k Ω . Specifications above 100k Ω apply to 2 Wire

2 Wire compensated Output : Add 6uV divided by Measurement Current in Amps to floor specification

2 Wire output is relative to the 0 Ω output of the calibrator. Connect multimeter and press REL/Null with 0 Ω set

Input measurement current must be a constant DC current isolated from earth

Performance/compatibility may be affected using other measurement methods/techniques for the simulated resistance function
eg. AC or pulsed, in which case passive resistance functionality may be employed.

Current must be stable for a period of 1s - it is therefore recommended the UUT range is selected manually

Specifications apply at TCal $\pm 5^{\circ}\text{C}$.

Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 4000 Series calibrators use passive standard capacitors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Voltage	Display Resolution	D	R _s
1nF	50V	0.1pF	0.006	N/A
2nF	50V	0.1pF	0.006	N/A
5nF	50V	0.1pF	0.006	N/A
10nF	50V	0.1pF	0.006	N/A
100nF	50V	10pF	0.006	N/A
1uF	30V	100pF	0.002	N/A
10uF	20V	1nF	0.014	0.2mΩ

Specifications apply at 1kHz. Allow 20pF for lead effects.

No appreciable variation is noticeable at frequencies below 1kHz.

1 year Total Accuracy Specifications at TCal ±5°C

Range	90 day %	180 Day %	1 year %	2 year %
1nF	0.2	0.225	0.25	0.35
2nF	0.2	0.225	0.25	0.35
5nF	0.2	0.225	0.25	0.35
10nF	0.2	0.225	0.25	0.35
100nF	0.2	0.225	0.25	0.35
1uF	0.32	0.36	0.4	0.56
10uF	0.48	0.54	0.6	0.84

Measurement methods

C_p up to 1uF
C_s above 1uF

Capacitance is calibrated as value at the terminals

ie. displayed value incorporates capacitance of circuit up to and including the terminals

Specifications apply at TCal ±5°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

General Specifications

Range	Maximum Voltage	Display Resolution
1nF to 10nF	8V	10pF
10nF to 100nF	8V	100pF
100nF to 950nF	8V	100pF
0.95uF to 9.5uF	8V	1nF
9.5uF to 95uF	8V	10nF
95uF to 0.95mF	8V	1uF
0.95mF to 9.5mF	8V	1uF
9.5mF to 100mF	8V	10uF

1 year Total Accuracy Specifications at TCal $\pm 5^{\circ}\text{C}$

Range	90 day % of Setting	180 Day % of Setting	1 year % of Setting	2 year % of Setting
1nF to 10nF	0.32 + 9pF	0.36 + 9pF	0.45 + 10pF	0.56 + 15pF
10nF to 100nF	0.44	0.495	0.55	0.77
100nF to 950nF	0.4	0.45	0.5	0.7
0.95uF to 9.5uF	0.4	0.45	0.5	0.7
9.5uF to 95uF	0.6	0.675	0.75	1.05
95uF to 0.95mF	0.6	0.675	0.75	1.05
0.95mF to 9.5mF	0.6	0.675	0.75	1.05
9.5mF to 100mF	1.12	1.26	1.4	1.96

Specifications apply at TCal $\pm 5^{\circ}\text{C}$.

Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.

Specifications apply relative to the 0nF output

Minimum terminal voltage = 80mV

Maximum terminal voltage = 8V

Maximum current input = 20mA

Performance/compatibility may be affected using other measurement methods/techniques for the simulated capacitance function in which case passive capacitance functionality may be employed.

A constant charging current is required for specifications to apply. AC measurement techniques will fall outside of the specification

Connection	1 x Neutral (copper) industry standard thermocouple socket with integral temperature sensor
Sensor Type	Thermistor
Output impedance	10 Ohms

Thermocouple Type	Range Source / Measure	90 Day ¹ Rel. (°C)	180 Day ¹ Rel. (°C)	1 Year ¹ Rel. (°C)	2 Year ¹ Rel. (°C)
B	600°C to 800°C	0.58	0.66	0.73	1.02
	800°C to 1000°C	0.52	0.59	0.65	0.91
	1000°C to 1550°C	0.43	0.49	0.54	0.76
	1550°C to 1820°C	0.44	0.50	0.55	0.77
C	0°C to 150°C	0.25	0.28	0.31	0.43
	150°C to 650°C	0.22	0.24	0.27	0.38
	650°C to 1000°C	0.26	0.29	0.32	0.45
	1000°C to 1800°C	0.38	0.42	0.47	0.66
	1800°C to 2316°C	0.54	0.61	0.68	0.95
E	-250°C to -100°C	0.40	0.45	0.50	0.70
	-100°C to -25°C	0.08	0.09	0.10	0.14
	-25°C to 350°C	0.07	0.08	0.09	0.13
	350°C to 650°C	0.10	0.11	0.12	0.17
	650°C to 1000°C	0.12	0.14	0.15	0.21
J	-210°C to -100°C	0.18	0.21	0.23	0.32
	-100°C to -30°C	0.09	0.10	0.11	0.15
	-30°C to 150°C	0.07	0.08	0.09	0.13
	150°C to 760°C	0.11	0.13	0.14	0.20
	760°C to 1200°C	0.15	0.17	0.19	0.27
K	-200°C to -100°C	0.22	0.24	0.27	0.38
	-100°C to -25°C	0.12	0.14	0.15	0.21
	-25°C to 120°C	0.09	0.10	0.11	0.15
	-120°C to -1000°C	0.16	0.18	0.20	0.28
	1000°C to 1370°C	0.21	0.23	0.26	0.36
L	-200°C to -100°C	0.27	0.31	0.34	0.48
	-100°C to 800°C	0.26	0.30	0.33	0.46
	800°C to 900°C	0.27	0.31	0.34	0.48
N	-200°C to -100°C	0.34	0.38	0.42	0.59
	-100°C to -25°C	0.16	0.18	0.20	0.28
	-25°C to 120°C	0.13	0.14	0.16	0.22
	120°C to 410°C	0.12	0.14	0.15	0.21
	410°C to 1300°C	0.19	0.22	0.24	0.34
R	-0°C to 250°C	0.64	0.72	0.80	1.12
	250°C to 1000°C	0.35	0.40	0.44	0.62
	1000°C to 1760°C	0.41	0.46	0.51	0.71

Due to continuous development specifications may be subject to change.

4610M Extended Specifications

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S	0°C to 250°C	0.64	0.72	0.80	1.12
	250°C to 1000°C	0.35	0.40	0.44	0.62
	1000°C to 1760°C	0.41	0.46	0.51	0.71
T	-250°C to -150°C	0.48	0.54	0.60	0.84
	-150°C to 0°C	0.08	0.09	0.10	0.14
	0°C to 120°C	0.07	0.08	0.09	0.13
	-120°C to 400°C	0.09	0.10	0.11	0.15
U	-200°C to 0°C	0.34	0.38	0.42	0.59
	0°C to 600°C	0.24	0.27	0.30	0.42

Thermocouple Type	Range Source / Measure	90 Day [†] Zero + % Output	180 Day [†] Zero + % Output	1 Year [†] Zero + % Output	2 Year [†] Zero + % Output
1mV / °C	-100°C to +100°C	4uV + 0.011	4uV + 0.013	4uV + 0.014	6uV

Note 1 : Does not include cold junction compensation errors

Cold Junction Compensation Error = $\pm 0.2^{\circ}\text{C}$

All thermocouple measurement specifications assume correct compensation cable is being used

Specifications apply at TCal $\pm 5^{\circ}\text{C}$.

Outside this range an allowance of 0.18 x 1 Year Spec. per $^{\circ}\text{C}$ should be added.

General Specifications

PRT Type	Range °C	1 Year * ± °C
PT25	-200 to 0	0.50
	0 to 800	0.60
PT100	-200 to 0	0.13
	0 to 800	0.55
PT250	-200 to 0	0.25
	0 to 800	0.30
PT500	-200 to 260	0.10
	260 to 500	0.90
PT1000	-200 to 0	0.08
	0 to 800	0.45

2-Wire connection only

Display resolution : 10m°C

Minimum terminal voltage = 80mV

Maximum current input = 20mA

Input measurement current must be a constant DC current isolated from earth

Performance/compatibility may be affected using other measurement methods/techniques for the variable PRT function

e.g.. AC or pulsed, in which case passive resistance functionality may be employed.

Current must be stable for a period of 1s - it is therefore recommended the UUT range is selected manually

* Specifications apply at TCal ± 5°C.

Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

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