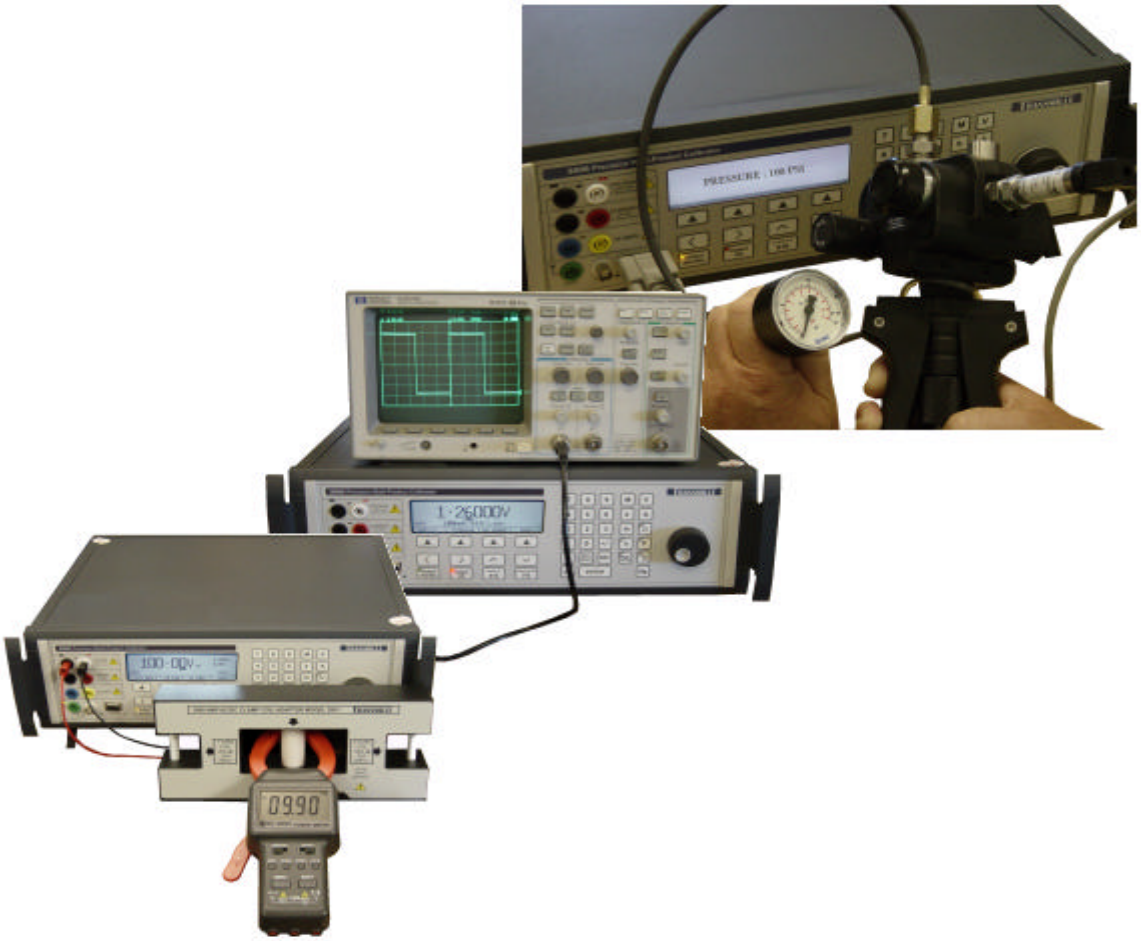
2041A MULTI-PRODUCT CALIBRATOR

25ppm MULTI-PRODUCT CALIBRATOR



EXTENDED SPECIFICATIONS

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2041A General Specifications

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Warm Up Time	Double the time since last used up to 20 minutes maximum	
Standard Interfaces	RS232	
Optional Interfaces	GPIB (IEEE-488) : USB (Universal Serial Bus)	
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 : 110V / 230V Line Frequency : 50Hz to 60Hz Line Voltage Variation : -6% +10%	
Power Consumption	28 Watts (Standby)	200 Watts (Maximum)
Low Analogue Isolation	100V	
Connections	Voltage / 2 Wire Resistance Low Current (<=2A) High current (>2A) Earth Connection Oscilloscope Functions Feature (Ext. Pod) RS232 Interface	1x Black : 1x White 4mm Safety sockets 1x Black : 1x Red 4mm Safety sockets 1x Blue : 1x Yellow 4mm Safety sockets 1x Green 4mm Safety Socket 1x BNC terminal 1x Female 'D' type socket 1x Female 'D' type socket
RS232 Settings	Baud Rate Parity Data Bits Stop Bits	9600 None 8 1
Display Information	Type Viewing Area Resolution Backlight Type Brightness	Backlit Black on white film STN type 124.3mm * 34mm 256 * 94 dots Cold fluorescent lamp 70 to 90 cd/m^2
Indicators	Voltage / Current / High Current Negative to ground Oscilloscope Feature Connector (Ext. Pod)	Red LED (between terminals) Green LED (left of Earth terminal) Green LED (right of BNC Connector) Green LED (right of 'D' type connector)
Keyboard	Membrane type with tactile feedback	
Fuses	Mains Inlet	3.15A A/S (240 Volt) 5A A/S (110 Volt operation)
Isolation	Outputs are opto-isolated from mains earth and the RS-232 interface Maximum common mode voltage between earth and the low terminals 30 Volts ac/dc.	
Dimensions & Weights	Calibrator Only Calibrator in Shipping Box Calibrator in Soft Carry Case Calibrator in Hard Transit case	14cm x 43cm x 46cm : 12.5kgs 58cm x 56cm x 37cm : 15kgs 49cm x 50cm x 19cm : 13.5kgs 55cm x 56cm x 26cm : 22kgs
Warranty Period	3 Years (Parts & Labour)	
Recommended Service Interval	1 Year	
Supplied Connections	1x Serial Interface Connection 1x Adaptor Connection Lead (if at least one adaptor ordered)	1x Mains Lead
Optional Lead Set Kit	1x Voltage connection leadset 1x Low Current connection leadset 1x High current connection leadset 1x AC connection leadset	
Mounting Kit (optional)	3U rack mount kit	
Case Colour	Matt Dark Grey (RAL7016)	

Due to continuous development specifications may be subject to change.

2041A DC Voltage Specifications

TRANSMILLE
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General Specifications [1]

Range	Resolution	Max. Burden Current	Output Resistance	Overload Protection
0-202mV	0.1uV	1mA[2]	50 Ohms	20 V
0.2-2.02V	1uV	50mA	0.2 Ohms	150V
2-20.2V	10uV	50mA	0.2 Ohms	150V
20-202V	100uV	10mA[3]	0.5 Ohms	1200V
200-1020V	1mV	10mA[3]	0.7 Ohms	1200V

Accuracy Relative to Calibration Standards Specifications [1]

Range	24 Hour Stability		Noise[4]	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
	ppm Set	Rng	1Hz to 10Hz	ppm Set	Rng	ppm Set	Rng	ppm Set	Rng	ppm Set	Rng
0-202mV	2	+ 1	60nV	24	+ 3	27	+ 3	30	+ 3	42	+ 4.2
0.2-2.02V	2	+ 1	280nV	24	+ 3	27	+ 3	30	+ 3	42	+ 4.2
2-20.2V	2	+ 1	2.5uV	20	+ 3	22.5	+ 3	25	+ 3	35	+ 4.2
20-202V	3.5	+ 1	50.7uV	24	+ 3	27	+ 3	30	+ 3	42	+ 4.2
200-1020V	5	+ 2	280uV	24	+ 6	27	+ 6	30	+ 6	42	+ 8.4

All specifications allow 3uV for lead and thermal emf effects [5]

Notes

Note 1 : Specifications apply up to 10% of maximum load current. Above this level, allowance must be made for output resistance.

Note 2 : Limited by 50 Ohm output impedance.

Note 3 : Internally adjustable from 2mA to 30mA - Factory set to 10mA as standard. For safety the trip is controlled by a fail-safe circuit independant 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.

Note 5 : Zero or floor allowance.

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.
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 between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Worked Accuracy Calculation of 5V output on the 20V range at 20°C using 1 year specification

25ppm Set (Output setting on calibrator = 5V)	25ppm of 5V =	125uV
3ppm Rng (Full scale of range selected = 20V)	3ppm of 20V =	60uV
Zero or floor allowance		3uV
Total accuracy of calibrator only =		± 188uV

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.

2041A DC Current Specifications

General Specifications

Range	Resolution	Max. Inductive Load	Compliance Voltage	Overload Protection
0-202uA	100pA	10mH	4.2 Volts	150V
0.2-2.02mA	1nA	10mH	4.2 Volts	150V
2-20.2mA	10nA	10mH	4.2 Volts	150V
20-202mA	100nA	10mH	4.2 Volts	150V
0.2-2.02A	1uA	10mH	4.2 Volts	150V
2-20.2A	10uA	10mH	3.9 Volts	150V

Accuracy Relative to Calibration Standards Specifications [3]

Range	Noise [1]	90 day Rel			180 Day Rel			1 year Rel			2 year Rel		
	0.1-1Hz	%Set		%Rng	%Set		%Rng	%Set		%Rng	%Set		%Rng
0-202uA	180pA	0.008	+	0.008	0.009	+	0.008	0.01	+	0.008	0.014	+	0.0112
0.2-2.02mA	500pA	0.0064	+	0.002	0.0072	+	0.002	0.008	+	0.002	0.0112	+	0.0028
2-20.2mA	4nA	0.004	+	0.002	0.0045	+	0.002	0.005	+	0.002	0.007	+	0.0028
20-202mA	40nA	0.0064	+	0.002	0.0072	+	0.002	0.008	+	0.002	0.0112	+	0.0028
0.2-2.02A	1uA	0.012	+	0.002	0.0135	+	0.002	0.015	+	0.002	0.021	+	0.0028
2-20.2A [2]	20uA	0.032	+	0.002	0.036	+	0.002	0.04	+	0.002	0.056	+	0.0028

All specification +/- 4nA. [4]

Notes

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

Note 2 : Power & temperature sensor on 20A 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.

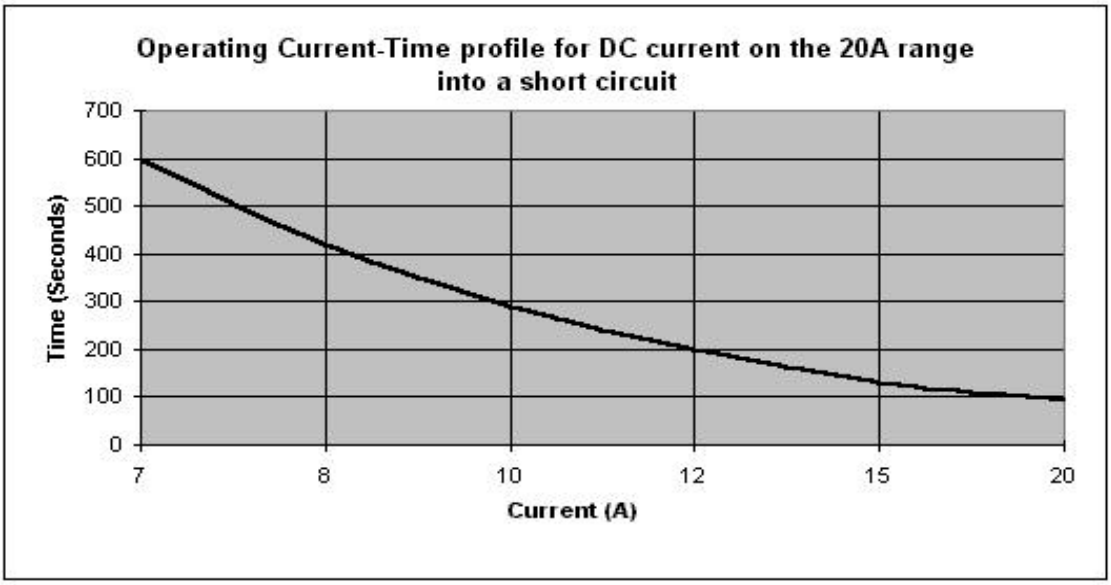
Note 4: Zero or floor allowance.

Specifications apply between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

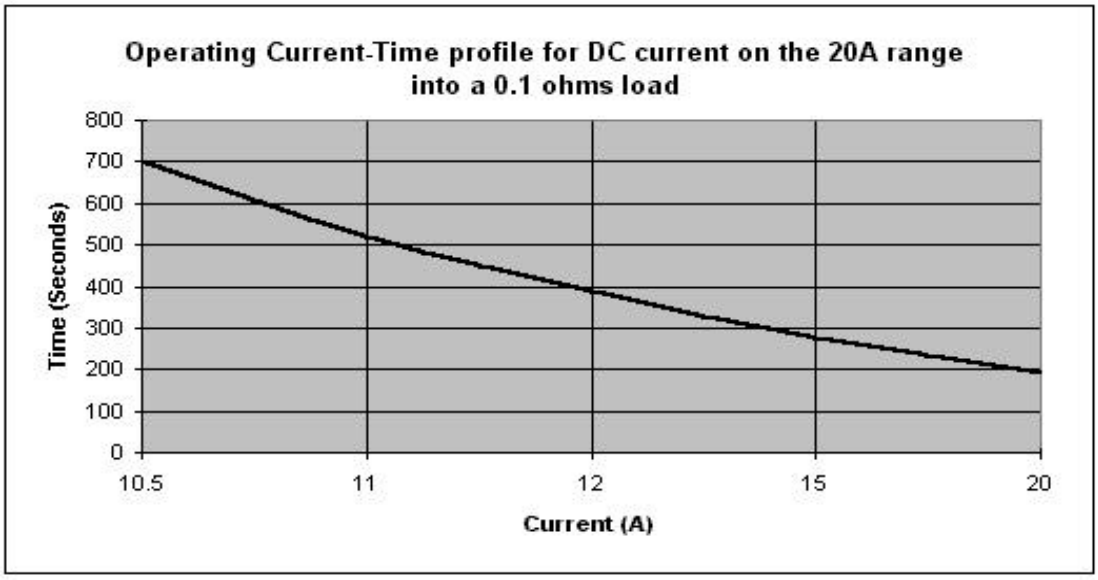
Worked Accuracy Calculation of 1.2mA output on the 2mA range at 20°C using 1 year spec.

0.008% Set (Output setting on calibrator = 1.2mA)	0.008% of 1.2mA =	96nA
0.002% Rng (Full scale of range selected = 2mA)	0.002% of 2mA =	40nA
Zero or floor allowance		4nA
Total accuracy of calibrator only =		± 140nA

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.



Graph 1* : Operating time on 20A range with current into a short circuit at 20 deg C.
Continuous current in availiable below 7A output.



Graph 2* : Operating time on 20A range with current into a 0.1ohm load at 20 deg C.
Continuous current in availiable below 10.5A output.

* Note Timing is started after a minimum period of 7 minutes at zero output.
Shorter periods will reduce the output time availiable.

2041A AC Voltage Specifications

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General Specifications

Range	Frequency	Resolution	Max. Burden Current	Output Resistance	Overload Protection
0-202mV	10Hz to 29Hz	1uV	1mA [1]	50 Ohms	20 V
	30Hz to 999Hz	1uV	1mA [1]	50 Ohms	20 V
	1kHz to 9.999kHz	1uV	1mA [1]	50 Ohms	20 V
	10kHz to 40kHz	1uV	1mA [1]	50 Ohms	20 V
0.2-2.02V	10Hz to 29Hz	10uV	50mA	0.2 Ohms	1200V
	30Hz to 999Hz	10uV	50mA	0.2 Ohms	1200V
	1Hz to 19.999kHz	10uV	50mA	0.2 Ohms	1200V
	20kHz to 100kHz	10uV	50mA	0.2 Ohms	1200V
2-20.2V	10Hz to 29Hz	100uV	50mA	0.2 Ohms	1200V
	30Hz to 999Hz	100uV	50mA	0.2 Ohms	1200V
	1Hz to 19.999kHz	100uV	50mA	0.2 Ohms	1200V
	20kHz to 100kHz	100uV	50mA	0.2 Ohms	1200V
20-202V	30Hz to 999Hz	1mV	10mA [2]	0.5 Ohms	1200V
	1kHz to 9.999kHz	1mV	5mA [2]	0.5 Ohms	1200V
	10kHz to 20kHz	1mV	2mA [2]	0.5 Ohms	1200V
200-1020V [3]	30Hz to 999Hz	10mV	10mA [2]	0.7 Ohms	1200V
	1kHz to 10kHz	10mV	2mA [2]	0.7 Ohms	1200V

Accuracy Relative to Calibration Standards Specifications [4]

Range	Frequency	Frequency Resolution	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
			%Set	%Rng	%Set	%Rng	%Set	%Rng	%Set	%Rng
0-202mV	10Hz to 29Hz	1Hz	0.16	+ 0.08	0.18	+ 0.08	0.2	+ 0.08	0.28	+ 0.112
	30Hz to 999Hz	1Hz	0.032	+ 0.01	0.036	+ 0.01	0.04	+ 0.01	0.056	+ 0.014
	1kHz to 9.999kHz	1Hz	0.048	+ 0.04	0.054	+ 0.04	0.06	+ 0.04	0.084	+ 0.056
	10kHz to 40kHz	1Hz	0.08	+ 0.07	0.09	+ 0.07	0.1	+ 0.07	0.14	+ 0.098
0.2-2.02V	10Hz to 29Hz	1Hz	0.112	+ 0.09	0.126	+ 0.09	0.14	+ 0.09	0.196	+ 0.126
	30Hz to 999Hz	1Hz	0.032	+ 0.01	0.036	+ 0.008	0.04	+ 0.008	0.056	+ 0.011
	1kHz to 19.999kHz	1Hz	0.072	+ 0.04	0.081	+ 0.04	0.09	+ 0.04	0.126	+ 0.056
	20kHz to 59.999kHz	1Hz	0.184	+ 0.18	0.207	+ 0.18	0.23	+ 0.18	0.322	+ 0.252
	60kHz to 100kHz	2Hz	0.184	+ 0.18	0.207	+ 0.18	0.23	+ 0.18	0.322	+ 0.252
2-20.2V	10Hz to 29Hz	1Hz	0.112	+ 0.09	0.126	+ 0.09	0.14	+ 0.09	0.196	+ 0.126
	30Hz to 999Hz	1Hz	0.024	+ 0.01	0.027	+ 0.008	0.03	+ 0.008	0.042	+ 0.011
	1kHz to 19.999kHz	1Hz	0.072	+ 0.04	0.081	+ 0.04	0.09	+ 0.04	0.126	+ 0.056
	20kHz to 59.999kHz	1Hz	0.184	+ 0.18	0.207	+ 0.18	0.23	+ 0.18	0.322	+ 0.252
	60kHz to 100kHz	2Hz	0.184	+ 0.18	0.207	+ 0.18	0.23	+ 0.18	0.322	+ 0.252
20-202V	30Hz to 999Hz	1Hz	0.032	+ 0.01	0.036	+ 0.01	0.04	+ 0.01	0.056	+ 0.014
	1kHz to 9.999kHz	1Hz	0.048	+ 0.04	0.054	+ 0.04	0.06	+ 0.04	0.084	+ 0.056
	10kHz to 20kHz	1Hz	0.08	+ 0.05	0.09	+ 0.05	0.1	+ 0.05	0.14	+ 0.070
200-1020V [3]	30Hz to 999Hz	1Hz	0.032	+ 0.02	0.036	+ 0.02	0.04	+ 0.02	0.056	+ 0.028
	1kHz to 10kHz	1Hz	0.12	+ 0.1	0.135	+ 0.1	0.15	+ 0.1	0.21	+ 0.140

All specifications ± 20uV. All specifications apply from 10% of full scale. [5]

Notes

Note 1: Current limited by 50 ohms output resistance.

Note 2 : Internally adjustable from 2mA to 30mA - Factory set to 10mA as standard
For safety the trip is controlled by a fail-safe circuit independant of the processor which shuts the high voltage output off in the event of an overload.

Note 3 : Frequency and voltage combinations are limited. See Volt-Hertz profile in Graph 3

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.

2 Wire output / Remote sensing not available. Maximum floating voltage : 100V.
Isolation : Floating or grounded selection available as standard.
Specifications apply between 17°C and 27°C. Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

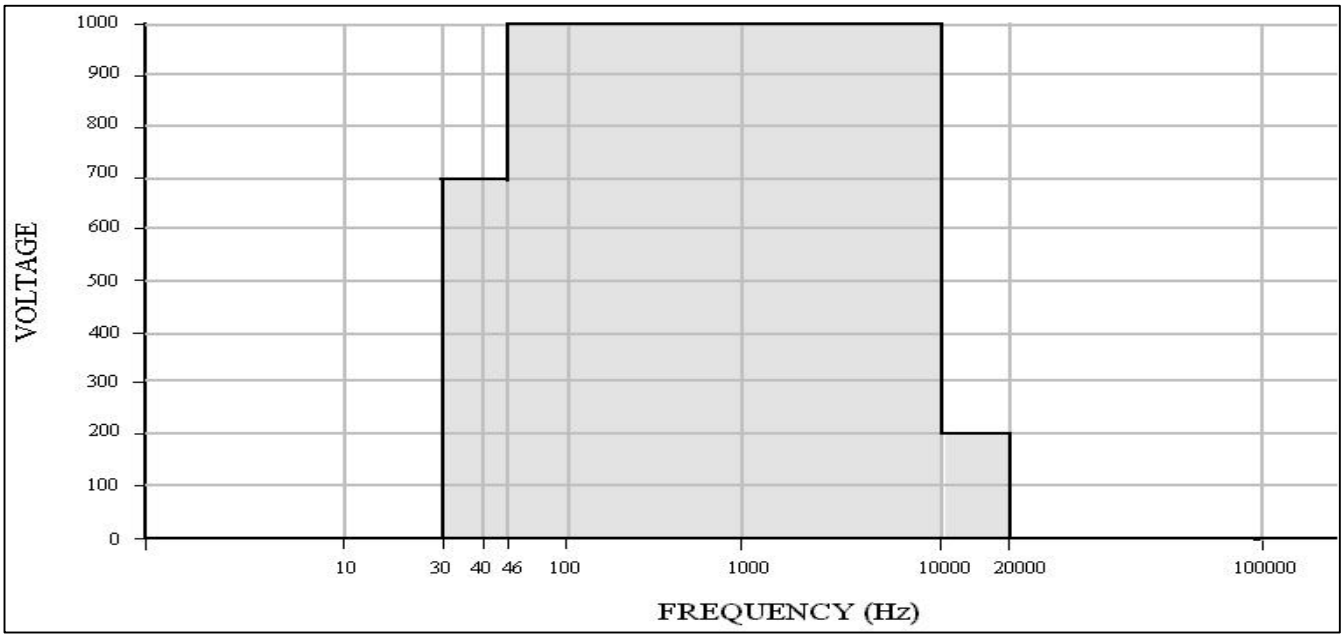
Due to continuous development specifications may be subject to change.

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 up to 5kHz or 3 mins for frequencies above 5kHz. See graph 4.
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.

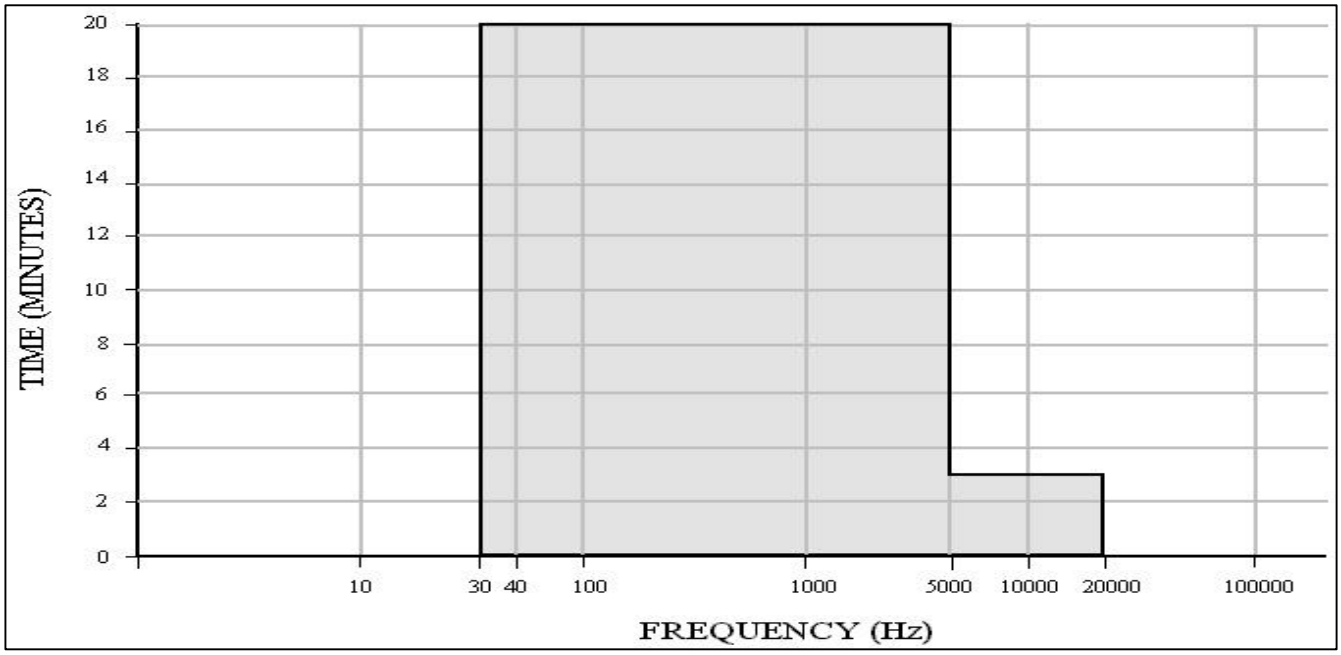
Worked Accuracy Calibration of 1V output at 5kHz on the 2V range at 20°C using 180 day spec.

0.081% Set (Output setting on calibrator = 1V)	0.081% of 1V =	810uV
0.04% Rng (Full scale of range selected = 2V)	0.04% of 2V =	800uV
Zero or floor allowance		20uV
Total accuracy of calibrator only =		± 1630uV

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.



Graph 3 : Volt-Hertz profile for 1000V AC range



Graph 4 : Time-Hertz profile for voltages above 20V

General Specifications

Range	Frequency	Resolution	Maximum Burden Voltage	Overload Protection	Inductive Load
20-202uA	10Hz to 2kHz	1nA	3 Volts	150V	5mH
0.2-2.02mA	10Hz to 10kHz	10nA	3 Volts	150V	5mH
2-20.2mA	10Hz to 10kHz	100nA	3 Volts	150V	5mH
20-202mA	10Hz to 2kHz	1uA	3 Volts	150V	5mH
0.2-2.02A	30Hz to 2kHz	10uA	3 Volts	150V	5mH
2-20.2A	30Hz to 500Hz	100uA	2.8 Volts	150V	0.8mH

All specifications +/- 650nA. All specifications apply from 10% of full scale.

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.

Accuracy Relative to Calibration Standards Specifications [2]

Range	Frequency	Frequency Resolution	90 day Rel		180 Day Rel		1 year Rel		2 year Rel	
			%Set	%Rng	%Set	%Rng	%Set	%Rng	%Set	%Rng
20-202uA	10Hz to 29Hz	1Hz	0.16	0.08	0.18	0.08	0.2	0.08	0.28	0.112
	30Hz to 999Hz	1Hz	0.072	0.02	0.081	0.02	0.09	0.02	0.126	0.028
	1kHz to 2kHz	1Hz	0.8	0.2	0.9	0.2	1	0.2	1.4	0.28
0.2-2.02mA	10Hz to 29Hz	1Hz	0.16	0.08	0.18	0.08	0.2	0.08	0.28	0.112
	30Hz to 999Hz	1Hz	0.072	0.01	0.081	0.01	0.09	0.01	0.126	0.014
	1kHz to 10kHz	1Hz	0.32	0.1	0.36	0.1	0.4	0.1	0.56	0.14
2mA-20.2mA	10Hz to 29Hz	1Hz	0.16	0.08	0.18	0.08	0.2	0.08	0.28	0.112
	30Hz to 999Hz	1Hz	0.072	0.01	0.081	0.01	0.09	0.01	0.126	0.014
	1kHz to 10kHz	1Hz	0.32	0.1	0.36	0.1	0.4	0.1	0.56	0.14
20-202mA	10Hz to 29Hz	1Hz	0.16	0.08	0.18	0.08	0.2	0.08	0.28	0.112
	30Hz to 999Hz	1Hz	0.072	0.01	0.081	0.01	0.09	0.01	0.126	0.014
	1kHz to 2kHz	1Hz	0.32	0.1	0.36	0.1	0.4	0.1	0.56	0.14
200-2.02A	30Hz to 999Hz	1Hz	0.072	0.01	0.081	0.01	0.09	0.01	0.126	0.014
	1kHz to 2kHz	1Hz	0.56	0.2	0.63	0.2	0.7	0.2	0.98	0.28
2-20.2A[1]	30Hz to 500Hz	1Hz	0.08	0.01	0.09	0.01	0.1	0.01	0.14	0.014

Notes

Note 1 : Temperature sensor on 20A range - microprocessor monitors & protects from overheating.
Higher resistance loads allow a longer ON period. See graphs 5 and 6 for details.

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

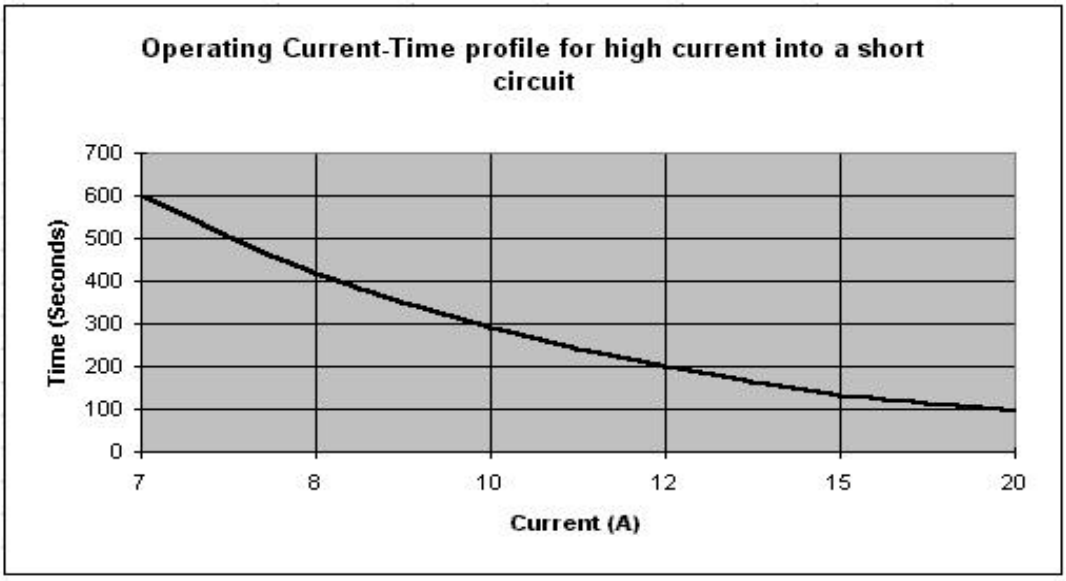
Specifications apply between 17°C and 27°C.

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

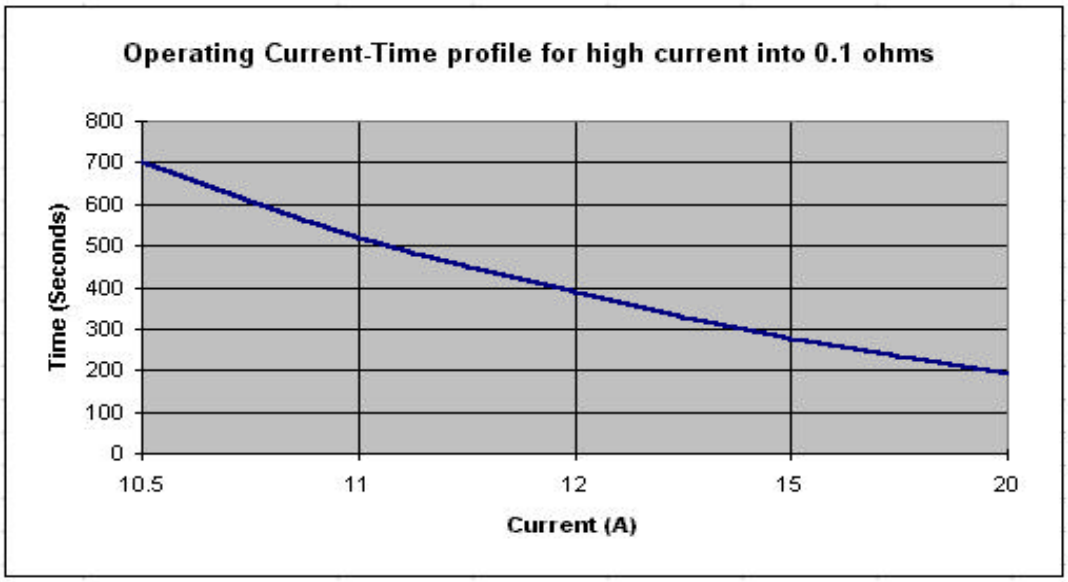
Worked Accuracy Calibration of 8mA output at 500Hz on the 20mA range at 20°C using 1 year spec.

0.09% Set (Output setting on calibrator = 8mA)	0.09% of 8mA =	7.2uA
0.01% Rng (Full scale of range selected = 20mA)	0.01% of 20mA =	2.0uA
Zero or floor allowance		0.65nA
Total accuracy of calibrator only =		± 9.85uA

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.



Graph 5* : Operating time on 20A range with current into a short circuit at 20 deg C.
Continuous current in availiable below 7A output.



Graph 6* : Operating time on 20A range with current into a 0.1ohm load at 20 deg C.
Continuous current in availiable below 10.5A output.

* Note Timing is started after a minimum period of 7 minutes at zero output.
Shorter periods will reduce the output time availiable.

2041A DC Resistance Specifications

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 2000 Series calibrators use passive standard resistors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Current	Maximum Voltage
0Ω	0.5A	-
0.1Ω	200mA	2 Volts
1Ω	200mA	2 Volts
10Ω	100mA	5 Volts
100Ω	50mA	5 Volts
1kΩ	10mA	10 Volts
10kΩ	3mA	30 Volts
100kΩ	1mA	100 Volts
1MΩ*	0.1mA	100 Volts
10MΩ*	10uA	100 Volts
100MΩ*	1uA	100 Volts
1GΩ*	100nA	100 Volts

*** 2-Wire only**

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
0Ω	-	-	-	-
0.1Ω	0.012	0.0135	0.015	0.021
1Ω	0.008	0.009	0.01	0.014
10Ω	0.008	0.009	0.01	0.014
100Ω	0.004	0.0045	0.005	0.007
1κΩ	0.0032	0.0036	0.004	0.0056
10κΩ	0.0032	0.0036	0.004	0.0056
100κΩ	0.0032	0.0036	0.004	0.0056
1MΩ	0.008	0.009	0.01	0.014
10MΩ	0.028	0.0315	0.035	0.049
100MΩ	0.24	0.27	0.3	0.42
1000MΩ	0.8	0.9	1	1.4

For 4-Wire connection allow 1mW on all resistance specifications.

For 2-Wire connection allow 40mW 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 between 17°C and 27°C.

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

Worked Examples

100 ohms 4-wire output at 31°C using 2 year specification.

0.007% of setting (100Ω)	7 mΩ
Zero allowance (4 wire connection)	1mΩ
Temp coefficient (31-27) X 0.18 X 0.005% X 100Ω	3.6mΩ
Total accuracy of calibrator only =	140nA

1k ohms 2-wire output at 25°C using 180 day specification.

0.0036% of setting (1kΩ)	36mΩ
Zero allowance (2 wire connection)	40mΩ
Total accuracy of calibrator only =	76mΩ

Absolute accuracy must also include the accuracy (uncertainty) of the origional calibration of the 2041A and the accuracy of the instrument used to verify its performance.

2041A Capacitance Specifications

For the highest possible accuracy and dependability of the measured value, regardless of the measurement technique used, the 2000 Series calibrators use passive standard capacitors, the calibrated value of which is displayed when selected.

General Specifications

Range	Maximum Voltage	D	R_s
1nF	50V	0.006	N/A
10nF	50V	0.006	N/A
20nF	50V	0.006	N/A
50nF	50V	0.006	N/A
100nF	50V	0.006	N/A
1uF	30V	0.002	N/A
10uF	20V	0.014	0.2Ω
100uF	10V	0.1	0.15Ω

Specifications apply at 1kHz. Allow 20pF for lead effects.
No appreciable variation is noticable at frequencies above 1kHz.

Accuracy Relative to Calibration Standards Specifications

Range	90 day Rel %	180 Day Rel %	1 year Rel %	2 year Rel %
1nF	0.2	0.225	0.25	0.35
10nF	0.2	0.225	0.25	0.35
20nF	0.2	0.225	0.25	0.35
50nF	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
100uF	0.64	0.72	0.8	1.12

Measurement methods
C_p up to 1uF
C_s from 10uF to 100uF

Capacitance is calibrated as value at the terminals
ie. displayed value incorporates capacitance of circuit up to and including the terminals

Specifications apply between 17°C and 27°C.
Outside this range an allowance of 0.18 x 1 Year Spec. per °C should be added.

Worked Accuracy Calculation of 50nF output at 20°C using 90 day specification.

0.2% of setting (50nF) =	100pF
Zero or floor allowance (Lead effects) =	20pF
Total accuracy of calibrator only =	120pF

Absolute accuracy must also include the accuracy (uncertainty) of the original calibration of the 2041A and the accuracy of the instrument used to verify its performance.