Test Waveforms Used in NPL Flickermeter Calibrations

This document defines the test waveforms used by NPL to perform calibrations of Flickermeters.

IEC61000-4-15 Flicker With Rectangular Modulation

These traditional flicker test waveforms involve the rectangular modulation of the line voltage at modulation rates and depths of modulation as shown in Table 1. These values are defined in IEC 61000-4-15: 1997 Amendment 1: 2003. The rectangular modulation caused the amplitude of the sinewave to have two distinct root mean square (RMS) levels, the higher of the two is defined as V_{RMS1} and the lower is defined as V_{RMS2}. When these waveforms are applied to a flickermeter, the instrument should return a P_{st} value of 1.0 ± 0.05.

Modulation Frequency	Voltage Changes per Minute	Nominal Applied DV/V
(mHz)		(%)
8.333	1	2.724
16.667	2	2.211
58.333	7	1.459
325	39	0.906
916.667	110	0.725
13 500	1620	0.402
33 333	4000	2.4

Table 1, Rectangular Modulation Flicker Test Waveform Definition for P_{st}=1

where $\left(\frac{DV}{V}\right)\%$ is defined as follows:

$$\left(\frac{DV}{V}\right)\% = 200\frac{(V_{RMS1} - V_{RMS2})}{(V_{RMS1} + V_{RMS2})}$$

For Other values of P_{st} the DV/V values in Table 1 are scaled proportionally, e.g. for P_{st}=5, the DV/V values used to define the waveform are those shown in Table 1 but multiplied by 5.

IEC Joint Working Group on Power Quality Draft Pattern 1 Waveform

The International Electrotechnical Committee (IEC) have drafted the following modulation pattern to test flickermeters. The IEC "Pattern 1" waveform is described in Table 2.

Minute	Duration (sec)[1]	Type	% V	Duty Cycle[2]	Rate (Hz)
1	10 on 5 off	Rectangle	d_{max1}	10%	1
1	10 on 5 off	Rectangle	d_{max2}	30%	1
1	10 on 5 off	Rectangle	d_{max1}	10%	1
1	10 on 5 off	Rectangle	d_{max2}	30%	1
2	Repeat as above[3]	Rectangle	Repeat as above[3]	Repeat as above[3]	2
3	..	Rectangle	..	..	4
4	..	Rectangle	..	..	8
5	..	Rectangle	..	..	10
6	..	Rectangle	..	..	15

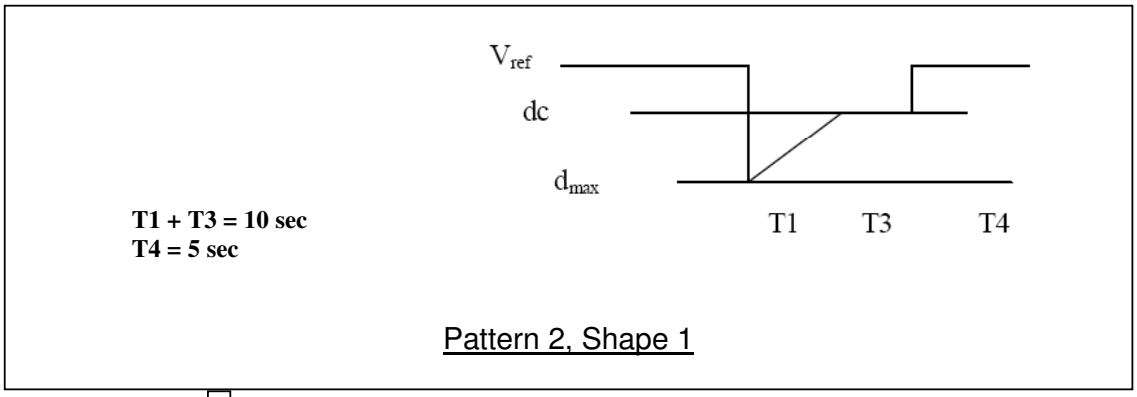
[1] A rest period of 5 seconds is required between each step.
[2] A duty cycle of 10% means that for one period of signal at the given rate, the voltage is only reduced to the specified d_{max} for 10% of the total period.
[3] Repeat as above means to repeat the series of 4 pulse trains of varying depth and duty cycle as described for minute 1 but at the specified frequency for a particular test minute in the table.

Table 2 – IEC Pattern 1

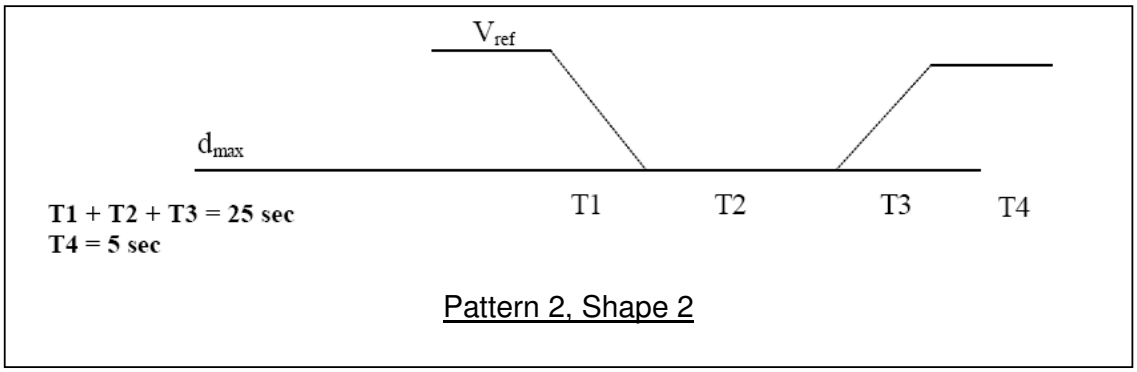
The waveform parameters are set to give a known P_{st} value.

IEC Joint Working Group on Power Quality Draft Pattern 2 Waveform

The IEC have drafted the following modulation pattern to test flickermeters. To specify the IEC "Pattern 2" waveform the following two waveform shapes are defined.



Pattern 2, Shape 1



Pattern 2, Shape 2

Using the above specified shapes the "Pattern 2" waveform is defined as follows in Table 3.

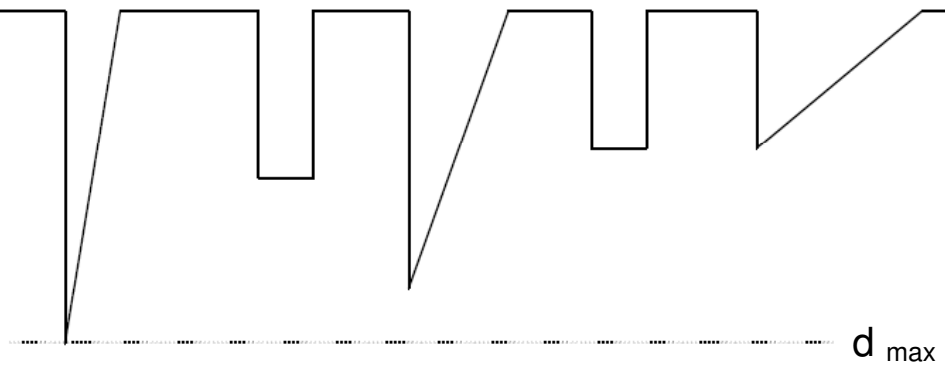
Minute	Shape	T1 (sec)	T2 (sec)	T3 (sec)	T4 (sec)	Count
1	1	0.2	-	9.8	5	4
2	1	0.2	-	9.8	5	4
3	1	2.0	-	8.0	5	4
4	1	2.0	-	8.0	5	4
5	2	1.0	22.0	2.0	5	2
6	2	1.0	22.0	2.0	5	2
7	2	5.0	10.0	10.0	5	2
8	2	5.0	10.0	10.0	5	2

Table 3, IEC Pattern 2

The waveform parameters are set to give a known P_{st} value.

IEC Joint Working Group on Power Quality Draft Pattern 3 Waveform

The IEC have drafted the following modulation pattern to test flickermeters. To specify the IEC “Pattern 3” waveform the following waveform shapes is defined.



Pattern 3, Shape 3

The timing and depths of the components of Pattern 3 are defined in Table 4.

Shape	Depth (per unit of d_{max})	Duration (per unit of T)
Rest	0.0	1.0
Ramp	1.0	1.0
Rest	0.0	1.0
Rectangle	0.5	0.5
Rest	0.0	1.0
Ramp	0.8	2.0
Rest	0.0	1.5
Rectangle	0.4	1.0
Rest	0.0	2.0
Ramp	0.4	3.0
Rest	0.0	1.0

Table 4, Shape 3 Definition

Using the above specified shape the “Pattern 3” waveform is defined as follows in Table 5.

Minute	Duration (sec)	Shape	% dmax	Period T (sec)
1	30	3	d_1	t_1
2	30	3	d_2	t_1
3	30	3	d_1	t_2
4	30	3	d_2	t_2
5	30	3	d_1	t_3
6	30	3	d_2	t_3
7	30	3	d_1	t_4
8	30	3	d_2	t_4

Table 5, IEC Pattern 3

Times $t_1 \ldots t_4$ and depths of modulation d_1 and d_2 will be varied to obtain known P_{st} readings.