

## APPLICATION NOTE - 028

### N4L Harmonics and Flicker Compliance Verification of PPA55xx to IEC61000-3-2, IEC61000-3-3, IEC61000-3-11 and IEC61000-3-12.

#### 1. Introduction

This document presents measurements made with PPA5500 family of precision power analysers from Newtons4th Ltd in order to verify the performance of the analyser in a test system fully compliant to the relevant standards.

The standards in force to which this document relates are:

BSEN61000-3-2:2014 IEC61000-3-2:2014	Limits for harmonic current emissions (equipment input current $\leq 16A$ per phase).
BSEN61000-3-3:2013 IEC61000-3-3:2013	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current $\leq 16 A$ per phase and not subject to conditional connection.
BSEN61000-3-11:2001 IEC61000-3-11:2000	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current $\leq 75A$ and subject to conditional connection.
BSEN61000-3-12:2011 IEC61000-3-12:2011	Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current $> 16 A$ and $\leq 75 A$ per phase.
BSEN61000-4-7:2002+A1:2009 IEC61000-4-7:2002+A1:2008	Testing and measurement techniques — General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto.
BSEN61000-4-15:2011 IEC61000-4-15:2010	Testing and measurement techniques — Flickermeter — Functional and design specifications.

The harmonic measurement and testing techniques contained in the standard BSEN61000-4-7:2002+A1:2009 apply to equipment with a rated current of  $\leq 16A$  per phase (BSEN61000-3-2:2014) and to equipment with a rated current of  $>16A$  and  $\leq 75A$  per phase (BSEN61000-3-12:2011).

The Flickermeter measurement and testing techniques contained in the standard BSEN61000-4-15:2011 apply to equipment with a rated current of  $\leq 16A$  per phase (BSEN61000-3-3:2013) and to equipment with a rated current of  $>16A$  and  $\leq 75A$  per phase (BSEN61000-3-11:2001).

The same relationship exists between the relevant IEC standards.

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These standards impose many constraints on the physical characteristics, the accuracy, and the measurement algorithms of the instrument.

The tests were carried out on standard production units, a PPA5530 and PPA5531, the results of the comprehensive tests are detailed in the following pages.

## 2. Requirement summary

Function	Requirement	Test results
Current input circuit	61000-4-7 {5.1}	N4L
Voltage input circuit	61000-4-7 {5.2}	N4L
Current accuracy and linearity	61000-4-7 {5.3}	NPL p3
Power accuracy	61000-4-7 {5.3}	NPL p4,5
Steady state harmonic accuracy	61000-4-7 {5.3}	NPL p5,6 N4L
Current harmonic grouping	61000-4-7 {5.5.1}	N4L
Class A limit pass/fail	61000-3-2 {6.2.3.4}	NPL p7
Partial odd harmonic limit assessment	61000-3-2 {6.2.3.4}	NPL p7,8
Use of power in class D limit assessment	61000-3-2 {6.2.2}	NPL p8
Short term limit assessment	61000-3-2 {6.2.3.4}	NPL p10
Fluctuating harmonic class A test	61000-4-7	NPL p11,12
Fluctuating harmonic step change	61000-4-7 {5.5.1}	NPL p13,14
Normalised flickermeter Pinst response	61000-4-15 {6.2}	N4L
Flickermeter classifier Pst = 1 accuracy	61000-4-15 {6.3}	*NPL p16,17 N4L
Flickermeter classifier Pst range	61000-4-15 {6.3}	N4L
Combined frequency and voltage changes	61000-4-15 {6.4}	N4L
Distorted voltage with multiple zero crossings	61000-4-15 {6.5}	N4L
Harmonics with sideband bandwidth test	61000-4-15 {6.6}	N4L
Phase jumps	61000-4-15 {6.7}	N4L
Rectangular changes with 20% duty cycle	61000-4-15 {6.8}	N4L
'd' parameter test	61000-4-15 {6.9}	N4L

\* Note, NPL tested Pst =1 to the older (1998) issue of the standard which contained an error on one of the tests

### 3. Verification

The details of the test techniques and procedures used by NPL are given in the NPL test certificate.

Further more extensive tests have been carried out at Newtons4th Ltd using a Fluke 6105A power calibrator with accuracies traceable to National standards certified by a UKAS accredited facility. Details of the extra tests are given below.

Measurement of the 'd' parameters has been verified by tests at Newtons4th Ltd using an arbitrary waveform generator and high voltage amplifier.

The verification of the current and voltage input circuits also involved an Agilent A3458A precision DMM with accuracies traceable to National standards certified by a UKAS accredited facility.

#### 3.1. Current input circuit

IEC61000-4-7 section 5.1 requires that the rms input voltage drop shall not exceed 150mV. At Newtons4th a Fluke 6105A was used to generate 16A rms, the maximum current covered by this standard, while an Agilent A3458A was used to verify the voltage drop across the current input terminals.

Voltage drop < 122mV

#### 3.2. Voltage input circuit

IEC61000-4-7 section 5.2 requires that the power absorption of the voltage input circuit shall not exceed 0.5VA. At Newtons4th a Fluke 6105A was used to generate 230V rms, the maximum voltage covered by this standard, while an Agilent A3458A was used to verify the current drawn into the voltage input.

Power absorption < 0.08VA

#### 3.3. Current, Voltage and Power accuracy

Every power analyser manufactured by Newtons4th is verified for accuracy to a specification which exceeds that required by IEC6100.

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### 3.4. Steady state harmonic accuracy

IEC61000-4-7 section 5.3 specifies a current harmonic measurement accuracy of +/-5% of the harmonic limit or +/-0.15% of the nominal current. Using the same test as NPL, a distorted waveshape with a harmonic content equal to the class A limits was created using the Fluke 6105A.

#### 3.4.1. Harmonic accuracy at 230V 50Hz

	frequency	actual	measured	dev	spec
OK: H01	50.00 Hz	2.300 A	2.299 A	<-0.04%>	[5.00%]
OK: H02	100.0 Hz	1.080 A	1.079 A	<-0.06%>	[5.00%]
OK: H03	150.0 Hz	2.300 A	2.299 A	<-0.04%>	[5.00%]
OK: H04	200.0 Hz	430.0mA	429.8mA	<-0.06%>	[5.00%]
OK: H05	250.0 Hz	1.140 A	1.140 A	<-0.04%>	[5.00%]
OK: H06	300.0 Hz	300.0mA	299.8mA	<-0.07%>	[5.00%]
OK: H07	350.0 Hz	770.0mA	769.3mA	<-0.09%>	[5.00%]
OK: H08	400.0 Hz	230.0mA	229.7mA	<-0.11%>	[5.00%]
OK: H09	450.0 Hz	400.0mA	399.8mA	<-0.05%>	[5.00%]
OK: H10	500.0 Hz	184.0mA	183.9mA	<-0.05%>	[5.00%]
OK: H11	550.0 Hz	330.0mA	329.6mA	<-0.12%>	[5.00%]
OK: H12	600.0 Hz	153.3mA	153.3mA	<-0.02%>	[5.00%]
OK: H13	650.0 Hz	210.0mA	209.9mA	<-0.05%>	[5.00%]
OK: H14	700.0 Hz	131.4mA	131.2mA	<-0.13%>	[5.00%]
OK: H15	750.0 Hz	150.0mA	149.7mA	<-0.17%>	[5.00%]
OK: H16	800.0 Hz	115.0mA	115.0mA	< 0.02%>	[5.00%]
OK: H17	850.0 Hz	132.4mA	132.2mA	<-0.14%>	[5.00%]
OK: H18	900.0 Hz	102.2mA	102.1mA	<-0.08%>	[5.00%]
OK: H19	950.0 Hz	118.4mA	118.4mA	<-0.03%>	[5.00%]
OK: H20	1.000kHz	92.00mA	91.85mA	<-0.16%>	[5.00%]
OK: H21	1.050kHz	107.1mA	107.0mA	<-0.11%>	[5.00%]
OK: H22	1.100kHz	83.60mA	83.42mA	<-0.22%>	[5.00%]
OK: H23	1.150kHz	97.80mA	97.48mA	<-0.33%>	[5.00%]
OK: H24	1.200kHz	76.70mA	76.54mA	<-0.21%>	[5.00%]
OK: H25	1.250kHz	90.00mA	89.67mA	<-0.37%>	[5.00%]
OK: H26	1.300kHz	78.00mA	77.81mA	<-0.24%>	[5.00%]
OK: H27	1.350kHz	83.30mA	83.10mA	<-0.24%>	[5.00%]
OK: H28	1.400kHz	65.70mA	65.41mA	<-0.45%>	[5.25%]
OK: H29	1.450kHz	77.60mA	77.47mA	<-0.16%>	[5.00%]
OK: H30	1.500kHz	61.30mA	61.14mA	<-0.25%>	[5.63%]
OK: H31	1.550kHz	72.60mA	72.44mA	<-0.22%>	[5.00%]
OK: H32	1.600kHz	57.50mA	57.29mA	<-0.37%>	[6.00%]
OK: H33	1.650kHz	68.20mA	67.92mA	<-0.41%>	[5.06%]
OK: H34	1.700kHz	54.10mA	54.10mA	< 0.00%>	[6.38%]
OK: H35	1.750kHz	64.30mA	64.19mA	<-0.18%>	[5.37%]
OK: H36	1.800kHz	51.10mA	51.02mA	<-0.15%>	[6.75%]
OK: H37	1.850kHz	60.80mA	60.72mA	<-0.13%>	[5.67%]
OK: H38	1.900kHz	48.40mA	48.20mA	<-0.42%>	[7.13%]
OK: H39	1.950kHz	57.70mA	57.72mA	< 0.03%>	[5.98%]
OK: H40	2.000kHz	46.00mA	45.91mA	<-0.19%>	[7.50%]

### 3.4.2. Harmonic accuracy at 120V 60Hz

	frequency	actual	measured	deviation	spec
OK: H01	60.00 Hz	2.300 A	2.299 A	<-0.03%>	[5.00%]
OK: H02	120.0 Hz	1.080 A	1.079 A	<-0.07%>	[5.00%]
OK: H03	180.0 Hz	2.300 A	2.299 A	<-0.03%>	[5.00%]
OK: H04	240.0 Hz	430.0mA	430.0mA	<-0.01%>	[5.00%]
OK: H05	300.0 Hz	1.140 A	1.140 A	<-0.04%>	[5.00%]
OK: H06	360.0 Hz	300.0mA	300.2mA	< 0.05%>	[5.00%]
OK: H07	420.0 Hz	770.0mA	769.7mA	<-0.03%>	[5.00%]
OK: H08	480.0 Hz	230.0mA	230.0mA	<-0.01%>	[5.00%]
OK: H09	540.0 Hz	400.0mA	399.8mA	<-0.06%>	[5.00%]
OK: H10	600.0 Hz	184.0mA	183.9mA	<-0.08%>	[5.00%]
OK: H11	660.0 Hz	330.0mA	329.9mA	<-0.04%>	[5.00%]
OK: H12	720.0 Hz	153.3mA	153.2mA	<-0.05%>	[5.00%]
OK: H13	780.0 Hz	210.0mA	209.8mA	<-0.10%>	[5.00%]
OK: H14	840.0 Hz	131.4mA	131.1mA	<-0.19%>	[5.00%]
OK: H15	900.0 Hz	150.0mA	149.8mA	<-0.13%>	[5.00%]
OK: H16	960.0 Hz	115.0mA	115.0mA	<-0.01%>	[5.00%]
OK: H17	1.020kHz	132.4mA	132.3mA	<-0.08%>	[5.00%]
OK: H18	1.080kHz	102.2mA	102.2mA	<-0.02%>	[5.00%]
OK: H19	1.140kHz	118.4mA	118.3mA	<-0.11%>	[5.00%]
OK: H20	1.200kHz	92.00mA	91.96mA	<-0.05%>	[5.00%]
OK: H21	1.260kHz	107.1mA	106.8mA	<-0.27%>	[5.00%]
OK: H22	1.320kHz	83.60mA	83.55mA	<-0.06%>	[5.00%]
OK: H23	1.380kHz	97.80mA	97.68mA	<-0.12%>	[5.00%]
OK: H24	1.440kHz	76.70mA	76.63mA	<-0.09%>	[5.00%]
OK: H25	1.500kHz	90.00mA	89.89mA	<-0.12%>	[5.00%]
OK: H26	1.560kHz	78.00mA	77.75mA	<-0.32%>	[5.00%]
OK: H27	1.620kHz	83.30mA	83.23mA	<-0.08%>	[5.00%]
OK: H28	1.680kHz	65.70mA	65.72mA	< 0.02%>	[5.25%]
OK: H29	1.740kHz	77.60mA	77.45mA	<-0.20%>	[5.00%]
OK: H30	1.800kHz	61.30mA	61.35mA	< 0.08%>	[5.63%]
OK: H31	1.860kHz	72.60mA	72.50mA	<-0.14%>	[5.00%]
OK: H32	1.920kHz	57.50mA	57.52mA	< 0.03%>	[6.00%]
OK: H33	1.980kHz	68.20mA	68.06mA	<-0.21%>	[5.06%]
OK: H34	2.040kHz	54.10mA	53.92mA	<-0.33%>	[6.38%]
OK: H35	2.100kHz	64.30mA	64.18mA	<-0.19%>	[5.37%]
OK: H36	2.160kHz	51.10mA	50.79mA	<-0.60%>	[6.75%]
OK: H37	2.220kHz	60.80mA	60.53mA	<-0.44%>	[5.67%]
OK: H38	2.280kHz	48.40mA	48.19mA	<-0.44%>	[7.13%]
OK: H39	2.340kHz	57.70mA	57.43mA	<-0.47%>	[5.98%]
OK: H40	2.400kHz	46.00mA	45.90mA	<-0.22%>	[7.50%]

### 3.5. Current harmonic grouping (interharmonics)

Changes in the harmonic currents drawn by a load can result in spurious frequency components which are not true harmonics ie not multiples of the fundamental frequency. In order to detect these interharmonic effects, it is required that any components between the harmonics are grouped together to form a composite measurement for each harmonic.

Note: The IEC and BSEN standards differ slightly in section 5.5.1, the IEC standard excludes interharmonics below the frequency of the 2nd harmonic (for example with a 50Hz fundamental, all interharmonic components below 100Hz are excluded from the grouping process)

IEC61000-4-7 section 5.5.1 specifies the grouping of frequency components spaced at 5Hz intervals into the resulting harmonics. At Newtons4th Ltd an instrument was tested by varying the frequency of a component added to a fixed fundamental in steps of 5Hz all the way from 75Hz (start of 2<sup>nd</sup> harmonic group) to 2025Hz (end of 40<sup>th</sup> harmonic group). For all 391 tests, the harmonic measurements show zero for those harmonics where the 5Hz component falls outside of the grouping and the correct measurement where the 5Hz component lies inside a group. This process was performed for both BSEN and IEC grouping techniques, verifying correct rejection of interharmonics below the 2nd harmonic when in IEC mode.

NB it would not be sufficient to test only some components and groups in case of variations over the bandwidth of the instrument.

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### 3.6. Normalised flickermeter Pinst response

A flickermeter measures voltage fluctuations in the form of instantaneous flicker perception, Pinst, which corresponds to the effect of the voltage changes on lighting circuits. The flickermeter contains filters which shape the frequency response to simulate the human "lamp-eye-brain" response. To test the correct response, the maximum value of Pinst is specified for voltage fluctuations over a range of frequencies and depth, both for sinusoidal and rectangular modulations.

IEC61000-4-15 section 5.2 and 6.2 require that the instrument should measure 1.00 unit of perceptibility with a tolerance of +/-8% for all conditions given in Table 1 (sinusoidal fluctuations) and Table 2 (rectangular fluctuations). These tests were carried out using the Fluke 6105A over a 10 minute measurement time following a 1 minute settling period (results shown below).

NB while the standard does not require that all these modulations are tested, the nature of the required filtering is such that the only way to be really sure of the accuracy of the response is to test all these points.

#### 3.6.1. Pinst max from sinewave modulation (Table 1) at 230V 50Hz

frequency	applied	Pinst	dev	spec
OK: 50.00Hz	230.0 V 0.5000 Hz sin 2.3250%	1.000	0.991	-0.94% [8.00%]
OK: 50.00Hz	230.0 V 1.0000 Hz sin 1.3970%	1.000	0.990	-0.98% [8.00%]
OK: 50.00Hz	230.0 V 1.5000 Hz sin 1.0670%	1.000	0.991	-0.91% [8.00%]
OK: 50.00Hz	230.0 V 2.0000 Hz sin 0.8790%	1.000	0.994	-0.65% [8.00%]
OK: 50.00Hz	230.0 V 2.5000 Hz sin 0.7470%	1.000	0.995	-0.53% [8.00%]
OK: 50.00Hz	230.0 V 3.0000 Hz sin 0.6450%	1.000	0.995	-0.47% [8.00%]
OK: 50.00Hz	230.0 V 3.5000 Hz sin 0.5640%	1.000	0.997	-0.25% [8.00%]
OK: 50.00Hz	230.0 V 4.0000 Hz sin 0.4970%	1.000	0.998	-0.24% [8.00%]
OK: 50.00Hz	230.0 V 4.5000 Hz sin 0.4420%	1.000	1.000	-0.00% [8.00%]
OK: 50.00Hz	230.0 V 5.0000 Hz sin 0.3960%	1.000	1.006	0.55% [8.00%]
OK: 50.00Hz	230.0 V 5.5000 Hz sin 0.3570%	1.000	0.997	-0.26% [8.00%]
OK: 50.00Hz	230.0 V 6.0000 Hz sin 0.3250%	1.000	0.999	-0.12% [8.00%]
OK: 50.00Hz	230.0 V 6.5000 Hz sin 0.3000%	1.000	1.004	0.42% [8.00%]
OK: 50.00Hz	230.0 V 7.0000 Hz sin 0.2800%	1.000	1.010	0.97% [8.00%]
OK: 50.00Hz	230.0 V 7.5000 Hz sin 0.2650%	1.000	1.005	0.53% [8.00%]
OK: 50.00Hz	230.0 V 8.0000 Hz sin 0.2560%	1.000	1.015	1.45% [8.00%]
OK: 50.00Hz	230.0 V 8.8000 Hz sin 0.2500%	1.000	1.015	1.49% [8.00%]
OK: 50.00Hz	230.0 V 9.5000 Hz sin 0.2540%	1.000	1.017	1.68% [8.00%]
OK: 50.00Hz	230.0 V 10.000 Hz sin 0.2610%	1.000	1.016	1.55% [8.00%]
OK: 50.00Hz	230.0 V 10.500 Hz sin 0.2710%	1.000	1.018	1.77% [8.00%]
OK: 50.00Hz	230.0 V 11.000 Hz sin 0.2830%	1.000	1.016	1.64% [8.00%]
OK: 50.00Hz	230.0 V 11.500 Hz sin 0.2980%	1.000	1.014	1.44% [8.00%]
OK: 50.00Hz	230.0 V 12.000 Hz sin 0.3140%	1.000	1.011	1.05% [8.00%]
OK: 50.00Hz	230.0 V 13.000 Hz sin 0.3510%	1.000	1.011	1.12% [8.00%]
OK: 50.00Hz	230.0 V 14.000 Hz sin 0.3930%	1.000	1.012	1.21% [8.00%]
OK: 50.00Hz	230.0 V 15.000 Hz sin 0.4380%	1.000	1.011	1.07% [8.00%]
OK: 50.00Hz	230.0 V 16.000 Hz sin 0.4860%	1.000	1.010	0.95% [8.00%]
OK: 50.00Hz	230.0 V 17.000 Hz sin 0.5370%	1.000	1.007	0.71% [8.00%]
OK: 50.00Hz	230.0 V 18.000 Hz sin 0.5900%	1.000	1.004	0.44% [8.00%]
OK: 50.00Hz	230.0 V 19.000 Hz sin 0.6460%	1.000	1.005	0.52% [8.00%]
OK: 50.00Hz	230.0 V 20.000 Hz sin 0.7040%	1.000	1.001	0.08% [8.00%]
OK: 50.00Hz	230.0 V 21.000 Hz sin 0.7640%	1.000	0.999	-0.08% [8.00%]
OK: 50.00Hz	230.0 V 22.000 Hz sin 0.8280%	1.000	1.001	0.12% [8.00%]
OK: 50.00Hz	230.0 V 23.000 Hz sin 0.8940%	1.000	0.999	-0.09% [8.00%]
OK: 50.00Hz	230.0 V 24.000 Hz sin 0.9640%	1.000	0.998	-0.22% [8.00%]
OK: 50.00Hz	230.0 V 25.000 Hz sin 1.0370%	1.000	0.994	-0.55% [8.00%]
OK: 50.00Hz	230.0 V 33.333 Hz sin 2.1280%	1.000	0.991	-0.87% [8.00%]



3.6.2. Pinst max from squarewave modulation (Table 2) at 230V 50Hz

frequency	applied	Pinst	dev	spec
OK: 50.00Hz	230.0 V 0.5000 Hz squ	0.5090%	1.000 0.999	-0.11% [8.00%]
OK: 50.00Hz	230.0 V 1.0000 Hz squ	0.4670%	1.000 1.000	-0.05% [8.00%]
OK: 50.00Hz	230.0 V 1.5000 Hz squ	0.4290%	1.000 0.994	-0.59% [8.00%]
OK: 50.00Hz	230.0 V 2.0000 Hz squ	0.3980%	1.000 0.992	-0.78% [8.00%]
OK: 50.00Hz	230.0 V 2.5000 Hz squ	0.3700%	1.000 0.998	-0.22% [8.00%]
OK: 50.00Hz	230.0 V 3.0000 Hz squ	0.3520%	1.000 0.999	-0.13% [8.00%]
OK: 50.00Hz	230.0 V 3.5000 Hz squ	0.3420%	1.000 0.998	-0.20% [8.00%]
OK: 50.00Hz	230.0 V 4.0000 Hz squ	0.3320%	1.000 0.999	-0.10% [8.00%]
OK: 50.00Hz	230.0 V 4.5000 Hz squ	0.3120%	1.000 0.991	-0.87% [8.00%]
OK: 50.00Hz	230.0 V 5.0000 Hz squ	0.2910%	1.000 0.991	-0.87% [8.00%]
OK: 50.00Hz	230.0 V 5.5000 Hz squ	0.2680%	1.000 1.000	-0.03% [8.00%]
OK: 50.00Hz	230.0 V 6.0000 Hz squ	0.2480%	1.000 0.997	-0.28% [8.00%]
OK: 50.00Hz	230.0 V 6.5000 Hz squ	0.2310%	1.000 0.999	-0.13% [8.00%]
OK: 50.00Hz	230.0 V 7.0000 Hz squ	0.2160%	1.000 1.002	0.17% [8.00%]
OK: 50.00Hz	230.0 V 7.5000 Hz squ	0.2070%	1.000 1.008	0.80% [8.00%]
OK: 50.00Hz	230.0 V 8.0000 Hz squ	0.1990%	1.000 0.996	-0.41% [8.00%]
OK: 50.00Hz	230.0 V 8.8000 Hz squ	0.1960%	1.000 1.006	0.63% [8.00%]
OK: 50.00Hz	230.0 V 9.5000 Hz squ	0.1990%	1.000 1.007	0.73% [8.00%]
OK: 50.00Hz	230.0 V 10.000 Hz squ	0.2030%	1.000 1.012	1.17% [8.00%]
OK: 50.00Hz	230.0 V 10.500 Hz squ	0.2120%	1.000 1.007	0.65% [8.00%]
OK: 50.00Hz	230.0 V 11.000 Hz squ	0.2220%	1.000 1.004	0.37% [8.00%]
OK: 50.00Hz	230.0 V 11.500 Hz squ	0.2330%	1.000 1.006	0.59% [8.00%]
OK: 50.00Hz	230.0 V 12.000 Hz squ	0.2450%	1.000 1.008	0.75% [8.00%]
OK: 50.00Hz	230.0 V 13.000 Hz squ	0.2720%	1.000 1.004	0.39% [8.00%]
OK: 50.00Hz	230.0 V 14.000 Hz squ	0.3080%	1.000 1.004	0.35% [8.00%]
OK: 50.00Hz	230.0 V 15.000 Hz squ	0.3410%	1.000 0.991	-0.89% [8.00%]
OK: 50.00Hz	230.0 V 16.000 Hz squ	0.3760%	1.000 0.992	-0.76% [8.00%]
OK: 50.00Hz	230.0 V 17.000 Hz squ	0.4110%	1.000 0.990	-1.00% [8.00%]
OK: 50.00Hz	230.0 V 18.000 Hz squ	0.4460%	1.000 0.994	-0.61% [8.00%]
OK: 50.00Hz	230.0 V 19.000 Hz squ	0.4970%	1.000 0.993	-0.71% [8.00%]
OK: 50.00Hz	230.0 V 20.000 Hz squ	0.5530%	1.000 1.003	0.32% [8.00%]
OK: 50.00Hz	230.0 V 21.000 Hz squ	0.5850%	1.000 0.995	-0.46% [8.00%]
OK: 50.00Hz	230.0 V 21.500 Hz squ	0.5920%	1.000 0.994	-0.61% [8.00%]
OK: 50.00Hz	230.0 V 22.000 Hz squ	0.6120%	1.000 0.996	-0.35% [8.00%]
OK: 50.00Hz	230.0 V 23.000 Hz squ	0.6800%	1.000 0.992	-0.84% [8.00%]
OK: 50.00Hz	230.0 V 24.000 Hz squ	0.7430%	1.000 0.997	-0.28% [8.00%]
OK: 50.00Hz	230.0 V 25.000 Hz squ	0.7640%	1.000 0.983	-1.75% [8.00%]
OK: 50.00Hz	230.0 V 25.500 Hz squ	0.8060%	1.000 0.990	-1.01% [8.00%]
OK: 50.00Hz	230.0 V 28.000 Hz squ	0.9150%	1.000 0.991	-0.87% [8.00%]
OK: 50.00Hz	230.0 V 30.500 Hz squ	0.8470%	1.000 1.001	0.12% [8.00%]
OK: 50.00Hz	230.0 V 33.333 Hz squ	1.6710%	1.000 0.991	-0.87% [8.00%]



### 3.6.3. Pinst max from sinewave modulation (Table 1) at 120V 60Hz

frequency	applied	Pinst	dev	spec
OK: 60.00Hz	120.0 V 0.5000 Hz sin 2.4530%	1.000	0.999	-0.15% [ 8.00%]
OK: 60.00Hz	120.0 V 1.0000 Hz sin 1.4650%	1.000	1.002	0.21% [ 8.00%]
OK: 60.00Hz	120.0 V 1.5000 Hz sin 1.1260%	1.000	1.001	0.06% [ 8.00%]
OK: 60.00Hz	120.0 V 2.0000 Hz sin 0.9420%	1.000	1.005	0.51% [ 8.00%]
OK: 60.00Hz	120.0 V 2.5000 Hz sin 0.8150%	1.000	1.003	0.30% [ 8.00%]
OK: 60.00Hz	120.0 V 3.0000 Hz sin 0.7170%	1.000	1.005	0.51% [ 8.00%]
OK: 60.00Hz	120.0 V 3.5000 Hz sin 0.6370%	1.000	1.007	0.68% [ 8.00%]
OK: 60.00Hz	120.0 V 4.0000 Hz sin 0.5700%	1.000	1.009	0.87% [ 8.00%]
OK: 60.00Hz	120.0 V 4.5000 Hz sin 0.5140%	1.000	1.013	1.26% [ 8.00%]
OK: 60.00Hz	120.0 V 5.0000 Hz sin 0.4660%	1.000	1.011	1.06% [ 8.00%]
OK: 60.00Hz	120.0 V 5.5000 Hz sin 0.4260%	1.000	1.014	1.43% [ 8.00%]
OK: 60.00Hz	120.0 V 6.0000 Hz sin 0.3930%	1.000	1.015	1.53% [ 8.00%]
OK: 60.00Hz	120.0 V 6.5000 Hz sin 0.3660%	1.000	1.017	1.73% [ 8.00%]
OK: 60.00Hz	120.0 V 7.0000 Hz sin 0.3460%	1.000	1.020	2.01% [ 8.00%]
OK: 60.00Hz	120.0 V 7.5000 Hz sin 0.3320%	1.000	1.022	2.19% [ 8.00%]
OK: 60.00Hz	120.0 V 8.0000 Hz sin 0.3230%	1.000	1.019	1.86% [ 8.00%]
OK: 60.00Hz	120.0 V 8.8000 Hz sin 0.3210%	1.000	1.031	3.10% [ 8.00%]
OK: 60.00Hz	120.0 V 9.5000 Hz sin 0.3290%	1.000	1.026	2.60% [ 8.00%]
OK: 60.00Hz	120.0 V 10.000 Hz sin 0.3410%	1.000	1.037	3.66% [ 8.00%]
OK: 60.00Hz	120.0 V 10.500 Hz sin 0.3550%	1.000	1.025	2.47% [ 8.00%]
OK: 60.00Hz	120.0 V 11.000 Hz sin 0.3730%	1.000	1.025	2.49% [ 8.00%]
OK: 60.00Hz	120.0 V 11.500 Hz sin 0.3940%	1.000	1.027	2.73% [ 8.00%]
OK: 60.00Hz	120.0 V 12.000 Hz sin 0.4170%	1.000	1.020	2.01% [ 8.00%]
OK: 60.00Hz	120.0 V 13.000 Hz sin 0.4690%	1.000	1.033	3.30% [ 8.00%]
OK: 60.00Hz	120.0 V 14.000 Hz sin 0.5280%	1.000	1.023	2.33% [ 8.00%]
OK: 60.00Hz	120.0 V 15.000 Hz sin 0.5920%	1.000	1.022	2.20% [ 8.00%]
OK: 60.00Hz	120.0 V 16.000 Hz sin 0.6600%	1.000	1.017	1.68% [ 8.00%]
OK: 60.00Hz	120.0 V 17.000 Hz sin 0.7340%	1.000	1.016	1.60% [ 8.00%]
OK: 60.00Hz	120.0 V 18.000 Hz sin 0.8110%	1.000	1.015	1.51% [ 8.00%]
OK: 60.00Hz	120.0 V 19.000 Hz sin 0.8920%	1.000	1.017	1.70% [ 8.00%]
OK: 60.00Hz	120.0 V 20.000 Hz sin 0.9770%	1.000	1.018	1.84% [ 8.00%]
OK: 60.00Hz	120.0 V 21.000 Hz sin 1.0670%	1.000	1.013	1.33% [ 8.00%]
OK: 60.00Hz	120.0 V 22.000 Hz sin 1.1600%	1.000	1.012	1.21% [ 8.00%]
OK: 60.00Hz	120.0 V 23.000 Hz sin 1.2570%	1.000	1.009	0.87% [ 8.00%]
OK: 60.00Hz	120.0 V 24.000 Hz sin 1.3590%	1.000	1.010	0.96% [ 8.00%]
OK: 60.00Hz	120.0 V 25.000 Hz sin 1.4640%	1.000	1.009	0.94% [ 8.00%]
OK: 60.00Hz	120.0 V 33.333 Hz sin 2.5700%	1.000	1.002	0.15% [ 8.00%]
OK: 60.00Hz	120.0 V 40.000 Hz sin 4.3930%	1.000	1.003	0.31% [ 8.00%]

3.6.4. Pinst max from squarewave modulation (Table 2) at 120V 60Hz

frequency	applied	Pinst	dev	spec
OK: 60.00Hz	120.0 V 0.5000 Hz squ	0.5980% 1.000 1.010	0.97%	[ 8.00%]
OK: 60.00Hz	120.0 V 1.0000 Hz squ	0.5480% 1.000 1.008	0.83%	[ 8.00%]
OK: 60.00Hz	120.0 V 1.5000 Hz squ	0.5030% 1.000 1.012	1.16%	[ 8.00%]
OK: 60.00Hz	120.0 V 2.0000 Hz squ	0.4690% 1.000 1.016	1.57%	[ 8.00%]
OK: 60.00Hz	120.0 V 2.5000 Hz squ	0.4390% 1.000 1.007	0.66%	[ 8.00%]
OK: 60.00Hz	120.0 V 3.0000 Hz squ	0.4190% 1.000 1.000	0.01%	[ 8.00%]
OK: 60.00Hz	120.0 V 3.5000 Hz squ	0.4080% 1.000 1.010	0.97%	[ 8.00%]
OK: 60.00Hz	120.0 V 4.0000 Hz squ	0.3940% 1.000 1.003	0.33%	[ 8.00%]
OK: 60.00Hz	120.0 V 4.5000 Hz squ	0.3730% 1.000 1.013	1.30%	[ 8.00%]
OK: 60.00Hz	120.0 V 5.0000 Hz squ	0.3480% 1.000 1.003	0.31%	[ 8.00%]
OK: 60.00Hz	120.0 V 5.5000 Hz squ	0.3240% 1.000 1.008	0.81%	[ 8.00%]
OK: 60.00Hz	120.0 V 6.0000 Hz squ	0.3020% 1.000 1.011	1.14%	[ 8.00%]
OK: 60.00Hz	120.0 V 6.5000 Hz squ	0.2830% 1.000 1.009	0.87%	[ 8.00%]
OK: 60.00Hz	120.0 V 7.0000 Hz squ	0.2690% 1.000 1.016	1.57%	[ 8.00%]
OK: 60.00Hz	120.0 V 7.5000 Hz squ	0.2580% 1.000 1.016	1.57%	[ 8.00%]
OK: 60.00Hz	120.0 V 8.0000 Hz squ	0.2530% 1.000 1.015	1.49%	[ 8.00%]
OK: 60.00Hz	120.0 V 8.8000 Hz squ	0.2520% 1.000 1.021	2.14%	[ 8.00%]
OK: 60.00Hz	120.0 V 9.5000 Hz squ	0.2580% 1.000 1.021	2.08%	[ 8.00%]
OK: 60.00Hz	120.0 V 10.000 Hz squ	0.2660% 1.000 1.022	2.16%	[ 8.00%]
OK: 60.00Hz	120.0 V 10.500 Hz squ	0.2780% 1.000 1.011	1.09%	[ 8.00%]
OK: 60.00Hz	120.0 V 11.000 Hz squ	0.2920% 1.000 1.010	1.02%	[ 8.00%]
OK: 60.00Hz	120.0 V 11.500 Hz squ	0.3080% 1.000 1.017	1.74%	[ 8.00%]
OK: 60.00Hz	120.0 V 12.000 Hz squ	0.3240% 1.000 1.018	1.84%	[ 8.00%]
OK: 60.00Hz	120.0 V 13.000 Hz squ	0.3670% 1.000 1.010	0.96%	[ 8.00%]
OK: 60.00Hz	120.0 V 14.000 Hz squ	0.4110% 1.000 1.012	1.24%	[ 8.00%]
OK: 60.00Hz	120.0 V 15.000 Hz squ	0.4570% 1.000 1.006	0.60%	[ 8.00%]
OK: 60.00Hz	120.0 V 16.000 Hz squ	0.5090% 1.000 1.010	0.96%	[ 8.00%]
OK: 60.00Hz	120.0 V 17.000 Hz squ	0.5750% 1.000 1.007	0.72%	[ 8.00%]
OK: 60.00Hz	120.0 V 18.000 Hz squ	0.6260% 1.000 1.003	0.28%	[ 8.00%]
OK: 60.00Hz	120.0 V 19.000 Hz squ	0.6880% 1.000 1.003	0.28%	[ 8.00%]
OK: 60.00Hz	120.0 V 20.000 Hz squ	0.7460% 1.000 1.012	1.15%	[ 8.00%]
OK: 60.00Hz	120.0 V 21.000 Hz squ	0.8150% 1.000 1.002	0.17%	[ 8.00%]
OK: 60.00Hz	120.0 V 21.500 Hz squ	0.8370% 1.000 1.004	0.39%	[ 8.00%]
OK: 60.00Hz	120.0 V 22.000 Hz squ	0.8510% 1.000 1.007	0.66%	[ 8.00%]
OK: 60.00Hz	120.0 V 23.000 Hz squ	0.9460% 1.000 1.004	0.35%	[ 8.00%]
OK: 60.00Hz	120.0 V 24.000 Hz squ	1.0670% 1.000 1.006	0.55%	[ 8.00%]
OK: 60.00Hz	120.0 V 25.000 Hz squ	1.0880% 1.000 1.003	0.30%	[ 8.00%]
OK: 60.00Hz	120.0 V 25.500 Hz squ	1.0720% 1.000 1.011	1.14%	[ 8.00%]
OK: 60.00Hz	120.0 V 28.000 Hz squ	1.3830% 1.000 1.006	0.56%	[ 8.00%]
OK: 60.00Hz	120.0 V 30.500 Hz squ	1.6020% 1.000 1.002	0.17%	[ 8.00%]
OK: 60.00Hz	120.0 V 33.333 Hz squ	1.8230% 1.000 1.004	0.44%	[ 8.00%]
OK: 60.00Hz	120.0 V 37.000 Hz squ	1.3040% 1.000 1.013	1.30%	[ 8.00%]
OK: 60.00Hz	120.0 V 40.000 Hz squ	3.4600% 1.000 0.990	-0.96%	[ 8.00%]

### 3.7. Flickermeter classifier Pst = 1 accuracy

To give a meaningful assessment of the severity of the fluctuations over time, the instantaneous flicker perception values, Pinst, are statistically analysed to give a measure of “short term severity”, known as Pst.

IEC61000-4-15 section 6.3 requires that the instrument shall read a Pst of 1.00 with a tolerance of +/-5% for all test points in Table 5. This has been verified using the Fluke 6105A (results given below) and independently by NPL (see the attached report).

#### 3.7.1. Pst =1 at 230V 50Hz

frequency	applied				Pst	dev	spec
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	2.7150%	1.000	0.989 -1.09% [5.00%]
OK: 50.00Hz	230.0 V	2.0000	cpm	sq	2.1910%	1.000	0.989 -1.06% [5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	sq	1.4500%	1.000	0.997 -0.34% [5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	sq	0.8940%	1.000	0.996 -0.44% [5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	sq	0.7220%	1.000	0.997 -0.31% [5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	sq	0.4070%	1.000	1.003 0.32% [5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	sq	2.3430%	1.000	1.003 0.32% [5.00%]

#### 3.7.2. Pst =1 at 120V 60Hz

frequency	applied				Pst	dev	spec
OK: 60.00Hz	120.0 V	1.0000	cpm	sq	3.1810%	1.000	0.993 -0.68% [5.00%]
OK: 60.00Hz	120.0 V	2.0000	cpm	sq	2.5640%	1.000	0.992 -0.75% [5.00%]
OK: 60.00Hz	120.0 V	7.0000	cpm	sq	1.6940%	1.000	0.998 -0.23% [5.00%]
OK: 60.00Hz	120.0 V	39.000	cpm	sq	1.0400%	1.000	0.994 -0.59% [5.00%]
OK: 60.00Hz	120.0 V	110.00	cpm	sq	0.8440%	1.000	0.999 -0.05% [5.00%]
OK: 60.00Hz	120.0 V	1620.0	cpm	sq	0.5480%	1.000	1.003 0.32% [5.00%]
OK: 60.00Hz	120.0 V	4800.0	cpm	sq	4.8370%	1.000	1.003 0.32% [5.00%]

### 3.8. Flickermeter classifier Pst range

IEC61000-4-15 section 6.3 also requires that the instrument shall be tested over a range of Pst values. Using the Fluke 6105A, at each of the modulations specified in table 5 of section 6.3 for 230V 50Hz, the instrument was verified from Pst = 0.25 to 2.00 in steps of 0.25 and from Pst = 2.50 to 5.00 in steps of 0.50 to confirm a specified operating range of Pst = 0.25 to 5.0.

NB it would not be sufficient to test only the extremes of the range because of possible variations over the whole range.

#### 3.8.1. Pst range from 0.25 to 2.00 in steps of 0.25 at 230V 50Hz

frequency	applied				Pst	dev	spec
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	0.6787%	0.250	0.257 2.70% [5.00%]
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	1.3575%	0.500	0.498 -0.40% [5.00%]
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	2.0362%	0.750	0.743 -0.87% [5.00%]
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	2.7150%	1.000	0.989 -1.11% [5.00%]
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	3.3937%	1.250	1.235 -1.18% [5.00%]
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	4.0725%	1.500	1.481 -1.25% [5.00%]
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	4.7512%	1.750	1.725 -1.41% [5.00%]
OK: 50.00Hz	230.0 V	1.0000	cpm	sq	5.4300%	2.000	1.972 -1.42% [5.00%]

OK: 50.00Hz	230.0 V	2.0000	cpm	squ	0.5477%	0.250	0.256	2.34%	[5.00%]
OK: 50.00Hz	230.0 V	2.0000	cpm	squ	1.0955%	0.500	0.497	-0.54%	[5.00%]
OK: 50.00Hz	230.0 V	2.0000	cpm	squ	1.6432%	0.750	0.741	-1.17%	[5.00%]
OK: 50.00Hz	230.0 V	2.0000	cpm	squ	2.1910%	1.000	0.990	-1.05%	[5.00%]
OK: 50.00Hz	230.0 V	2.0000	cpm	squ	2.7387%	1.250	1.236	-1.14%	[5.00%]
OK: 50.00Hz	230.0 V	2.0000	cpm	squ	3.2865%	1.500	1.482	-1.21%	[5.00%]
OK: 50.00Hz	230.0 V	2.0000	cpm	squ	3.8342%	1.750	1.729	-1.18%	[5.00%]
OK: 50.00Hz	230.0 V	2.0000	cpm	squ	4.3820%	2.000	1.975	-1.25%	[5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	squ	0.3625%	0.250	0.252	0.65%	[5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	squ	0.7250%	0.500	0.499	-0.17%	[5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	squ	1.0875%	0.750	0.746	-0.56%	[5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	squ	1.4500%	1.000	0.996	-0.37%	[5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	squ	1.8125%	1.250	1.244	-0.44%	[5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	squ	2.1750%	1.500	1.491	-0.59%	[5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	squ	2.5375%	1.750	1.742	-0.47%	[5.00%]
OK: 50.00Hz	230.0 V	7.0000	cpm	squ	2.9000%	2.000	1.991	-0.43%	[5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	squ	0.2235%	0.250	0.249	-0.24%	[5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	squ	0.4470%	0.500	0.498	-0.37%	[5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	squ	0.6705%	0.750	0.745	-0.68%	[5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	squ	0.8940%	1.000	0.996	-0.44%	[5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	squ	1.1175%	1.250	1.244	-0.51%	[5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	squ	1.3410%	1.500	1.490	-0.67%	[5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	squ	1.5645%	1.750	1.744	-0.37%	[5.00%]
OK: 50.00Hz	230.0 V	39.000	cpm	squ	1.7880%	2.000	1.991	-0.45%	[5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	squ	0.1805%	0.250	0.249	-0.37%	[5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	squ	0.3610%	0.500	0.499	-0.25%	[5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	squ	0.5415%	0.750	0.745	-0.73%	[5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	squ	0.7220%	1.000	0.997	-0.28%	[5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	squ	0.9025%	1.250	1.244	-0.52%	[5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	squ	1.0830%	1.500	1.489	-0.73%	[5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	squ	1.2635%	1.750	1.747	-0.19%	[5.00%]
OK: 50.00Hz	230.0 V	110.00	cpm	squ	1.4440%	2.000	1.994	-0.30%	[5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	squ	0.1017%	0.250	0.251	0.50%	[5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	squ	0.2035%	0.500	0.502	0.32%	[5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	squ	0.3052%	0.750	0.750	0.05%	[5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	squ	0.4070%	1.000	1.003	0.32%	[5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	squ	0.5087%	1.250	1.246	-0.33%	[5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	squ	0.6105%	1.500	1.501	0.07%	[5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	squ	0.7122%	1.750	1.761	0.65%	[5.00%]
OK: 50.00Hz	230.0 V	1620.0	cpm	squ	0.8140%	2.000	2.007	0.32%	[5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	squ	0.5857%	0.250	0.251	0.32%	[5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	squ	1.1715%	0.500	0.502	0.32%	[5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	squ	1.7573%	0.750	0.766	2.09%	[5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	squ	2.3430%	1.000	1.003	0.32%	[5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	squ	2.9288%	1.250	1.246	-0.33%	[5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	squ	3.5145%	1.500	1.531	2.03%	[5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	squ	4.1003%	1.750	1.762	0.69%	[5.00%]
OK: 50.00Hz	230.0 V	4000.0	cpm	squ	4.6860%	2.000	2.007	0.32%	[5.00%]

### 3.8.2. Pst range from 2.50 to 5.00 in steps of 0.50 at 230V 50Hz

frequency	applied					Pst	dev	spec
OK: 50.00Hz	230.0 V 1.0000	cpm	squ	6.7875%	2.500	2.466	-1.37%	[5.00%]
OK: 50.00Hz	230.0 V 1.0000	cpm	squ	8.1450%	3.000	2.963	-1.22%	[5.00%]
OK: 50.00Hz	230.0 V 1.0000	cpm	squ	9.5025%	3.500	3.436	-1.84%	[5.00%]
OK: 50.00Hz	230.0 V 1.0000	cpm	squ	10.860%	4.000	3.953	-1.17%	[5.00%]
OK: 50.00Hz	230.0 V 1.0000	cpm	squ	12.217%	4.500	4.497	-0.06%	[5.00%]
OK: 50.00Hz	230.0 V 1.0000	cpm	squ	13.575%	5.000	5.039	0.78%	[5.00%]
OK: 50.00Hz	230.0 V 2.0000	cpm	squ	5.4775%	2.500	2.474	-1.04%	[5.00%]
OK: 50.00Hz	230.0 V 2.0000	cpm	squ	6.5730%	3.000	2.970	-1.01%	[5.00%]
OK: 50.00Hz	230.0 V 2.0000	cpm	squ	7.6685%	3.500	3.447	-1.50%	[5.00%]
OK: 50.00Hz	230.0 V 2.0000	cpm	squ	8.7640%	4.000	3.952	-1.21%	[5.00%]
OK: 50.00Hz	230.0 V 2.0000	cpm	squ	9.8595%	4.500	4.454	-1.03%	[5.00%]
OK: 50.00Hz	230.0 V 2.0000	cpm	squ	10.955%	5.000	4.970	-0.60%	[5.00%]
OK: 50.00Hz	230.0 V 7.0000	cpm	squ	3.6250%	2.500	2.488	-0.46%	[5.00%]
OK: 50.00Hz	230.0 V 7.0000	cpm	squ	4.3500%	3.000	2.981	-0.64%	[5.00%]
OK: 50.00Hz	230.0 V 7.0000	cpm	squ	5.0750%	3.500	3.480	-0.56%	[5.00%]
OK: 50.00Hz	230.0 V 7.0000	cpm	squ	5.8000%	4.000	3.976	-0.61%	[5.00%]
OK: 50.00Hz	230.0 V 7.0000	cpm	squ	6.5250%	4.500	4.464	-0.80%	[5.00%]
OK: 50.00Hz	230.0 V 7.0000	cpm	squ	7.2500%	5.000	4.968	-0.63%	[5.00%]
OK: 50.00Hz	230.0 V 39.000	cpm	squ	2.2350%	2.500	2.486	-0.55%	[5.00%]
OK: 50.00Hz	230.0 V 39.000	cpm	squ	2.6820%	3.000	2.979	-0.71%	[5.00%]
OK: 50.00Hz	230.0 V 39.000	cpm	squ	3.1290%	3.500	3.486	-0.41%	[5.00%]
OK: 50.00Hz	230.0 V 39.000	cpm	squ	3.5760%	4.000	3.981	-0.48%	[5.00%]
OK: 50.00Hz	230.0 V 39.000	cpm	squ	4.0230%	4.500	4.470	-0.66%	[5.00%]
OK: 50.00Hz	230.0 V 39.000	cpm	squ	4.4700%	5.000	4.971	-0.58%	[5.00%]
OK: 50.00Hz	230.0 V 110.00	cpm	squ	1.8050%	2.500	2.486	-0.55%	[5.00%]
OK: 50.00Hz	230.0 V 110.00	cpm	squ	2.1660%	3.000	2.978	-0.74%	[5.00%]
OK: 50.00Hz	230.0 V 110.00	cpm	squ	2.5270%	3.500	3.490	-0.27%	[5.00%]
OK: 50.00Hz	230.0 V 110.00	cpm	squ	2.8880%	4.000	3.987	-0.32%	[5.00%]
OK: 50.00Hz	230.0 V 110.00	cpm	squ	3.2490%	4.500	4.483	-0.38%	[5.00%]
OK: 50.00Hz	230.0 V 110.00	cpm	squ	3.6100%	5.000	4.971	-0.58%	[5.00%]
OK: 50.00Hz	230.0 V 1620.0	cpm	squ	1.0175%	2.500	2.492	-0.33%	[5.00%]
OK: 50.00Hz	230.0 V 1620.0	cpm	squ	1.2210%	3.000	3.000	0.01%	[5.00%]
OK: 50.00Hz	230.0 V 1620.0	cpm	squ	1.4245%	3.500	3.522	0.64%	[5.00%]
OK: 50.00Hz	230.0 V 1620.0	cpm	squ	1.6280%	4.000	4.013	0.32%	[5.00%]
OK: 50.00Hz	230.0 V 1620.0	cpm	squ	1.8315%	4.500	4.551	1.14%	[5.00%]
OK: 50.00Hz	230.0 V 1620.0	cpm	squ	2.0350%	5.000	4.984	-0.33%	[5.00%]
OK: 50.00Hz	230.0 V 4000.0	cpm	squ	5.8575%	2.500	2.502	0.06%	[5.00%]
OK: 50.00Hz	230.0 V 4000.0	cpm	squ	7.0290%	3.000	3.084	2.79%	[5.00%]
OK: 50.00Hz	230.0 V 4000.0	cpm	squ	8.2005%	3.500	3.524	0.68%	[5.00%]
OK: 50.00Hz	230.0 V 4000.0	cpm	squ	9.3720%	4.000	4.035	0.88%	[5.00%]
OK: 50.00Hz	230.0 V 4000.0	cpm	squ	10.544%	4.500	4.570	1.55%	[5.00%]
OK: 50.00Hz	230.0 V 4000.0	cpm	squ	11.715%	5.000	5.146	2.93%	[5.00%]

### 3.8.3. Pst range from 0.25 to 2.00 in steps of 0.25 at 120V 60Hz

frequency	applied				Pst	dev	spec
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	0.7953%	0.250	0.258	3.00% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	1.5905%	0.500	0.501	0.15% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	2.3857%	0.750	0.747	-0.47% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	3.1810%	1.000	0.991	-0.86% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	3.9763%	1.250	1.238	-0.99% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	4.7715%	1.500	1.484	-1.04% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	5.5668%	1.750	1.735	-0.83% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	6.3620%	2.000	1.984	-0.78% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	0.6410%	0.250	0.256	2.58% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	1.2820%	0.500	0.500	-0.06% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	1.9230%	0.750	0.744	-0.75% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	2.5640%	1.000	0.993	-0.68% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	3.2050%	1.250	1.241	-0.74% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	3.8460%	1.500	1.488	-0.83% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	4.4870%	1.750	1.733	-0.96% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	5.1280%	2.000	1.982	-0.89% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	0.4235%	0.250	0.252	0.73% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	0.8470%	0.500	0.500	-0.03% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	1.2705%	0.750	0.748	-0.28% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	1.6940%	1.000	0.999	-0.15% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	2.1175%	1.250	1.248	-0.18% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	2.5410%	1.500	1.495	-0.32% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	2.9645%	1.750	1.743	-0.38% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	3.3880%	2.000	1.995	-0.25% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	0.2600%	0.250	0.249	-0.60% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	0.5200%	0.500	0.497	-0.56% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	0.7800%	0.750	0.745	-0.69% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	1.0400%	1.000	0.994	-0.62% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	1.3000%	1.250	1.242	-0.61% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	1.5600%	1.500	1.489	-0.73% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	1.8200%	1.750	1.739	-0.65% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	2.0800%	2.000	1.988	-0.59% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	0.2110%	0.250	0.250	-0.06% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	0.4220%	0.500	0.500	-0.01% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	0.6330%	0.750	0.747	-0.43% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	0.8440%	1.000	1.000	-0.03% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	1.0550%	1.250	1.248	-0.17% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	1.2660%	1.500	1.493	-0.45% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	1.4770%	1.750	1.750	0.02% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	1.6880%	2.000	1.999	-0.03% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	0.1370%	0.250	0.252	0.96% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	0.2740%	0.500	0.502	0.46% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	0.4110%	0.750	0.763	1.76% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	0.5480%	1.000	1.003	0.32% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	0.6850%	1.250	1.248	-0.18% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	0.8220%	1.500	1.527	1.79% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	0.9590%	1.750	1.762	0.69% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	1.0960%	2.000	2.007	0.32% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	1.2092%	0.250	0.251	0.32% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	2.4185%	0.500	0.502	0.32% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	3.6277%	0.750	0.741	-1.23% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	4.8370%	1.000	1.003	0.32% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	6.0462%	1.250	1.246	-0.33% [ 5.00%]

OK: 60.00Hz 120.0 V 4800.0 cpm squ 7.2555% 1.500 1.547 3.15% [ 5.00%]  
OK: 60.00Hz 120.0 V 4800.0 cpm squ 8.4647% 1.750 1.762 0.69% [ 5.00%]  
OK: 60.00Hz 120.0 V 4800.0 cpm squ 9.6740% 2.000 2.006 0.32% [ 5.00%]

N4L Harmonics and Flicker Compliance Verification	525-019	Issue 2
Newtons4th Ltd 1 Bede Island Rd Leicester LE2 7EA UK Tel: +44 (0)116 2301066		



### 3.8.4. Pst range from 2.50 to 5.00 in steps of 0.50 at 120V 60Hz

frequency	applied				Pst	dev	spec
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	7.9525%	2.500	2.480	-0.82% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	9.5430%	3.000	2.982	-0.61% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	11.134%	3.500	3.486	-0.39% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	12.724%	4.000	4.022	0.56% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	14.315%	4.500	4.574	1.63% [ 5.00%]
OK: 60.00Hz	120.0 V 1.0000	cpm	squ	15.905%	5.000	5.132	2.63% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	6.4100%	2.500	2.482	-0.72% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	7.6920%	3.000	2.980	-0.68% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	8.9740%	3.500	3.476	-0.70% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	10.256%	4.000	3.982	-0.45% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	11.538%	4.500	4.495	-0.12% [ 5.00%]
OK: 60.00Hz	120.0 V 2.0000	cpm	squ	12.820%	5.000	5.008	0.15% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	4.2350%	2.500	2.493	-0.26% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	5.0820%	3.000	2.989	-0.38% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	5.9290%	3.500	3.484	-0.46% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	6.7760%	4.000	3.983	-0.43% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	7.6230%	4.500	4.474	-0.58% [ 5.00%]
OK: 60.00Hz	120.0 V 7.0000	cpm	squ	8.4700%	5.000	4.977	-0.45% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	2.6000%	2.500	2.485	-0.62% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	3.1200%	3.000	2.977	-0.76% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	3.6400%	3.500	3.475	-0.70% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	4.1600%	4.000	3.973	-0.68% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	4.6800%	4.500	4.450	-1.11% [ 5.00%]
OK: 60.00Hz	120.0 V 39.000	cpm	squ	5.2000%	5.000	4.965	-0.71% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	2.1100%	2.500	2.496	-0.18% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	2.5320%	3.000	2.987	-0.44% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	2.9540%	3.500	3.500	0.01% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	3.3760%	4.000	3.997	-0.07% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	3.7980%	4.500	4.500	-0.01% [ 5.00%]
OK: 60.00Hz	120.0 V 110.00	cpm	squ	4.2200%	5.000	4.988	-0.23% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	1.3700%	2.500	2.492	-0.33% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	1.6440%	3.000	3.054	1.78% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	1.9180%	3.500	3.524	0.68% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	2.1920%	4.000	4.013	0.32% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	2.4660%	4.500	4.567	1.49% [ 5.00%]
OK: 60.00Hz	120.0 V 1620.0	cpm	squ	2.7400%	5.000	4.984	-0.33% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	12.092%	2.500	2.491	-0.36% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	14.511%	3.000	2.963	-1.23% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	16.929%	3.500	3.524	0.68% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	19.348%	4.000	3.843	-3.93% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	21.767%	4.500	4.363	-3.04% [ 5.00%]
OK: 60.00Hz	120.0 V 4800.0	cpm	squ	24.185%	5.000	5.213	4.25% [ 5.00%]

### 3.9. Combined frequency and voltage changes

For F1 flickermeters, IEC61000-4-15 section 6.4 requires that  $P_{inst,max}$  shall be 1.00 +/- 8% for a specified test varying both the frequency and voltage.

frequency	applied	Pinst	dev	spec
OK: 50.00Hz	230.0 V PERFREQCH	1.000 1.005	0.51%	[8.00%]
OK: 60.00Hz	120.0 V PERFREQCH	1.000 1.022	2.17%	[8.00%]

### 3.10. Distorted voltage with multiple zero crossings

For F1 flickermeters, IEC61000-4-15 section 6.5 requires that  $P_{inst,max}$  shall be 1.00 +/- 8% for a specified test with specified harmonics giving multiple zero crossings.

frequency	applied	Pinst	dev	spec
OK: 50.00Hz	230.0 V DVMULTIZC	1.000 1.010	0.97%	[8.00%]
OK: 60.00Hz	120.0 V DVMULTIZC	1.000 1.024	2.38%	[8.00%]

#### Harmonics with sideband bandwidth test

For F1 flickermeters, IEC61000-4-15 section 6.6 requires that the input bandwidth shall be at least 450Hz as measured by modulating with two frequencies spaced apart by 10Hz. Using the Fluke 6105A the specified signal was generated at frequencies from 150Hz to 4kHz in steps of 50Hz. As all the tests were well within the +/-8% limit, the bandwidth of the instrument according to IEC61000-4-15 is greater than 4kHz.

NB it would not be sufficient to test only at 450Hz in case of variations over the bandwidth of the instrument.

#### 3.10.1. Bandwidth test at 230V 50Hz

frequency	applied	harmonic	Pinst	dev	spec
OK: 50.00Hz	230.0 V HSIDEBAND	150.0 Hz	1.000 1.013	1.34%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	200.0 Hz	1.000 0.997	-0.34%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	250.0 Hz	1.000 1.012	1.22%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	300.0 Hz	1.000 0.989	-1.14%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	350.0 Hz	1.000 0.995	-0.52%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	400.0 Hz	1.000 1.000	0.02%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	450.0 Hz	1.000 0.988	-1.20%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	500.0 Hz	1.000 0.995	-0.47%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	550.0 Hz	1.000 0.995	-0.47%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	600.0 Hz	1.000 0.995	-0.48%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	650.0 Hz	1.000 0.993	-0.69%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	700.0 Hz	1.000 0.993	-0.71%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	750.0 Hz	1.000 0.991	-0.93%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	800.0 Hz	1.000 1.000	-0.04%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	850.0 Hz	1.000 1.001	0.06%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	900.0 Hz	1.000 0.993	-0.71%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	950.0 Hz	1.000 1.000	0.05%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	1.000kHz	1.000 0.993	-0.75%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	1.050kHz	1.000 1.014	1.37%	[8.00%]
OK: 50.00Hz	230.0 V HSIDEBAND	1.100kHz	1.000 0.990	-0.96%	[8.00%]

OK: 50.00Hz	230.0 V	HSIDEBAND	1.150kHz	1.000	1.017	1.73%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.200kHz	1.000	0.991	-0.85%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.250kHz	1.000	0.995	-0.48%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.300kHz	1.000	0.991	-0.94%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.350kHz	1.000	1.011	1.12%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.400kHz	1.000	0.994	-0.58%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.450kHz	1.000	0.992	-0.84%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.500kHz	1.000	0.988	-1.23%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.550kHz	1.000	0.990	-1.00%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.600kHz	1.000	0.995	-0.55%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.650kHz	1.000	0.994	-0.62%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.700kHz	1.000	0.989	-1.14%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.750kHz	1.000	0.989	-1.14%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.800kHz	1.000	0.982	-1.77%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.850kHz	1.000	0.985	-1.55%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.900kHz	1.000	0.986	-1.38%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	1.950kHz	1.000	0.987	-1.32%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.000kHz	1.000	0.984	-1.59%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.050kHz	1.000	0.981	-1.89%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.100kHz	1.000	0.985	-1.48%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.150kHz	1.000	0.984	-1.62%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.200kHz	1.000	0.984	-1.65%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.250kHz	1.000	0.987	-1.28%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.300kHz	1.000	0.984	-1.64%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.350kHz	1.000	0.988	-1.16%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.400kHz	1.000	0.978	-2.24%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.450kHz	1.000	0.981	-1.90%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.500kHz	1.000	0.980	-2.01%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.550kHz	1.000	0.977	-2.29%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.600kHz	1.000	0.980	-1.95%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.650kHz	1.000	0.977	-2.33%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.700kHz	1.000	0.983	-1.68%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.750kHz	1.000	0.982	-1.84%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.800kHz	1.000	0.980	-1.97%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.850kHz	1.000	0.991	-0.89%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.900kHz	1.000	0.971	-2.91%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	2.950kHz	1.000	0.995	-0.48%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.000kHz	1.000	0.977	-2.30%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.050kHz	1.000	0.973	-2.69%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.100kHz	1.000	0.972	-2.85%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.150kHz	1.000	0.971	-2.94%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.200kHz	1.000	0.971	-2.94%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.250kHz	1.000	0.969	-3.08%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.300kHz	1.000	0.979	-2.06%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.350kHz	1.000	0.971	-2.90%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.400kHz	1.000	0.970	-3.02%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.450kHz	1.000	0.972	-2.80%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.500kHz	1.000	0.969	-3.09%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.550kHz	1.000	0.968	-3.19%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.600kHz	1.000	0.965	-3.51%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.650kHz	1.000	0.968	-3.22%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.700kHz	1.000	0.962	-3.75%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.750kHz	1.000	0.976	-2.43%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.800kHz	1.000	0.964	-3.64%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.850kHz	1.000	0.964	-3.55%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.900kHz	1.000	0.965	-3.46%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	3.950kHz	1.000	0.974	-2.58%	[8.00%]
OK: 50.00Hz	230.0 V	HSIDEBAND	4.000kHz	1.000	0.965	-3.55%	[8.00%]

### 3.10.2. Bandwidth test at 120V 60Hz

OK: 60.00Hz	120.0 V	HSIDEBAND	180.0 Hz	1.000	1.016	1.63%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	240.0 Hz	1.000	1.004	0.44%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	300.0 Hz	1.000	1.043	4.26%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	360.0 Hz	1.000	1.002	0.22%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	420.0 Hz	1.000	1.026	2.59%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	480.0 Hz	1.000	1.005	0.49%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	540.0 Hz	1.000	1.037	3.71%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	600.0 Hz	1.000	1.009	0.91%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	660.0 Hz	1.000	1.047	4.70%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	720.0 Hz	1.000	1.007	0.73%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	780.0 Hz	1.000	1.027	2.72%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	840.0 Hz	1.000	1.012	1.20%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	900.0 Hz	1.000	0.998	-0.20%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	960.0 Hz	1.000	1.004	0.45%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.020kHz	1.000	1.000	-0.01%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.080kHz	1.000	1.002	0.22%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.140kHz	1.000	1.000	-0.01%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.200kHz	1.000	0.999	-0.07%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.260kHz	1.000	1.003	0.29%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.320kHz	1.000	1.014	1.39%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.380kHz	1.000	1.002	0.23%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.440kHz	1.000	1.001	0.10%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.500kHz	1.000	1.014	1.40%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.560kHz	1.000	1.007	0.68%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.620kHz	1.000	0.999	-0.11%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.680kHz	1.000	0.996	-0.45%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.740kHz	1.000	0.992	-0.79%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.800kHz	1.000	0.996	-0.44%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.860kHz	1.000	1.007	0.73%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.920kHz	1.000	0.997	-0.25%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	1.980kHz	1.000	0.992	-0.83%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.040kHz	1.000	0.993	-0.66%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.100kHz	1.000	1.015	1.53%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.160kHz	1.000	0.989	-1.07%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.220kHz	1.000	0.998	-0.21%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.280kHz	1.000	0.994	-0.57%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.340kHz	1.000	0.999	-0.15%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.400kHz	1.000	0.991	-0.92%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.460kHz	1.000	1.001	0.07%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.520kHz	1.000	0.986	-1.38%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.580kHz	1.000	0.984	-1.61%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.640kHz	1.000	0.995	-0.51%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.700kHz	1.000	1.008	0.76%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.760kHz	1.000	0.984	-1.61%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.820kHz	1.000	0.997	-0.34%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.880kHz	1.000	0.985	-1.47%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	2.940kHz	1.000	0.991	-0.91%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.000kHz	1.000	0.989	-1.10%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.060kHz	1.000	0.993	-0.72%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.120kHz	1.000	0.985	-1.47%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.180kHz	1.000	1.001	0.06%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.240kHz	1.000	0.985	-1.49%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.300kHz	1.000	0.980	-1.97%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.360kHz	1.000	0.984	-1.63%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.420kHz	1.000	0.980	-1.98%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.480kHz	1.000	0.977	-2.35%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.540kHz	1.000	0.978	-2.17%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.600kHz	1.000	0.974	-2.56%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.660kHz	1.000	0.979	-2.08%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.720kHz	1.000	0.971	-2.88%	[ 8.00%]

OK: 60.00Hz	120.0 V	HSIDEBAND	3.780kHz	1.000	0.974	-2.63%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.840kHz	1.000	0.968	-3.25%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.900kHz	1.000	0.976	-2.37%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	3.960kHz	1.000	0.970	-3.00%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.020kHz	1.000	0.975	-2.49%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.080kHz	1.000	0.967	-3.30%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.140kHz	1.000	0.975	-2.49%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.200kHz	1.000	0.969	-3.06%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.260kHz	1.000	0.964	-3.63%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.320kHz	1.000	0.969	-3.12%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.380kHz	1.000	0.970	-2.96%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.440kHz	1.000	0.972	-2.83%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.500kHz	1.000	0.965	-3.48%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.560kHz	1.000	0.960	-4.00%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.620kHz	1.000	0.973	-2.73%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.680kHz	1.000	0.960	-3.98%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.740kHz	1.000	0.976	-2.38%	[ 8.00%]
OK: 60.00Hz	120.0 V	HSIDEBAND	4.800kHz	1.000	0.955	-4.50%	[ 8.00%]

### 3.11. Phase jumps

For F1 flickermeters, IEC61000-4-15 section 6.7 requires that Pst shall be within +/-5% of the specified values when subjected to phase jumps. This was tested at Newtons4th using the Fluke 6105A.

frequency	applied	angle	Pst	dev	spec
OK: 50.00Hz	230.0 V PHASEJUMP	30.00°	0.913 0.901	-1.30%	[5.00%]
OK: 50.00Hz	230.0 V PHASEJUMP	-30.00°	0.913 0.917	0.42%	[5.00%]
OK: 50.00Hz	230.0 V PHASEJUMP	45.00°	1.060 1.039	-1.94%	[5.00%]
OK: 50.00Hz	230.0 V PHASEJUMP	-45.00°	1.060 1.069	0.88%	[5.00%]
OK: 60.00Hz	120.0 V PHASEJUMP	30.00°	0.587 0.590	0.05%	[5.00%]
OK: 60.00Hz	120.0 V PHASEJUMP	-30.00°	0.587 0.595	1.36%	[5.00%]
OK: 60.00Hz	120.0 V PHASEJUMP	45.00°	0.681 0.676	-0.73%	[5.00%]
OK: 60.00Hz	120.0 V PHASEJUMP	-45.00°	0.681 0.688	1.03%	[5.00%]

### 3.12. Rectangular changes with 20% duty cycle

For F1 flickermeters, IEC61000-4-15 section 6.8 requires that the instrument shall measure Pst of 1.00 within +/-5% when subjected to the specified modulation with a 20% duty cycle. This was tested at Newtons4th using the Fluke 6105A.

frequency	applied	Pst	dev	spec
OK: 50.00Hz	230.0 V DUTYCYCLE	1.000 0.994	-0.64%	[5.00%]
OK: 60.00Hz	120.0 V DUTYCYCLE	1.000 0.994	-0.62%	[5.00%]

### 3.13. 'd' parameters

Voltage fluctuations can also be assessed by direct measurement of the changes in each half cycle, d(t). The 'd' parameters, dc, dmax and dt, represent respectively the difference between steady state conditions (dc), maximum deviation (dmax), and the time for which the disturbance is greater than 3.3% from the steady state (dt).

IEC61000-4-15 section 6.9 specifies two waveforms which vary the voltage magnitude in a sequence with precise timing. The dc and dmax values were tested at Newtons4th Ltd using the Fluke 6105A, the dt value was tested at Newtons4th using an arbitrary waveform generator driving an LPA400 high voltage amplifier.

frequency	start	dc	dmax	dc	dmax	dev	spec
OK: 50.00Hz	230.0 V	2.00%	4.00%	2.00%	4.09%	2.25%	[5.00%]
OK: 50.00Hz	230.0 V	1.00%	5.00%	0.98%	5.07%	1.40%	[5.00%]
OK: 60.00Hz	120.0 V	2.00%	4.00%	2.00%	4.03%	0.75%	[5.00%]
OK: 60.00Hz	120.0 V	1.00%	5.00%	1.00%	5.02%	0.40%	[5.00%]