Supplementary Information

KEYSIGHT TECHNOLOGIES

Order Number 1-9433014534-1

Model Number	3458A
Manufacturer	Keysight Technologies Inc
Description	Digital multimeter, 8.5 digit
Serial Number	2823A08758
Date of Calibration	23 Feb 2018
Procedure	LF1003UK
Temperature	(23 ± 1) °C
Humidity	(45 ±10) %RH

Customer
Voltech Instruments Ltd
66 Innovation Dr
Milton Park
ABINGDON OX14 4RQ
United Kingdom

Location of Calibration
Keysight Technologies UK Limited
610 Wharfedale Road
Winnersh Triangle
Wokingham Berkshire RG41 5TP
United Kingdom

Remarks or Special Requirements
THIS COVER SHEET IS SUPPLEMENTARY TO THE ACCREDITED CALIBRATION CERTIFICATE.

Calibration Equipment Used

Model Number	Model Description	Equipment ID	Cal Due Date	Order Number
100M	100 MOhm Resistance box	UK7709	21 Sep 2018	1-9212538318-1
1613	Resistor	UK4216	14 May 2019	1-9306952442-1
1G	Resistance Std.	UK7708	25 May 2019	1-8808807767-1
3325A	Synthesizer/Function Generator	UK7740	31 Jul 2018	1-8456172886-1
3458A	Digital multimeter, 8.5 digit	UK8606	30 Apr 2018	1-9642314087-1
4000A	Calibrator, Transconductance AMP	UK5802	25 May 2018	1-9367041721-1
4200	Datron 4200	UK5906	20 May 2018	1-9306951890-1
4210	1 Ohm Standard Resistor	DE911	11 Jan 2019	1-8270959083-1
5071A	Primary frequency standard	UK13623	20 Feb 2019	1-9714516345-1
5685A	AC/DC Standard Resistor	UK10999	11 Jul 2018	1-8346339197-1
5685B	Resistance Standard	SE2109	19 Jul 2018	1-9030771123-1
5720A	Calibrator	UK15273	11 Jul 2018	1-8880763575-1
732A	DC Reference Standard	UK8509	17 Apr 2018	1-9068985089-1
752A	Reference Divider	UK11024	8 May 2018	1-8820229410-1
80010	Standard Resistor	UK4275	15 May 2018	1-8062852771-1
9330	Standard Resistor	UK4613	28 Sep 2018	1-9140664070-1
SR104	Standard Resistor	ITSVC311	4 Jan 2019	1-9140663785-1

Keysight Technologies UK Limited
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Mike Horsefield - Approved Signatory

CERTIFICATE OF CALIBRATION

0147

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CERTIFICATE NUMBER

1-9433014534-1B

APPROVED SIGNATORY

Mike Horsefield

Date Of Issue:	26 February 2018	Page 1 of 9 pages	
Instrument Description:	Digital Multimeter		
Instrument Manufacturer:	Hewlett-Packard		
Model Number:	3458A		
Serial Number:	2823A08758		
Our Reference Number:	1-9433014534-1		
Customer:	Voltech Instruments Ltd., Abingdon, Oxfordshire		
Date Of Calibration:	23 February 2018		
Ambient Temperature:	(23 ± 1) °C	Relative Humidity:	(45 ± 10) %

REMARKS:

This certificate records the calibration status of the instrument after it was adjusted.

The instruments performance conformed to the manufacturers specification at the points measured with due allowance having been made for measurement uncertainties.

TEST DESCRIPTION:

The 1-year specification has been used to define the absolute test limits in this certificate. They include the original manufacturer's calibration uncertainty for NIST traceability as published in the product's Calibration Manual 03458-90017:Dec2000.

A minimum warm-up period of 4 hours was allowed before testing. In accordance with the manufacturer's recommended practice, the appropriate "ACAL" routines were invoked before testing each function.

The Firmware version reported by REV? was	7.2
The value for CALNUM? reported by the 3458A PRIOR to testing was	168
and at COMPLETION of testing was	181

UKAS certificate 1-9433014534-1A contains pre-adjustment results.

Test location
(●) Permanent lab ( ) Mobile lab ( ) Customer's building

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
Any quoted uncertainty refers only to the measured value and does not carry any implication regarding the long term stability of the instrument.

CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0147

KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1B

Applicable Specification :

(●) Standard

( ) Option 002

DC Voltage Accuracy

Last calibration internal temperature (Cal? 59) = **34.76** **ºC**

Present internal temperature (Temp?) = **35.1** **ºC**

3458A set-up: NPLC 500, NDIG 8

Zero Offsets

A low thermal short was connected to the input terminals.

Applied Voltage	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
Internal Offset Tests (Front)					
Input Shorted	100 mV	± 1.0 µV	-0.00004 mV	± 0.1 µV	
Input Shorted	1 V	± 1.0 µV	0.00000002 V	± 0.1 µV	
Input Shorted	10 V	± 2.0 µV	0.0000003 V	± 0.1 µV	
Input Shorted	100 V	± 30.0 µV	0.000001 V	± 1.0 µV	
Input Shorted	1000 V	± 100.0 µV	0.00002 V	± 12.0 µV	
Internal Offset Tests (Rear)					
Input Shorted	100 mV	± 1.0 µV	-0.00075 mV	± 0.1 µV	
Input Shorted	1 V	± 1.0 µV	-0.00000069 V	± 0.1 µV	
Input Shorted	10 V	± 2.0 µV	-0.0000004 V	± 0.1 µV	
Input Shorted	100 V	± 30.0 µV	0.000013 V	± 1.0 µV	
Input Shorted	1000 V	± 100.0 µV	0.00004 V	± 12.0 µV	

Gain

The following measurements used the multimeter's "Math Null" function to exclude thermal emf's and other internal offsets from the measured value.

Applied	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
100 mV	100 mV	± 1.40 µV	99.99991 mV	± 0.25 µV	
1 V	1 V	± 10.3 µV	0.99999876 V	± 1.0 µV	
-1 V	1 V	± 10.3 µV	-0.99999909 V	± 1.0 µV	
-1 V	10 V	± 10.5 µV	-0.9999988 V	± 1.0 µV	
-5 V	10 V	± 50.5 µV	-4.9999949 V	± 6.5 µV	
-10 V	10 V	± 100.5 µV	-9.9999899 V	± 10.0 µV	
1 V	10 V	± 10.5 µV	0.9999991 V	± 1.0 µV	
5 V	10 V	± 50.5 µV	4.9999952 V	± 6.5 µV	
10 V	10 V	± 100.5 µV	9.9999911 V	± 10.0 µV	
100 V	100 V	± 1230 µV	99.999916 V	± 100 µV	
1000 V	1000 V	± 24.1 mV	999.98544 V	± 1.0 mV	

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
Any quoted uncertainty refers only to the measured value and does not carry any implication regarding the long term stability of the instrument.

CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0147

KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1B

AC Voltage Accuracy (Synchronous mode)
A voltage of substantially sinusoidal form was applied to the 3458A input.
3458A set-up: SETACV SYNC; RES .002; ACBAND 10,1E6
LFILTER ON for frequencies <= 50 kHz, otherwise LFILTER OFF

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 mV	1 kHz	10 mV	± 3.12 µV	10.00052 mV	± 0.7 µV	
100 mV	1 kHz	100 mV	± 9.2 µV	100.0045 mV	± 4.6 µV	
1 V	20 Hz	1 V	± 0.112 mV	0.999997 V	± 39 µV	
1 V	1 kHz	1 V	± 0.092 mV	1.000026 V	± 30 µV	
1 V	20 kHz	1 V	± 0.162 mV	0.999957 V	± 36 µV	
1 V	50 kHz	1 V	± 0.322 mV	1.000012 V	± 33 µV	
1 V	100 kHz	1 V	± 0.822 mV	1.000107 V	± 34 µV	
0.9 V	1 kHz	1 V	± 0.085 mV	0.900027 V	± 0.032 mV	
0.7 V	1 kHz	1 V	± 0.071 mV	0.700020 V	± 0.025 mV	
0.5 V	1 kHz	1 V	± 0.056 mV	0.500001 V	± 0.018 mV	
0.3 V	1 kHz	1 V	± 0.042 mV	0.299999 V	± 0.011 mV	
0.1 V	1 kHz	1 V	± 0.027 mV	0.100000 V	± 0.005 mV	
1 V	1 kHz	10 V	± 0.27 mV	1.00000 V	± 0.03 mV	
10 V	20 Hz	10 V	± 1.12 mV	10.00015 V	± 0.57 mV	
10 V	1 kHz	10 V	± 0.92 mV	10.00033 V	± 0.32 mV	
10 V	20 kHz	10 V	± 1.62 mV	9.99976 V	± 0.36 mV	
10 V	100 kHz	10 V	± 8.22 mV	9.99776 V	± 0.33 mV	
10 V	1 MHz	10 V	± 101.02 mV	10.05106 V	± 3.90 mV	
100 V	20 Hz	100 V	± 0.0242 V	99.9986 V	± 0.0048 V	
100 V	1 kHz	100 V	± 0.0222 V	100.0004 V	± 0.0036 V	
100 V	20 kHz	100 V	± 0.0222 V	99.9990 V	± 0.0043 V	
100 V	50 kHz	100 V	± 0.0372 V	100.0051 V	± 0.0037 V	
100 V	100 kHz	100 V	± 0.1222 V	100.0113 V	± 0.0038 V	
700 V	50 Hz	1000 V	± 0.301 V	700.014 V	± 0.030 V	
700 V	1 kHz	1000 V	± 0.301 V	700.033 V	± 0.030 V	
700 V	20 kHz	1000 V	± 0.441 V	700.055 V	± 0.030 V	

AC Voltage Accuracy (Analogue mode)
A voltage of substantially sinusoidal form was applied to the 3458A input.
3458A set-up: SETACV ANA; NPLC 500; ACBAND 10,1E6

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 mV	1 kHz	10 mV	± 27.00 µV	10.00087 mV	± 1.00 µV	
100 mV	1 kHz	100 mV	± 30.0 µV	100.0098 mV	± 6.0 µV	
1 V	20 Hz	1 V	± 1.700 mV	0.999215 V	± 0.090 mV	
1 V	1 kHz	1 V	± 0.300 mV	1.000075 V	± 0.080 mV	
1 V	100 kHz	1 V	± 6.800 mV	0.998521 V	± 0.100 mV	
1 V	1 kHz	10 V	± 1.20 mV	0.99996 V	± 0.08 mV	
10 V	20 Hz	10 V	± 17.00 mV	9.99423 V	± 0.90 mV	
10 V	1 kHz	10 V	± 3.00 mV	10.00089 V	± 0.90 mV	
10 V	100 kHz	10 V	± 68.00 mV	9.98208 V	± 1.00 mV	
10 V	1 MHz	10 V	± 0.700 V	10.05448 V	± 20.00 mV	
100 V	20 Hz	100 V	± 0.1700 V	99.9434 V	± 0.0090 V	
100 V	1 kHz	100 V	± 0.0400 V	100.0092 V	± 0.0090 V	
100 V	100 kHz	100 V	± 0.6800 V	99.8486 V	± 0.0100 V	
700 V	50 Hz	1000 V	± 0.760 V	699.932 V	± 0.154 V	
700 V	1 kHz	1000 V	± 0.620 V	700.010 V	± 0.154 V	
700 V	20 kHz	1000 V	± 0.620 V	700.020 V	± 0.154 V	

AC Voltage Accuracy (Random mode)
A voltage of substantially sinusoidal form was applied to the 3458A input.
3458A set-up: SETACV RNDM; RES .1; ACBAND 10,1E6

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 mV	1 kHz	10 mV	± 0.052 mV	10.000 mV	± 0.003 mV	
100 mV	1 kHz	100 mV	± 0.08 mV	100.00 mV	± 0.03 mV	
1 V	50 Hz	1 V	± 0.0008 V	0.9999 V	± 0.0003 V	
1 V	1 kHz	1 V	± 0.0008 V	1.0004 V	± 0.0003 V	
1 V	100 kHz	1 V	± 0.0008 V	1.0000 V	± 0.0003 V	
1 V	1 kHz	10 V	± 0.001 V	1.000 V	± 0.001 V	
10 V	50 Hz	10 V	± 0.008 V	10.000 V	± 0.003 V	
10 V	1 kHz	10 V	± 0.008 V	10.002 V	± 0.003 V	
10 V	100 kHz	10 V	± 0.008 V	9.998 V	± 0.003 V	
10 V	1 MHz	10 V	± 0.101 V	10.021 V	± 0.024 V	

CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0147

KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1B

AC Voltage Accuracy (Random mode) - continued

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
100 V	50 Hz	100 V	± 0.12 V	99.96 V	± 0.03 V	
100 V	1 kHz	100 V	± 0.12 V	100.01 V	± 0.03 V	
100 V	100 kHz	100 V	± 0.12 V	99.92 V	± 0.03 V	
700 V	50 Hz	1000 V	2.2 V	700.0 V	± 0.3 V	
700 V	1 kHz	1000 V	2.2 V	700.1 V	± 0.3 V	
700 V	20 kHz	1000 V	2.2 V	699.7 V	± 0.3 V	

Resistance Accuracy

3458A set-up:

Below 1 megohm: 4-wire ohms; OCOMP ON; Delay 1; NPLC 100; NDIG 7

1 megohm and higher: 2-wire ohms; NPLC 500

100 MΩ: NDIG 6

1 GΩ: NDIG 5

Last calibration internal temperature (Cal? 60) = **34.74** **°C**

Present temperature (Temp?) = **35.1** **°C**

Range	Applied Resistance (AR)	Specification	Measured Value (MV)	Error (MV-AR)	Uncertainty	Status (if applicable)
2-Wire Mode						
10 ohms	Front Input Shorted	± 0.25 ohms	-0.00105 ohms	-1.1 m ohm	± 0.5 m ohm	
10 ohms	Rear Input Shorted	± 0.25 ohms	0.08575 ohms	85.8 m ohm	± 0.5 m ohm	
4-Wire Mode						
10 ohms	Front Input Shorted	± 50 µ ohms	0.00000 ohms	0 µ ohm	± 10 µ ohm	
10 ohms	Rear Input Shorted	± 50 µ ohms	0.00000 ohms	0 µ ohm	± 10 µ ohm	
10 ohms	9.99997 ohms	± 23.0 ppm	10.00000 ohms	2.6 ppm	± 1.5 ppm	
100 ohms	99.99898 ohms	± 20.0 ppm	99.99908 ohms	1.0 ppm	± 1.5 ppm	
1 k ohm	1.0000089 k ohm	± 13.5 ppm	1.0000102 k ohm	1.3 ppm	± 1.5 ppm	
10 k ohm	10.000281 k ohm	± 13.5 ppm	10.000285 k ohm	0.4 ppm	± 0.5 ppm	
100 k ohm	100.00029 k ohm	± 13.5 ppm	100.00016 k ohm	-1.3 ppm	± 2.4 ppm	
2-Wire Mode						
1 M ohm	1.0000187 M ohm	± 20.0 ppm	1.0000075 M ohm	-11.2 ppm	± 5.7 ppm	
10 M ohm	10.000772 M ohm	± 63.0 ppm	10.000792 M ohm	2.0 ppm	± 7.1 ppm	
100 M ohm	99.9468 M ohm	± 513.0 ppm	99.9568 M ohm	100.4 ppm	± 36.0 ppm	
1 G ohm	1.00457 G ohm	± 0.501 %	1.00530 G ohm	0.073 %	± 0.027 %	

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
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CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0147

KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1B

DC Current Accuracy
3458A set-up: NPLC 500; NDIG 7
Note: The 100 mA and 1 A currents were applied for 5 minutes before measurement.

Applied Current	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
Front Input Open	1 µA	± 40 pA	-0.000001 µA	± 2 pA	
Front Input Open	10 µA	± 100 pA	0.000004 µA	± 8 pA	
Front Input Open	100 µA	± 800 pA	0.00010 µA	± 70 pA	
Front Input Open	1 mA	± 5 nA	0.0000012 mA	± 0.2 nA	
Front Input Open	10 mA	± 50 nA	0.000006 mA	± 2 nA	
Front Input Open	100 mA	± 500 nA	0.00011 mA	± 15 nA	
Front Input Open	1 A	± 10 µA	-0.0000006 A	± 1.9 µA	
Rear Input Open	1 µA	± 40 pA	-0.000001 µA	± 2 pA	
Rear Input Open	10 µA	± 100 pA	0.000038 µA	± 8 pA	
Rear Input Open	100 µA	± 800 pA	0.00038 µA	± 70 pA	
Rear Input Open	1 mA	± 5 nA	0.0000029 mA	± 0.2 nA	
Rear Input Open	10 mA	± 50 nA	0.000030 mA	± 2 nA	
Rear Input Open	100 mA	± 500 nA	0.00033 mA	± 15 nA	
Rear Input Open	1 A	± 10 µA	0.0000025 A	± 1.9 µA	
1 µA	1 µA	± 65 pA	1.000003 µA	± 27 pA	
10 µA	10 µA	± 350 pA	9.999965 µA	± 70 pA	
100 µA	100 µA	± 3.30 nA	99.99981 µA	± 0.40 nA	
1 mA	1 mA	± 30.0 nA	0.9999953 mA	± 4.0 nA	
10 mA	10 mA	± 0.300 µA	9.999955 mA	± 0.050 µA	
100 mA	100 mA	± 4.50 µA	99.99987 mA	± 0.50 µA	
1 A	1 A	± 125.0 µA	1.0000420 A	± 15.0 µA	

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
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AC Current Accuracy

The applied current was of substantially sinusoidal form.

3458A set-up: ACBAND 10,1E4; LFILTER ON; NPLC 100

Applied Current	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
100 µA	1 kHz	100 µA	± 0.0905 µA	100.0062 µA	± 20.0 nA	
1 mA	1 kHz	1 mA	± 0.000505 mA	1.000214 mA	± 155 nA	
10 mA	20 Hz	10 mA	± 0.01705 mA	9.99559 mA	± 1.10 µA	
10 mA	1 kHz	10 mA	± 0.00505 mA	10.00208 mA	± 1.10 µA	
10 mA	5 kHz	10 mA	± 0.00505 mA	10.00275 mA	± 1.10 µA	
100 mA	20 Hz	100 mA	± 0.1705 mA	99.9572 mA	± 11.0 µA	
100 mA	1 kHz	100 mA	± 0.0505 mA	100.0215 mA	± 11.0 µA	
100 mA	5 kHz	100 mA	± 0.0505 mA	100.0339 mA	± 11.0 µA	
1 A	20 Hz	1 A	± 0.001805 A	0.999322 A	± 0.150 mA	
1 A	1 kHz	1 A	± 0.001205 A	1.000008 A	± 0.150 mA	
1 A	5 kHz	1 A	± 0.001205 A	1.000549 A	± 0.150 mA	

Note: The 100mA and 1A currents were applied for 5 minutes before measurement.

AC/DC Current Accuracy
A single check is made to confirm the basic accuracy of this function.

Applied Current	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 mA	DC	10 mA	± 0.04000 mA	9.98588 mA	± 0.10 µA	

AC/DC Voltage Accuracy (Analogue Mode)
A single check is made to confirm the basic accuracy of this function.

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 V	DC	10 V	± 0.04000 V	9.98698 V	± 0.10 mV	

Frequency Accuracy

Applied Frequency	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 MHz	± 0.001 MHz	10.00001 MHz	± 10 Hz	

CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0147

KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1B

AC Voltage High Frequency
3458A set-up: SETACV SYNC; RES .001; ACBAND 10, 1E7

Range	Input Voltage	Input Freq.	Expected Value	Measured Value	Difference	Tolerance	Uncertainty	Status
0.01 V	0.01 V	1 MHz	0.00995385 V	0.00993979 V	-0.00001406 V	± 0.00012512 V	± 0.00001286 V	
0.01 V	0.01 V	4 MHz	0.00985023 V	0.00958046 V	-0.00026977 V	± 0.00070712 V	± 0.00001665 V	
0.1 V	0.10 V	1 MHz	0.09983267 V	0.09961588 V	-0.00021679 V	± 0.00101120 V	± 0.00009322 V	
0.1 V	0.10 V	4 MHz	0.09966565 V	0.09852295 V	-0.00114270 V	± 0.00407120 V	± 0.00015312 V	
0.1 V	0.10 V	8 MHz	0.09933979 V	0.09914448 V	-0.00019531 V	± 0.00408120 V	± 0.00015312 V	
0.1 V	0.10 V	10 MHz	0.09945320 V	0.10335542 V	0.00390222 V	± 0.01510120 V	± 0.00015348 V	
1 V	1.00 V	1 MHz	0.9980835 V	1.0041192 V	0.0060357 V	± 0.0101120 V	± 0.0005802 V	
1 V	1.00 V	4 MHz	0.9974839 V	0.9928061 V	-0.0046778 V	± 0.0407120 V	± 0.0014644 V	
1 V	1.00 V	8 MHz	0.9929757 V	0.9902471 V	-0.0027286 V	± 0.0408120 V	± 0.0014638 V	
1 V	1.00 V	10 MHz	0.9923212 V	0.9871254 V	-0.0051958 V	± 0.1510120 V	± 0.0014654 V	
10 V	3.00 V	2 MHz	2.994755 V	3.001717 V	0.006962 V	± 0.127036 V	± 0.002612 V	
10 V	3.00 V	4 MHz	2.990264 V	3.024798 V	0.034534 V	± 0.127036 V	± 0.004361 V	
10 V	3.00 V	8 MHz	2.993168 V	2.990066 V	-0.003102 V	± 0.128036 V	± 0.004362 V	
10 V	3.00 V	10 MHz	3.005446 V	2.981415 V	-0.024031 V	± 0.460036 V	± 0.004365 V	

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CERTIFICATE OF CALIBRATION

0147

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CERTIFICATE NUMBER

1-9433014534-1A

APPROVED SIGNATORY

Mike Horsefield

Date Of Issue:	26 February 2018	Page 1 of 9 pages	
Instrument Description:	Digital Multimeter		
Instrument Manufacturer:	Hewlett-Packard		
Model Number:	3458A		
Serial Number:	2823A08758		
Our Reference Number:	1-9433014534-1		
Customer:	Voltech Instruments Ltd., Abingdon, Oxfordshire		
Date Of Calibration:	7 February 2018		
Ambient Temperature:	(23 ± 1) °C	Relative Humidity:	(45 ± 10) %

REMARKS:

This certificate records the on-receipt calibration status of the instrument.

The instruments performance did not conform to the manufacturers specification at the point identified "Out-of-spec". In addition at the point identified "Guardband" it was not possible to confirm compliance at the stated level of confidence when the measured value was extended by the uncertainty, although compliance was more likely than non-compliance.

TEST DESCRIPTION:

The 1-year specification has been used to define the absolute test limits in this certificate. They include the original manufacturer's calibration uncertainty for NIST traceability as published in the product's Calibration Manual 03458-90017:Dec2000.

A minimum warm-up period of 4 hours was allowed before testing. In accordance with the manufacturer's recommended practice, the appropriate "ACAL" routines were invoked before testing each function.

The Firmware version reported by REV? was	7.2
The value for CALNUM? reported by the 3458A PRIOR to testing was	168
and at COMPLETION of testing was	168

UKAS certificate 1-9433014534-1B contains post adjustment results.

Test location
(●) Permanent lab ( ) Mobile lab ( ) Customer's building

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
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KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1A

Applicable Specification :

(●) Standard

( ) Option 002

DC Voltage Accuracy

Last calibration internal temperature (Cal? 59) = **35.31** **ºC**

Present internal temperature (Temp?) = **35.0** **ºC**

3458A set-up: NPLC 500, NDIG 8

Zero Offsets

A low thermal short was connected to the input terminals.

Applied Voltage	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
Internal Offset Tests (Front)					
Input Shorted	100 mV	± 1.0 µV	-0.00055 mV	± 0.1 µV	
Input Shorted	1 V	± 1.0 µV	-0.00000048 V	± 0.1 µV	
Input Shorted	10 V	± 2.0 µV	0.0000000 V	± 0.1 µV	
Input Shorted	100 V	± 30.0 µV	-0.000024 V	± 1.0 µV	
Input Shorted	1000 V	± 100.0 µV	-0.00001 V	± 12.0 µV	
Internal Offset Tests (Rear)					
Input Shorted	100 mV	± 1.0 µV	-0.00104 mV	± 0.1 µV	Out-of-spec
Input Shorted	1 V	± 1.0 µV	-0.00000086 V	± 0.1 µV	
Input Shorted	10 V	± 2.0 µV	-0.0000009 V	± 0.1 µV	
Input Shorted	100 V	± 30.0 µV	-0.000006 V	± 1.0 µV	
Input Shorted	1000 V	± 100.0 µV	-0.00001 V	± 12.0 µV	

Gain

The following measurements used the multimeter's "Math Null" function to exclude thermal emf's and other internal offsets from the measured value.

Applied	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
100 mV	100 mV	± 1.40 µV	99.99950 mV	± 0.25 µV	
1 V	1 V	± 10.3 µV	0.99999679 V	± 1.0 µV	
-1 V	1 V	± 10.3 µV	-0.99999757 V	± 1.0 µV	
-1 V	10 V	± 10.5 µV	-0.9999970 V	± 1.0 µV	
-5 V	10 V	± 50.5 µV	-4.9999870 V	± 6.5 µV	
-10 V	10 V	± 100.5 µV	-9.9999737 V	± 10.0 µV	
1 V	10 V	± 10.5 µV	0.9999954 V	± 1.0 µV	
5 V	10 V	± 50.5 µV	4.9999872 V	± 6.5 µV	
10 V	10 V	± 100.5 µV	9.9999748 V	± 10.0 µV	
100 V	100 V	± 1230 µV	99.999684 V	± 100 µV	
1000 V	1000 V	± 24.1 mV	999.98325 V	± 1.0 mV	

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
Any quoted uncertainty refers only to the measured value and does not carry any implication regarding the long term stability of the instrument.

AC Voltage Accuracy (Synchronous mode)
A voltage of substantially sinusoidal form was applied to the 3458A input.
3458A set-up: SETACV SYNC; RES .002; ACBAND 10,1E6
LFILTER ON for frequencies <= 50 kHz, otherwise LFILTER OFF

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 mV	1 kHz	10 mV	± 3.12 µV	10.00017 mV	± 0.7 µV	
100 mV	1 kHz	100 mV	± 9.2 µV	100.0043 mV	± 4.6 µV	
1 V	20 Hz	1 V	± 0.112 mV	0.999998 V	± 39 µV	
1 V	1 kHz	1 V	± 0.092 mV	1.000024 V	± 30 µV	
1 V	20 kHz	1 V	± 0.162 mV	0.999957 V	± 36 µV	
1 V	50 kHz	1 V	± 0.322 mV	1.000012 V	± 33 µV	
1 V	100 kHz	1 V	± 0.822 mV	1.000104 V	± 34 µV	
0.9 V	1 kHz	1 V	± 0.085 mV	0.900024 V	± 0.032 mV	
0.7 V	1 kHz	1 V	± 0.071 mV	0.700018 V	± 0.025 mV	
0.5 V	1 kHz	1 V	± 0.056 mV	0.500006 V	± 0.018 mV	
0.3 V	1 kHz	1 V	± 0.042 mV	0.299997 V	± 0.011 mV	
0.1 V	1 kHz	1 V	± 0.027 mV	0.100000 V	± 0.005 mV	
1 V	1 kHz	10 V	± 0.27 mV	1.00001 V	± 0.03 mV	
10 V	20 Hz	10 V	± 1.12 mV	10.00011 V	± 0.57 mV	
10 V	1 kHz	10 V	± 0.92 mV	10.00031 V	± 0.32 mV	
10 V	20 kHz	10 V	± 1.62 mV	10.00019 V	± 0.36 mV	
10 V	100 kHz	10 V	± 8.22 mV	9.99825 V	± 0.33 mV	
10 V	1 MHz	10 V	± 101.02 mV	10.05325 V	± 3.90 mV	
100 V	20 Hz	100 V	± 0.0242 V	99.9985 V	± 0.0048 V	
100 V	1 kHz	100 V	± 0.0222 V	100.0005 V	± 0.0036 V	
100 V	20 kHz	100 V	± 0.0222 V	99.9989 V	± 0.0043 V	
100 V	50 kHz	100 V	± 0.0372 V	100.0053 V	± 0.0037 V	
100 V	100 kHz	100 V	± 0.1222 V	100.0116 V	± 0.0038 V	
700 V	50 Hz	1000 V	± 0.301 V	700.007 V	± 0.030 V	
700 V	1 kHz	1000 V	± 0.301 V	700.029 V	± 0.030 V	
700 V	20 kHz	1000 V	± 0.441 V	700.047 V	± 0.030 V	

AC Voltage Accuracy (Analogue mode)
A voltage of substantially sinusoidal form was applied to the 3458A input.
3458A set-up: SETACV ANA; NPLC 500; ACBAND 10,1E6

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 mV	1 kHz	10 mV	± 27.00 µV	10.00063 mV	± 1.00 µV	
100 mV	1 kHz	100 mV	± 30.0 µV	100.0085 mV	± 6.0 µV	
1 V	20 Hz	1 V	± 1.700 mV	0.999201 V	± 0.090 mV	
1 V	1 kHz	1 V	± 0.300 mV	1.000064 V	± 0.080 mV	
1 V	100 kHz	1 V	± 6.800 mV	0.998489 V	± 0.100 mV	
1 V	1 kHz	10 V	± 1.20 mV	0.99999 V	± 0.08 mV	
10 V	20 Hz	10 V	± 17.00 mV	9.99410 V	± 0.90 mV	
10 V	1 kHz	10 V	± 3.00 mV	10.00075 V	± 0.90 mV	
10 V	100 kHz	10 V	± 68.00 mV	9.98246 V	± 1.00 mV	
10 V	1 MHz	10 V	± 0.700 V	10.05703 V	± 20.00 mV	
100 V	20 Hz	100 V	± 0.1700 V	99.9424 V	± 0.0090 V	
100 V	1 kHz	100 V	± 0.0400 V	100.0085 V	± 0.0090 V	
100 V	100 kHz	100 V	± 0.6800 V	99.8475 V	± 0.0100 V	
700 V	50 Hz	1000 V	± 0.760 V	699.918 V	± 0.154 V	
700 V	1 kHz	1000 V	± 0.620 V	699.999 V	± 0.154 V	
700 V	20 kHz	1000 V	± 0.620 V	700.010 V	± 0.154 V	

AC Voltage Accuracy (Random mode)
A voltage of substantially sinusoidal form was applied to the 3458A input.
3458A set-up: SETACV RNDM; RES .1; ACBAND 10,1E6

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 mV	1 kHz	10 mV	± 0.052 mV	10.000 mV	± 0.003 mV	
100 mV	1 kHz	100 mV	± 0.08 mV	100.01 mV	± 0.03 mV	
1 V	50 Hz	1 V	± 0.0008 V	0.9999 V	± 0.0003 V	
1 V	1 kHz	1 V	± 0.0008 V	0.9999 V	± 0.0003 V	
1 V	100 kHz	1 V	± 0.0008 V	0.9996 V	± 0.0003 V	
1 V	1 kHz	10 V	± 0.001 V	1.000 V	± 0.001 V	
10 V	50 Hz	10 V	± 0.008 V	10.001 V	± 0.003 V	
10 V	1 kHz	10 V	± 0.008 V	10.001 V	± 0.003 V	
10 V	100 kHz	10 V	± 0.008 V	9.996 V	± 0.003 V	
10 V	1 MHz	10 V	± 0.101 V	10.032 V	± 0.024 V	

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KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1A

AC Voltage Accuracy (Random mode) - continued

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
100 V	50 Hz	100 V	± 0.12 V	99.99 V	± 0.03 V	
100 V	1 kHz	100 V	± 0.12 V	100.00 V	± 0.03 V	
100 V	100 kHz	100 V	± 0.12 V	99.95 V	± 0.03 V	
700 V	50 Hz	1000 V	2.2 V	699.9 V	± 0.3 V	
700 V	1 kHz	1000 V	2.2 V	699.9 V	± 0.3 V	
700 V	20 kHz	1000 V	2.2 V	699.6 V	± 0.3 V	

Resistance Accuracy

3458A set-up:

Below 1 megohm: 4-wire ohms; OCOMP ON; Delay 1; NPLC 100; NDIG 7

1 megohm and higher: 2-wire ohms; NPLC 500

100 MΩ: NDIG 6

1 GΩ: NDIG 5

Last calibration internal temperature (Cal? 60) = **35.47** **°C**

Present temperature (Temp?) = **35.0** **°C**

Range	Applied Resistance (AR)	Specification	Measured Value (MV)	Error (MV-AR)	Uncertainty	Status (if applicable)
2-Wire Mode						
10 ohms	Front Input Shorted	± 0.25 ohms	-0.00132 ohms	-1.3 m ohm	± 0.5 m ohm	
10 ohms	Rear Input Shorted	± 0.25 ohms	0.24970 ohms	249.7 m ohm	± 0.5 m ohm	Guardband
4-Wire Mode						
10 ohms	Front Input Shorted	± 50 µ ohms	0.00000 ohms	0 µ ohm	± 10 µ ohm	
10 ohms	Rear Input Shorted	± 50 µ ohms	0.00000 ohms	0 µ ohm	± 10 µ ohm	
10 ohms	9.99997 ohms	± 23.0 ppm	10.00001 ohms	3.6 ppm	± 1.5 ppm	
100 ohms	99.99898 ohms	± 20.0 ppm	99.99918 ohms	2.0 ppm	± 1.5 ppm	
1 k ohm	1.0000089 k ohm	± 13.5 ppm	1.0000115 k ohm	2.6 ppm	± 1.5 ppm	
10 k ohm	10.000281 k ohm	± 13.5 ppm	10.000303 k ohm	2.2 ppm	± 0.5 ppm	
100 k ohm	100.00029 k ohm	± 13.5 ppm	100.00032 k ohm	0.3 ppm	± 2.4 ppm	
2-Wire Mode						
1 M ohm	1.0000187 M ohm	± 20.0 ppm	1.0000094 M ohm	-9.3 ppm	± 5.7 ppm	
10 M ohm	10.000772 M ohm	± 63.0 ppm	10.000804 M ohm	3.2 ppm	± 7.1 ppm	
100 M ohm	99.9468 M ohm	± 513.0 ppm	99.9562 M ohm	94.4 ppm	± 36.0 ppm	
1 G ohm	1.00457 G ohm	± 0.501 %	1.00521 G ohm	0.064 %	± 0.027 %	

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
Any quoted uncertainty refers only to the measured value and does not carry any implication regarding the long term stability of the instrument.

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UKAS Accredited Calibration Laboratory No. 0147

KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1A

DC Current Accuracy
3458A set-up: NPLC 500; NDIG 7
Note: The 100 mA and 1 A currents were applied for 5 minutes before measurement.

Applied Current	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
Front Input Open	1 µA	± 40 pA	0.000002 µA	± 2 pA	
Front Input Open	10 µA	± 100 pA	0.000013 µA	± 8 pA	
Front Input Open	100 µA	± 800 pA	0.00021 µA	± 70 pA	
Front Input Open	1 mA	± 5 nA	0.0000008 mA	± 0.2 nA	
Front Input Open	10 mA	± 50 nA	0.000009 mA	± 2 nA	
Front Input Open	100 mA	± 500 nA	0.00010 mA	± 15 nA	
Front Input Open	1 A	± 10 µA	-0.0000009 A	± 1.9 µA	
Rear Input Open	1 µA	± 40 pA	0.000007 µA	± 2 pA	
Rear Input Open	10 µA	± 100 pA	0.000074 µA	± 8 pA	
Rear Input Open	100 µA	± 800 pA	0.00052 µA	± 70 pA	
Rear Input Open	1 mA	± 5 nA	0.0000038 mA	± 0.2 nA	
Rear Input Open	10 mA	± 50 nA	0.000041 mA	± 2 nA	
Rear Input Open	100 mA	± 500 nA	0.00042 mA	± 15 nA	
Rear Input Open	1 A	± 10 µA	0.0000026 A	± 1.9 µA	
1 µA	1 µA	± 65 pA	0.999985 µA	± 27 pA	
10 µA	10 µA	± 350 pA	9.999966 µA	± 70 pA	
100 µA	100 µA	± 3.30 nA	99.99960 µA	± 0.40 nA	
1 mA	1 mA	± 30.0 nA	0.9999934 mA	± 4.0 nA	
10 mA	10 mA	± 0.300 µA	9.999946 mA	± 0.050 µA	
100 mA	100 mA	± 4.50 µA	99.99970 mA	± 0.50 µA	
1 A	1 A	± 125.0 µA	1.0000227 A	± 15.0 µA	

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
Any quoted uncertainty refers only to the measured value and does not carry any implication regarding the long term stability of the instrument.

AC Current Accuracy

The applied current was of substantially sinusoidal form.

3458A set-up: ACBAND 10,1E4; LFILTER ON; NPLC 100

Applied Current	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
100 µA	1 kHz	100 µA	± 0.0905 µA	100.0051 µA	± 20.0 nA	
1 mA	1 kHz	1 mA	± 0.000505 mA	1.000197 mA	± 155 nA	
10 mA	20 Hz	10 mA	± 0.01705 mA	9.99546 mA	± 1.10 µA	
10 mA	1 kHz	10 mA	± 0.00505 mA	10.00195 mA	± 1.10 µA	
10 mA	5 kHz	10 mA	± 0.00505 mA	10.00259 mA	± 1.10 µA	
100 mA	20 Hz	100 mA	± 0.1705 mA	99.9571 mA	± 11.0 µA	
100 mA	1 kHz	100 mA	± 0.0505 mA	100.0211 mA	± 11.0 µA	
100 mA	5 kHz	100 mA	± 0.0505 mA	100.0331 mA	± 11.0 µA	
1 A	20 Hz	1 A	± 0.001805 A	0.999294 A	± 0.150 mA	
1 A	1 kHz	1 A	± 0.001205 A	0.999972 A	± 0.150 mA	
1 A	5 kHz	1 A	± 0.001205 A	1.000495 A	± 0.150 mA	

Note: The 100mA and 1A currents were applied for 5 minutes before measurement.

AC/DC Current Accuracy
A single check is made to confirm the basic accuracy of this function.

Applied Current	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 mA	DC	10 mA	± 0.04000 mA	10.01161 mA	± 0.10 µA	

AC/DC Voltage Accuracy (Analogue Mode)
A single check is made to confirm the basic accuracy of this function.

Applied Voltage	Frequency	Range	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 V	DC	10 V	± 0.04000 V	9.98652 V	± 0.10 mV	

Frequency Accuracy

Applied Frequency	Specification (applied ± limit)	Measured Value	Uncertainty	Status (if applicable)
10 MHz	± 0.001 MHz	10.00001 MHz	± 10 Hz	

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UKAS Accredited Calibration Laboratory No. 0147

KEYSIGHT TECHNOLOGIES

CERTIFICATE NUMBER

1-9433014534-1A

AC Voltage High Frequency
3458A set-up: SETACV SYNC; RES .001; ACBAND 10, 1E7

Range	Input Voltage	Input Freq.	Expected Value	Measured Value	Difference	Tolerance	Uncertainty	Status
0.01 V	0.01 V	1 MHz	0.00995385 V	0.00994074 V	-0.00001311 V	± 0.00012512 V	± 0.00001286 V	
0.01 V	0.01 V	4 MHz	0.00985023 V	0.00959605 V	-0.00025418 V	± 0.00070712 V	± 0.00001665 V	
0.1 V	0.10 V	1 MHz	0.09983267 V	0.09962551 V	-0.00020716 V	± 0.00101120 V	± 0.00009322 V	
0.1 V	0.10 V	4 MHz	0.09966565 V	0.09869110 V	-0.00097455 V	± 0.00407120 V	± 0.00015312 V	
0.1 V	0.10 V	8 MHz	0.09933979 V	0.09967753 V	0.00033774 V	± 0.00408120 V	± 0.00015312 V	
0.1 V	0.10 V	10 MHz	0.09945320 V	0.10401105 V	0.00455785 V	± 0.01510120 V	± 0.00015348 V	
1 V	1.00 V	1 MHz	0.9980835 V	1.0042279 V	0.0061444 V	± 0.0101120 V	± 0.0005802 V	
1 V	1.00 V	4 MHz	0.9974839 V	0.9954478 V	-0.0020361 V	± 0.0407120 V	± 0.0014644 V	
1 V	1.00 V	8 MHz	0.9929757 V	0.9986539 V	0.0056782 V	± 0.0408120 V	± 0.0014638 V	
1 V	1.00 V	10 MHz	0.9923212 V	0.9969702 V	0.0046490 V	± 0.1510120 V	± 0.0014654 V	
10 V	3.00 V	2 MHz	2.994755 V	3.022920 V	0.028165 V	± 0.127036 V	± 0.002612 V	
10 V	3.00 V	4 MHz	2.990264 V	3.027865 V	0.037601 V	± 0.127036 V	± 0.004361 V	
10 V	3.00 V	8 MHz	2.993168 V	3.001723 V	0.008555 V	± 0.128036 V	± 0.004362 V	
10 V	3.00 V	10 MHz	3.005446 V	2.996027 V	-0.009419 V	± 0.460036 V	± 0.004365 V	

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.
Any quoted uncertainty refers only to the measured value and does not carry any implication regarding the long term stability of the instrument.