Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

N4L | **Newtons4th Ltd**

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 ≤ 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 ≤ 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 ≤ 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 ≤ 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 ≤16A per phase (BSEN61000-3-2:2014) and to equipment with a rated current of >16A and ≤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 ≤16A per phase (BSEN61000-3-3:2013) and to equipment with a rated current of >16A and ≤75A per phase (BSEN61000-3-11:2001).

The same relationship exists between the relevant IEC standards.
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.

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

3. Verification

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

Furthermore 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.

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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 i.e. 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 interhamonics 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 2nd harmonic group) to 2025Hz (end of 40th 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.

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

3.6. Normalised flickermeter Pinst response

A flickermeter measures voltage fluctuation 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

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

```
      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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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 squ 2.7150% 1.000 0.989 -1.09% [5.00%]
OK: 50.00Hz  230.0 V 2.0000 cpm squ 2.1910% 1.000 0.989 -1.06% [5.00%]
OK: 50.00Hz  230.0 V 7.0000 cpm squ 1.4500% 1.000 0.997 -0.34% [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 110.00 cpm squ 0.7220% 1.000 0.997 -0.31% [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 4000.0 cpm squ 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 squ 3.1810% 1.000 0.993 -0.68% [5.00%]
OK: 60.00Hz  120.0 V 2.0000 cpm squ 2.5640% 1.000 0.992 -0.75% [5.00%]
OK: 60.00Hz  120.0 V 7.0000 cpm squ 1.6940% 1.000 0.998 -0.23% [5.00%]
OK: 60.00Hz  120.0 V 39.000 cpm squ 1.0400% 1.000 0.994 -0.59% [5.00%]
OK: 60.00Hz  120.0 V 110.00 cpm squ 0.8440% 1.000 0.999 -0.05% [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 4800.0 cpm squ 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 squ 0.6787% 0.250 0.257  2.70% [5.00%]
OK: 50.00Hz  230.0 V 1.0000 cpm squ 1.3575% 0.500 0.498 -0.40% [5.00%]
OK: 50.00Hz  230.0 V 1.0000 cpm squ 2.0362% 0.750 0.743 -0.87% [5.00%]
OK: 50.00Hz  230.0 V 1.0000 cpm squ 2.7150% 1.000 0.989 -1.11% [5.00%]
OK: 50.00Hz  230.0 V 1.0000 cpm squ 3.3937% 1.250 1.235 -1.18% [5.00%]
OK: 50.00Hz  230.0 V 1.0000 cpm squ 4.0725% 1.500 1.481 -1.25% [5.00%]
OK: 50.00Hz  230.0 V 1.0000 cpm squ 4.7512% 1.750 1.725 -1.41% [5.00%]
OK: 50.00Hz  230.0 V 1.0000 cpm squ 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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

```
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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

```
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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

3.9. Combined frequency and voltage changes

For F1 flickermeters, IEC61000-4-15 section 6.4 requires that Pinst,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 Pinst,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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

```
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%]
```

Newtons4th Ltd
office@newtons4th.com
www.newtons4th.com

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%]
```