

# Newtons4th ISO17025 Calibration

UKAS Laboratory no.7949



Compliance to IEC Harmonics and Flicker Measurement

Harmonics:

IEC61000-3-2 (2014) and IEC61000-3-12 (2011)  
in accordance with IEC61000-4-7 (2009)

Flicker:

IEC61000-3-3 (2013) and IEC61000-3-11 (2000)  
in accordance with IEC61000-4-15 (2010)

## Introduction

There are many companies that provide Harmonic and Flicker measurement instrumentation, with most of these companies claiming to provide fully compliant measurement functions.

However, given the complexity of this measurement application combined with the continually developing criteria that defines a compliant measurement product, how can a customer be confident that a product being offered to them is truly compliant?

## A certificate of conformance vs Accredited Calibration

Manufacturers may offer a wide range of documents to support an argument that their product will meet the requirements of a measurement standard. This includes type testing, reference measurements and certificates of conformance. While these forms of testing may have value in illustrating the nominal level of measurement ability for certain measurement functions, the ideal solution is an 'accredited certificate of calibration' including all of the required measurements defined in the associated standard.

An accredited calibration is supplied only by a laboratory that has been awarded and continually maintains standards, processes and procedures in accordance with internationally agreed levels. Most countries have an organisation that is responsible for managing this process and in the UK; the associated organisation is the United Kingdom Accreditation Service, UKAS.

UKAS is responsible for awarding and auditing the accreditation of all ISO17025 laboratories including for example, the National Physical Laboratory and of course, Newtons4th Ltd. The calibration that can be carried out by any laboratory and the uncertainty associated with that calibration is defined within a document called the 'Schedule of Accreditation'. The prevailing schedule of accreditation for any laboratory is available directly from the UKAS website. A link to the Newtons4th schedule of accreditation is available on the ISO17025 page of our website.

## Why accept less?

In the world of metrology, it is stated that you can only believe what you can prove. In other words, a supplier can claim what they like but unless their claim can be supported by an accredited calibration, it may be meaningless.

Until now, there has been no ISO17025 accredited laboratory with a Schedule of Accreditation that includes all of the latest tests defined for IEC61000 Harmonics and Flicker measurement instrumentation. Newtons4th UKAS Laboratory no.7949 is the first and presently the only laboratory with this facility.

While harmonic calibration is offered by a number of laboratories, the UKAS accredited laboratory at N4L is presently the only facility with a schedule that includes all the tests defined within Annex C of the IEC61000-4-15 standard. This standard defines the test protocol for a fully compliant flicker meter in accordance with IEC61000-3-3 and IEC61000-3-11. We follow with a copy of Annex C with colour coding of ALL sections then a copy of our UKAS accredited IEC61000 calibration certificate with corresponding colour coded sections that illustrate full compliance with ALL required tests.

## Annex C (informative)

### Sample protocols for type testing

 Manufacturer:  
 Serial number:

 Instrument:  
 Firmware version:

230 V/50 Hz	IEC 61000-4-15, Table 1a (sinusoidal)		IEC 61000-4-15, Table 2a (rectangular)		IEC 61000-4-15, Table 5 (rectangular)		
$f$ Hz	$\Delta U/U$ %	$P_{inst,max}$	$\Delta U/U$ %	$P_{inst,max}$	$r$ $min^{-1}$	$\Delta U/U$ %	$P_{st}$
0,5	2,325		0,509		1	2,715	
1,5	1,067		n.a.		2	2,191	
3,5	n.a.		0,342		7	1,450	
8,8	0,250		0,196		39	0,894	
18,0	n.a.		0,446		110	0,722	
20,0	0,704		n.a.		1 620	0,407	
21,5	n.a.		0,592		4 000	2,343	
25,0	1,037		0,764		<b>Performance Test</b>		
28,0	n.a.		0,915			$\leq P_{st} \leq$	
30,5	n.a.		0,847		<b>Frequency changes Test, Table 6<sup>a</sup></b>		
33 1/3	2,128		1,671		$P_{inst,max}$		
n.a. in above tables = not applicable					<b>Distorted voltage Test, Table 8<sup>a</sup></b>		
<p><sup>a</sup> not required for class-F2-instruments intended to use for measurements according to IEC 61000-3-3, IEC 61000-3-11 only</p> <p style="text-align: center;"><b>Result:</b></p> <p style="text-align: center;"><b>The instrument meets the applicable accuracy requirements according to Clauses 5 and 6 of IEC 61000-4-15:2010</b></p> <p>Date:</p> <p>Signature:</p>					$P_{inst,max}$		
					<b>Input Bandwidth, Table 9<sup>a</sup></b>		
					$f_{v,max}$		
					<b>Phase jumps Test, Table 10<sup>a</sup></b>		
					$\Delta\beta$	$P_{st,ref}$	$P_{st}$
					$\pm 30^\circ$	0,863...0,963	
					$\pm 45^\circ$	1,007...1,113	
					<b>Duty cycle test, Table 11</b>		
					$P_{st}$		
					<b>Table 12</b>		
$d_c$	$d_{max}$	$d(t)$ test					
<b>Table 13</b>							
$d_c$	$d_{max}$	$d(t)$ test					

Desired values:  $P_{inst,max} = 1,000 \pm 8 \%$ ;  $P_{st} = 1,000 \pm 5 \%$ ;  $d_c - d(t) - d_{max}$  per Tables 12 to 13.



**Newtons4th Ltd**

1 Bede Island Road  
Leicester, LE2 7EA  
United Kingdom

Tel: +44 116 2301066  
Fax: +44 116 2301061  
E-Mail: [office@newtons4th.com](mailto:office@newtons4th.com)  
Web Site: [www.newtons4th.com](http://www.newtons4th.com)

# CERTIFICATE OF CALIBRATION

## UKAS IEC61000 Calibration



Certificate No: **166-04860180821**  
Date of Issue: 18<sup>th</sup> August 2021

**Approved Signature:**

Name: M Wade

Title: Operations Manager

### Customer Name and Address:

Product	Model	Serial No	Calibration Date	Condition
Precision Power Analyser	5531(HC)	166-04860	18 <sup>th</sup> August 2021	Acceptable

### Calibration Comments:

All pre-adjustment tests passed.

Equipment Used	Model	Serial No	Calibration Due
Fluke Electrical Power Standard	6105A	176162845	22 <sup>nd</sup> March 2022
Precision AC Source	N4A03	91J-11145	17 <sup>th</sup> August 2022

### Calibration Type

IEC61000-3-2:(2014), IEC61000-3-2:(2018) IEC61000-3-3:(2013), IEC61000-3-11:(2000), IEC61000-3-12 (2011), IEC61000-4-7:(2002) + AMD1:(2008), IEC61000-4-15(2010)

### Method of Calibration

The results of this calibration report were obtained by applying voltage and current sinusoidal signals (or multiple sinusoidal signals where applicable) from a traceable calibrated source.

### Conditions of Calibration

Temperature: 23°C ±5°C (18°C - 28°C)  
Humidity Band: 20% - 85%

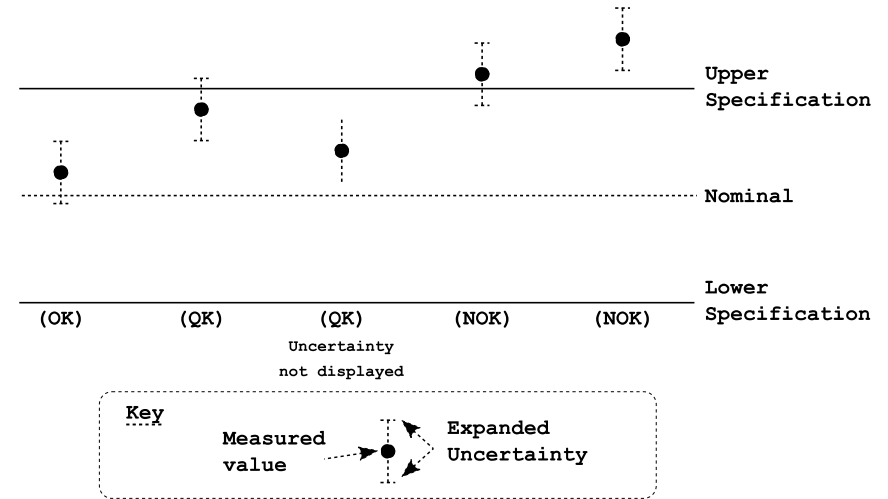
This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. (Calibration control is in accordance with ISO17025)

Calibration relates exclusively to the product(s) defined above without customer supplied leads unless defined otherwise

### Compliance with specification

A statement of compliance, indicating the performance of the instrument or system against its specification, is reported for each test line in the certificate. Compliance is determined by accounting for the expanded measurement of uncertainty as follows:

Statement	Explanation
<b>OK</b>	The margin between the measured value and the stated specification is greater than the expanded measurement uncertainty; the measurement is within the specification limits by at least the reported confidence level and therefore the instrument can be stated to comply with the specification.
<b>QK</b> (Uncertainty shown)	The margin between the measured value and the stated specification is less than the expanded measurement uncertainty, therefore it is not possible to state compliance with the reported confidence level, but the measurement is still more likely than not to be compliant.
<b>QK</b> (Uncertainty not shown)	Where no uncertainty is shown the measurement is beyond the scope of our UKAS accreditation but has been included as an indicative measurement for completeness.
<b>NOK</b>	The measurement is outside of the stated specification and is therefore non-compliant.



A complete summary is created at the end of each script, summing the number tests that have passed or qualified pass (OK or QK) or failed (NOK).

### Multiphase measurement

Where multiple instrument phases or channels have been calibrated to a common reference, the measurements may be recorded on a single line in the report. All measurement values are listed in the certificate but for conciseness, only the deviation of the greatest magnitude is included when multiple phases are measured.

### Additional comments

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service (UKAS). It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory (NPL) or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2$  to give a level of confidence of approximately 95%.

Where no uncertainty is shown the measurement is beyond the scope of UKAS accreditation but has been included as an indicative measurement for completeness.

Certificate No: **166-04860180821**  
 Date of Issue: 18<sup>th</sup> August 2021

## UKAS IEC61000 Calibration

18 Aug 2021 05:31 Script file: KinetiQ PPA5500-HC calibration v2.14  
 Automatic Calibration Environment release ACE v2.168  
 NEWTONS4TH,PPA5531,166-04860,2.185  
 Fluke,6105A,176162845,4.14  
 NEWTONS4TH,ACC-IV,91K-09999,1.60

Summary report

Verify all voltage ranges

	applied	range	phase 1	phase 2	phase 3	dev	voltage spec	uncert
OK:	55.00 Hz	100.00mV	500.00mA	1	99.955mV	99.946mV	99.971mV <-0.05%>	[5.12%] {
OK:	55.00 Hz	500.00mV	500.00mA	2	499.85mV	499.82mV	499.84mV <-0.04%>	[1.09%] {
OK:	55.00 Hz	2.0000 V	500.00mA	3	2.0002 V	1.9998 V	2.0001 V <+0.01%>	[0.32%] {0.018%}
OK:	400.0 Hz	2.0000 V	500.00mA	3	2.0003 V	1.9996 V	2.0001 V <-0.02%>	[0.32%] {0.020%}
OK:	850.0 Hz	2.0000 V	500.00mA	3	2.0004 V	1.9993 V	2.0000 V <-0.03%>	[0.32%] {0.020%}
OK:	55.00 Hz	6.3000 V	500.00mA	4	6.3003 V	6.2994 V	6.2997 V <-0.01%>	[0.15%] {0.012%}
OK:	400.0 Hz	6.3000 V	500.00mA	4	6.3006 V	6.2996 V	6.2999 V <+0.01%>	[0.15%] {0.013%}
OK:	850.0 Hz	6.3000 V	500.00mA	4	6.3008 V	6.2998 V	6.3001 V <+0.01%>	[0.15%] {0.013%}
OK:	55.00 Hz	20.000 V	500.00mA	5	19.999 V	20.000 V	19.999 V <-0.01%>	[0.09%] {0.009%}
OK:	400.0 Hz	20.000 V	500.00mA	5	20.001 V	20.001 V	20.000 V <+0.01%>	[0.09%] {0.011%}
OK:	850.0 Hz	20.000 V	500.00mA	5	20.001 V	20.001 V	20.000 V <+0.01%>	[0.10%] {0.011%}
OK:	55.00 Hz	63.000 V	500.00mA	6	62.998 V	62.996 V	62.996 V <-0.01%>	[0.08%] {0.009%}
OK:	400.0 Hz	63.000 V	500.00mA	6	63.003 V	63.001 V	63.002 V <+0.00%>	[0.08%] {0.010%}
OK:	850.0 Hz	63.000 V	500.00mA	6	63.003 V	63.001 V	63.001 V <+0.00%>	[0.08%] {0.010%}
OK:	55.00 Hz	200.00 V	500.00mA	7	199.97 V	199.98 V	199.97 V <-0.02%>	[0.07%] {0.011%}
OK:	400.0 Hz	200.00 V	500.00mA	7	200.00 V	200.00 V	199.99 V <-0.00%>	[0.07%] {0.011%}
OK:	850.0 Hz	200.00 V	500.00mA	7	200.00 V	200.00 V	199.99 V <-0.00%>	[0.07%] {0.011%}
OK:	55.00 Hz	630.00 V	500.00mA	8	629.97 V	630.00 V	629.95 V <-0.01%>	[0.07%] {0.010%}
OK:	400.0 Hz	630.00 V	500.00mA	8	629.96 V	630.03 V	629.93 V <-0.01%>	[0.07%] {0.010%}
OK:	850.0 Hz	630.00 V	500.00mA	8	629.93 V	630.05 V	629.88 V <-0.02%>	[0.07%] {0.010%}
OK:	55.00 Hz	975.00 V	500.00mA	9	975.08 V	975.09 V	975.06 V <+0.01%>	[0.13%] {0.011%}
OK:	400.0 Hz	975.00 V	500.00mA	9	975.02 V	975.04 V	975.01 V <+0.00%>	[0.13%] {0.011%}
OK:	850.0 Hz	975.00 V	500.00mA	9	974.98 V	975.01 V	974.97 V <-0.00%>	[0.13%] {0.011%}

Verify all current ranges

	applied	range	phase 1	phase 2	phase 3	dev	current spec	uncert
OK:	55.00 Hz	20.000 V	50.000mA	1	50.001mA	49.999mA	49.997mA <-0.01%>	[2.09%] {0.019%}
OK:	400.0 Hz	20.000 V	50.000mA	1	49.997mA	49.996mA	49.994mA <-0.01%>	[2.09%] {0.019%}
OK:	850.0 Hz	20.000 V	50.000mA	1	50.005mA	49.992mA	49.986mA <-0.03%>	[2.09%] {0.019%}
OK:	55.00 Hz	20.000 V	180.00mA	2	180.00mA	179.97mA	180.00mA <-0.02%>	[0.63%] {0.013%}
OK:	400.0 Hz	20.000 V	180.00mA	2	180.01mA	179.99mA	180.01mA <+0.01%>	[0.63%] {0.014%}
OK:	850.0 Hz	20.000 V	180.00mA	2	180.04mA	180.01mA	180.03mA <+0.02%>	[0.63%] {0.014%}
OK:	55.00 Hz	20.000 V	630.00mA	3	629.99mA	629.97mA	629.98mA <-0.00%>	[0.23%] {0.011%}
OK:	400.0 Hz	20.000 V	630.00mA	3	630.02mA	630.01mA	630.03mA <+0.00%>	[0.23%] {0.013%}
OK:	850.0 Hz	20.000 V	630.00mA	3	630.08mA	630.07mA	630.07mA <+0.01%>	[0.23%] {0.013%}
OK:	55.00 Hz	20.000 V	2.0000 A	4	1.9998 A	1.9997 A	1.9997 A <-0.01%>	[0.12%] {0.011%}
OK:	400.0 Hz	20.000 V	2.0000 A	4	1.9998 A	1.9998 A	1.9998 A <-0.01%>	[0.12%] {0.013%}
OK:	850.0 Hz	20.000 V	2.0000 A	4	1.9999 A	1.9999 A	1.9999 A <-0.00%>	[0.12%] {0.013%}
OK:	55.00 Hz	20.000 V	6.3000 A	5	6.3000 A	6.2998 A	6.2998 A <-0.00%>	[0.09%] {0.012%}
OK:	400.0 Hz	20.000 V	6.3000 A	5	6.2995 A	6.2998 A	6.2998 A <-0.01%>	[0.09%] {0.014%}
OK:	850.0 Hz	20.000 V	6.3000 A	5	6.2994 A	6.2997 A	6.2996 A <-0.01%>	[0.09%] {0.014%}
OK:	55.00 Hz	20.000 V	20.000 A	6	20.001 A	19.999 A	20.000 A <+0.01%>	[0.07%] {0.011%}
OK:	400.0 Hz	20.000 V	20.000 A	6	19.998 A	19.999 A	19.999 A <-0.01%>	[0.07%] {0.013%}

Certificate No: **166-04860180821**  
 Date of Issue: 18<sup>th</sup> August 2021

## UKAS IEC61000 Calibration

OK:	850.0 Hz	20.000 V	20.000 A	6	19.998 A	19.998 A	19.997 A	<-0.02%>	[0.08%]	{0.013%}
OK:	55.00 Hz	20.000 V	48.000 A	7	47.994 A	47.990 A	47.993 A	<-0.02%>	[0.09%]	{0.011%}
OK:	400.0 Hz	20.000 V	48.000 A	7	48.008 A	48.010 A	48.009 A	<+0.02%>	[0.09%]	{0.017%}
OK:	850.0 Hz	20.000 V	48.000 A	7	48.008 A	48.012 A	48.008 A	<+0.03%>	[0.09%]	{0.017%}
OK:	55.00 Hz	20.000 V	48.000 A	8	48.001 A	47.996 A	48.003 A	<-0.01%>	[0.25%]	{0.011%}
OK:	400.0 Hz	20.000 V	48.000 A	8	48.016 A	48.018 A	48.016 A	<+0.04%>	[0.25%]	{0.017%}
OK:	850.0 Hz	20.000 V	48.000 A	8	48.021 A	48.020 A	48.022 A	<+0.05%>	[0.25%]	{0.017%}
OK:	55.00 Hz	20.000 V	48.000 A	9	48.005 A	47.997 A	48.009 A	<+0.02%>	[0.80%]	{0.011%}
OK:	400.0 Hz	20.000 V	48.000 A	9	48.022 A	48.027 A	48.019 A	<+0.06%>	[0.81%]	{0.017%}
OK:	850.0 Hz	20.000 V	48.000 A	9	48.036 A	48.035 A	48.041 A	<+0.09%>	[0.81%]	{0.017%}

Phase tests

	applied	phase 1	phase 2	phase 3	dev	spec	uncert
OK:	55.00 Hz 220.00 V 10.000 A +0.000°	7 6 -0.001°	+0.001°	+0.000°	<+0.001°>	[0.011°]	{0.003°}
OK:	55.00 Hz 220.00 V 10.000 A +30.00°	7 6 +30.00°	+30.00°	+30.00°	<-0.001°>	[0.011°]	{0.003°}
OK:	55.00 Hz 220.00 V 10.000 A +60.00°	7 6 +60.00°	+60.00°	+60.00°	<-0.002°>	[0.011°]	{0.003°}
OK:	55.00 Hz 220.00 V 10.000 A +90.00°	7 6 +90.00°	+90.00°	+90.00°	<-0.002°>	[0.011°]	{0.003°}

Verify power measurement at 220V 20A at 40-850Hz

	applied	phase 1	phase 2	phase 3	VA	W
OK:	40.00 Hz 4.4000kVA 4.4000kW +0.000°	7 6 4.4002kVA	4.4001kW	4.4000kVA	4.3999kW	4.3998kVA
OK:	55.00 Hz 4.4000kVA 4.4000kW +0.000°	7 6 4.4002kVA	4.4000kW	4.4000kVA	4.3999kW	4.3996kVA
OK:	150.0 Hz 4.4000kVA 4.4000kW +0.000°	7 6 4.3998kVA	4.3997kW	4.4000kVA	4.4000kW	4.3996kVA
OK:	400.0 Hz 4.4000kVA 4.4000kW +0.000°	7 6 4.3994kVA	4.3992kW	4.3996kVA	4.3994kW	4.3990kVA
OK:	850.0 Hz 4.4000kVA 4.4000kW +0.000°	7 6 4.3986kVA	4.3985kW	4.3984kVA	4.3983kW	4.3977kVA

Verify power measurement at different phase angles at 220V 15A

	applied	phase 1	phase 2	phase 3	VA	W
OK:	55.00 Hz 3.3000kVA 3.3000kW +0.000°	7 6 3.3000kVA	3.2998kW	3.2997kVA	3.2996kW	3.2996kVA
OK:	55.00 Hz 3.3000kVA 2.8579kW -30.00°	7 6 3.2999kVA	2.8577kW	3.2997kVA	2.8576kW	3.2996kVA
OK:	55.00 Hz 3.3000kVA 2.3335kW +45.00°	7 6 3.3000kVA	2.3335kW	3.2997kVA	2.3332kW	3.2998kVA
OK:	55.00 Hz 3.3000kVA 1.6500kW -60.00°	7 6 3.2999kVA	1.6498kW	3.2996kVA	1.6498kW	3.2996kVA

All 72 tests passed

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service (UKAS). It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory (NPL) or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2 to give a level of confidence of approximately 95%.

Where no uncertainty is shown the measurement is beyond the scope of UKAS accreditation but has been included as an indicative measurement for completeness.

Certificate No: **166-04860180821**  
 Date of Issue: 18<sup>th</sup> August 2021

## UKAS IEC61000 Calibration

### Harmonics & Flicker

18 Aug 2021 14:19 Script file: KinetiQ PPA5500 IEC61000 50Hz tests v2.06  
 Automatic Calibration Environment release ACE v2.168  
 NEWTONS4TH, PPA5531, 166-04860, 2.185  
 Fluke, 6105A, 176162845, 4.14  
 NEWTONS4TH, ACC-IV, 91K-09999, 1.60

#### Result log

Verify response to Harmonics at Class A limit with 230V 2.3A 50Hz									
[----- applied -----]			[----- measured harmonic -----]						
						dev	spec	uncert	
OK: H01	50.00 Hz	2.300 A	2.300 A	2.299 A	2.299 A	<-0.03%>	[5.00%]	{0.16%}	
OK: H02	100.0 Hz	1.080 A	1.079 A	1.079 A	1.079 A	<-0.13%>	[5.00%]	{0.17%}	
OK: H03	150.0 Hz	2.300 A	2.299 A	2.299 A	2.299 A	<-0.05%>	[5.00%]	{0.16%}	
OK: H04	200.0 Hz	430.0mA	430.1mA	430.2mA	430.3mA	<+0.06%>	[5.00%]	{0.18%}	
OK: H05	250.0 Hz	1.140 A	1.140 A	1.140 A	1.140 A	<+0.02%>	[5.00%]	{0.17%}	
OK: H06	300.0 Hz	300.0mA	300.2mA	300.2mA	300.3mA	<+0.11%>	[5.00%]	{0.19%}	
OK: H07	350.0 Hz	770.0mA	769.8mA	769.8mA	769.6mA	<-0.06%>	[5.00%]	{0.17%}	
OK: H08	400.0 Hz	230.0mA	230.2mA	229.9mA	230.1mA	<+0.08%>	[5.00%]	{0.20%}	
OK: H09	450.0 Hz	400.0mA	400.0mA	400.1mA	400.2mA	<+0.06%>	[5.00%]	{0.18%}	
OK: H10	500.0 Hz	184.0mA	184.0mA	183.9mA	183.8mA	<-0.13%>	[5.00%]	{0.21%}	
OK: H11	550.0 Hz	330.0mA	329.8mA	330.0mA	330.0mA	<-0.07%>	[5.00%]	{0.19%}	
OK: H12	600.0 Hz	153.3mA	153.2mA	153.3mA	153.2mA	<-0.08%>	[5.00%]	{0.23%}	
OK: H13	650.0 Hz	210.0mA	209.8mA	210.0mA	210.0mA	<-0.07%>	[5.00%]	{0.21%}	
OK: H14	700.0 Hz	131.4mA	131.4mA	131.4mA	131.1mA	<-0.20%>	[5.00%]	{0.24%}	
OK: H15	750.0 Hz	150.0mA	149.9mA	149.9mA	149.9mA	<-0.07%>	[5.00%]	{0.23%}	
OK: H16	800.0 Hz	115.0mA	115.0mA	115.0mA	115.0mA	<+0.04%>	[5.00%]	{0.25%}	
OK: H17	850.0 Hz	132.4mA	132.1mA	132.3mA	132.2mA	<-0.21%>	[5.00%]	{0.55%}	
OK: H18	900.0 Hz	102.2mA	102.2mA	102.1mA	102.2mA	<-0.13%>	[5.00%]	{0.57%}	
OK: H19	950.0 Hz	118.4mA	118.4mA	118.1mA	118.4mA	<-0.24%>	[5.00%]	{0.55%}	
OK: H20	1.000kHz	92.00mA	91.88mA	92.03mA	92.19mA	<+0.21%>	[5.00%]	{0.58%}	
OK: H21	1.050kHz	107.1mA	107.0mA	107.0mA	107.2mA	<-0.11%>	[5.00%]	{0.56%}	
OK: H22	1.100kHz	83.60mA	83.51mA	83.45mA	83.51mA	<-0.18%>	[5.00%]	{0.59%}	
OK: H23	1.150kHz	97.80mA	97.77mA	97.86mA	97.79mA	<+0.06%>	[5.00%]	{0.57%}	
OK: H24	1.200kHz	76.70mA	76.55mA	76.69mA	76.68mA	<-0.19%>	[5.00%]	{0.60%}	
OK: H25	1.250kHz	90.00mA	89.94mA	90.07mA	89.96mA	<+0.08%>	[5.00%]	{0.58%}	
OK: H26	1.300kHz	78.00mA	77.91mA	77.84mA	78.00mA	<-0.20%>	[5.00%]	{0.60%}	
OK: H27	1.350kHz	83.30mA	83.27mA	83.40mA	83.23mA	<+0.12%>	[5.00%]	{0.59%}	
OK: H28	1.400kHz	65.70mA	65.70mA	65.60mA	65.77mA	<-0.16%>	[5.25%]	{0.62%}	
OK: H29	1.450kHz	77.60mA	77.50mA	77.49mA	77.61mA	<-0.14%>	[5.00%]	{0.60%}	
OK: H30	1.500kHz	61.30mA	61.29mA	61.20mA	61.39mA	<-0.16%>	[5.63%]	{0.63%}	
OK: H31	1.550kHz	72.60mA	72.44mA	72.58mA	72.47mA	<-0.21%>	[5.00%]	{0.61%}	
OK: H32	1.600kHz	57.50mA	57.38mA	57.41mA	57.40mA	<-0.21%>	[6.00%]	{0.64%}	
OK: H33	1.650kHz	68.20mA	67.93mA	68.18mA	68.12mA	<-0.39%>	[5.06%]	{0.62%}	
OK: H34	1.700kHz	54.10mA	54.01mA	54.07mA	53.97mA	<-0.24%>	[6.38%]	{0.65%}	
OK: H35	1.750kHz	64.30mA	64.04mA	64.07mA	64.21mA	<-0.40%>	[5.37%]	{0.63%}	
OK: H36	1.800kHz	51.10mA	50.95mA	51.05mA	51.16mA	<-0.30%>	[6.75%]	{0.67%}	
OK: H37	1.850kHz	60.80mA	60.71mA	60.76mA	60.71mA	<-0.15%>	[5.67%]	{0.63%}	
OK: H38	1.900kHz	48.40mA	48.35mA	48.29mA	48.34mA	<-0.23%>	[7.13%]	{0.68%}	
OK: H39	1.950kHz	57.70mA	57.50mA	57.55mA	57.57mA	<-0.34%>	[5.98%]	{0.64%}	
OK: H40	2.000kHz	46.00mA	45.87mA	45.99mA	45.92mA	<-0.27%>	[7.50%]	{0.69%}	



Certificate No: **166-04860180821**  
 Date of Issue: 18<sup>th</sup> August 2021

**UKAS IEC61000 Calibration**

Verify response to sine/square modulation

[----- applied -----]		[----- measured Pinst max -----]									
				dev		spec		uncert			
OK: 50.00Hz	230.0 V	0.5000 Hz	sin	2.3250%	1.000	0.998	0.990	0.998	<-0.97%	[8.00%]	{0.37%}
OK: 50.00Hz	230.0 V	0.5000 Hz	sq	0.5090%	1.000	1.003	1.002	1.004	<+0.37%	[8.00%]	{0.39%}
OK: 50.00Hz	230.0 V	1.5000 Hz	sin	1.0670%	1.000	0.998	0.991	0.997	<-0.93%	[8.00%]	{0.37%}
OK: 50.00Hz	230.0 V	3.5000 Hz	sq	0.3420%	1.000	0.998	0.991	0.997	<-0.85%	[8.00%]	{0.39%}
OK: 50.00Hz	230.0 V	8.8000 Hz	sin	0.2500%	1.000	1.003	1.005	1.007	<+0.73%	[8.00%]	{0.37%}
OK: 50.00Hz	230.0 V	8.8000 Hz	sq	0.1960%	1.000	1.013	1.003	1.009	<+1.29%	[8.00%]	{0.39%}
OK: 50.00Hz	230.0 V	18.000 Hz	sq	0.4460%	1.000	0.996	0.994	0.996	<-0.62%	[8.00%]	{0.39%}
OK: 50.00Hz	230.0 V	20.000 Hz	sin	0.7040%	1.000	1.006	1.005	1.006	<+0.62%	[8.00%]	{0.37%}
OK: 50.00Hz	230.0 V	21.500 Hz	sq	0.5920%	1.000	1.001	1.002	0.997	<-0.34%	[8.00%]	{0.39%}
OK: 50.00Hz	230.0 V	25.000 Hz	sin	1.0370%	1.000	0.996	0.998	0.994	<-0.55%	[8.00%]	{0.37%}
OK: 50.00Hz	230.0 V	25.000 Hz	sq	0.7640%	1.000	0.996	0.997	0.995	<-0.48%	[8.00%]	{0.39%}
OK: 50.00Hz	230.0 V	28.000 Hz	sq	0.9150%	1.000	1.004	0.996	0.998	<+0.43%	[8.00%]	{0.39%}
OK: 50.00Hz	230.0 V	30.500 Hz	sq	0.8470%	1.000	1.003	1.002	1.005	<+0.49%	[8.00%]	{1.05%}
OK: 50.00Hz	230.0 V	33.333 Hz	sin	2.1280%	1.000	0.992	0.994	0.992	<-0.83%	[8.00%]	{0.37%}
OK: 50.00Hz	230.0 V	33.333 Hz	sq	1.6710%	1.000	0.992	0.992	0.992	<-0.79%	[8.00%]	{0.39%}

Verify PST = 1 measurement at 50Hz to IEC61000-3-3:2013

[----- applied -----]		[----- measured Pst -----]									
				dev		spec		uncert			
OK: 50.00Hz	230.0 V	1.0000 cpm	sq	2.7240%	1.000	0.994	0.993	0.992	<-0.77%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	2.0000 cpm	sq	2.2110%	1.000	0.997	0.997	0.996	<-0.42%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	7.0000 cpm	sq	1.4590%	1.000	1.002	1.002	1.001	<+0.22%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	39.000 cpm	sq	0.9060%	1.000	1.008	1.007	1.007	<+0.75%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	110.00 cpm	sq	0.7250%	1.000	1.000	1.000	0.999	<-0.08%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	1620.0 cpm	sq	0.4020%	1.000	0.999	0.999	0.999	<-0.11%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	4000.0 cpm	sq	2.3430%	1.000	1.003	1.003	1.003	<+0.32%	[5.00%]	{0.25%}

Verify PST = 1 measurement at 50Hz to IEC61000-4-15:2011

[----- applied -----]		[----- measured Pst -----]									
				dev		spec		uncert			
OK: 50.00Hz	230.0 V	1.0000 cpm	sq	2.7150%	1.000	0.987	0.989	0.986	<-1.44%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	2.0000 cpm	sq	2.1910%	1.000	0.990	0.991	0.989	<-1.11%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	7.0000 cpm	sq	1.4500%	1.000	0.996	0.995	0.995	<-0.51%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	39.000 cpm	sq	0.8940%	1.000	0.995	0.995	0.994	<-0.57%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	110.00 cpm	sq	0.7220%	1.000	0.996	0.997	0.996	<-0.40%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	1620.0 cpm	sq	0.4070%	1.000	1.003	1.003	1.003	<+0.32%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	4000.0 cpm	sq	2.3430%	1.000	1.003	1.003	1.003	<+0.32%	[5.00%]	{0.25%}

Verify PST range measurement

[----- applied -----]		[----- measured Pst -----]									
				dev		spec		uncert			
OK: 50.00Hz	230.0 V	1620.0 cpm	sq	0.1017%	0.250	0.251	0.251	0.251	<+0.52%	[5.00%]	{0.25%}
OK: 50.00Hz	230.0 V	1620.0 cpm	sq	2.0350%	5.000	4.984	4.984	4.984	<-0.33%	[5.00%]	{0.25%}

Verify frequency changes test

[----- applied -----]		[----- measured Pinst max -----]									
				dev		spec		uncert			
OK: 50.00Hz	230.0 V	PERFREQCH	1.000	1.006	1.005	1.004	<+0.61%	[8.00%]	{1.50%}		

Certificate No: **166-04860180821**  
 Date of Issue: 18<sup>th</sup> August 2021

## UKAS IEC61000 Calibration

```
Verify distorted voltage with multiple zero crossings test
[----- applied -----] [----- measured Pinst max -----]
                                dev    spec    uncert
OK: 50.00Hz  230.0 V  DVMULTIZC 1.000 1.005 1.009 1.011 <+1.08%> [8.00%] {1.12%}
```

```
Verify input bandwidth
[----- applied -----] [----- measured Pinst max -----]
                                dev    spec    uncert
OK: 50.00Hz  230.0 V  HSIDEBAND  4.000k 1.000 0.965 0.965 0.969 <-3.54%> [8.00%] {1.30%}
```

```
Verify phase jumps test
[----- applied -----] [----- measured Pst -----]
                                dev    spec    uncert
OK: 50.00Hz  230.0 V  PHASEJUMP +30.00 0.913 0.907 0.907 0.907 <-0.67%> [5.00%] {1.00%}
OK: 50.00Hz  230.0 V  PHASEJUMP -30.00 0.913 0.918 0.918 0.918 <+0.57%> [5.00%] {1.00%}
OK: 50.00Hz  230.0 V  PHASEJUMP +45.00 1.060 1.045 1.045 1.045 <-1.44%> [5.00%] {1.00%}
OK: 50.00Hz  230.0 V  PHASEJUMP -45.00 1.060 1.066 1.067 1.065 <+0.63%> [5.00%] {1.00%}
```

```
Verify duty cycle test
[----- applied -----] [----- measured Pst -----]
                                dev    spec    uncert
OK: 50.00Hz  230.0 V  DUTYCYCLE 1.000 0.994 0.994 0.994 <-0.65%> [5.00%] {1.00%}
```

All 79 tests passed

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service (UKAS). It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory (NPL) or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2$  to give a level of confidence of approximately 95%.

Where no uncertainty is shown the measurement is beyond the scope of UKAS accreditation but has been included as an indicative measurement for completeness.

Certificate No: **166-04860180821**  
 Date of Issue: 18<sup>th</sup> August 2021

## UKAS IEC61000 Calibration

### IEC61000 d(t) test

19 Aug 2021 05:20 Script file: KinetiQ PPA5500 IEC61000 d(t) test v2.00  
 Automatic Calibration Environment release ACE v2.168  
 NEWTONS4TH, PPA5531, 166-04860, 2.185

Result log

```

Verify d(t) test waveforms at 230V 50Hz

  [----- applied -----] [----- measured -----]
                                dev   spec  uncert
OK: 50.00Hz 230.0 V +2.00% dc   +2.01% +2.00% +2.00% <+0.25%> [5.00%] {0.75%}
OK: 50.00Hz 230.0 V +4.00% dmax +3.96% +3.96% +3.97% <-1.00%> [5.00%] {0.37%}
OK: 50.00Hz 230.0 V 500ms tmax 500ms 500ms 500ms
OK: 50.00Hz 230.0 V +1.00% dc   +1.00% +1.01% +1.01% <+1.38%> [5.00%] {1.50%}
OK: 50.00Hz 230.0 V +5.00% dmax +5.04% +5.04% +5.03% <+0.84%> [5.00%] {0.30%}
OK: 50.00Hz 230.0 V 600ms tmax 600ms 600ms 600ms

Verify d(t) test waveforms at 100V 50Hz

  [----- applied -----] [----- measured -----]
                                dev   spec  uncert
OK: 50.00Hz 100.0 V +2.00% dc   +2.01% +2.02% +2.00% <+1.24%> [5.00%] {0.75%}
OK: 50.00Hz 100.0 V +4.00% dmax +3.93% +4.09% +3.94% <+2.37%> [5.00%] {0.37%}
OK: 50.00Hz 100.0 V 500ms tmax 500ms 500ms 500ms
OK: 50.00Hz 100.0 V +1.00% dc   +1.00% +1.03% +1.03% <+2.75%> [5.00%] {1.50%}
OK: 50.00Hz 100.0 V +5.00% dmax +5.03% +5.05% +5.03% <+0.92%> [5.00%] {0.30%}
OK: 50.00Hz 100.0 V 600ms tmax 600ms 600ms 600ms
    
```

All 12 tests passed

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service (UKAS). It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory (NPL) or other recognised national metrology institutes. This certificate may not be reproduced other than in full- except with the prior written approval of the issuing laboratory.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2$  to give a level of confidence of approximately 95%.

For clarity all values have been normalised appropriately.