Know Your Standards

The story continues...
Are we ready for a second helping of premium immunity standard? Last time, we looked at IEC 61000-4-1 to -10, so now we have to enter the second decade.

IEC 61000-4-11
This is a standard about tests for immunity to power-frequency phenomena, specifically voltage dips, short interruptions and voltage variations. These low-frequency standards are produced by IEC SC77A, while the high-frequency standards (above 9 kHz, with some exceptions) are produced by SC77B. Not all product standards call up IEC 61000-3-11, because the products concerned, such as heaters, are not seriously affected by these disturbances.

IEC 61000-4-12
The ring wave immunity test is not well known; indeed, what is a 'ring wave'? The standard says it's a damped oscillatory transient, so it should really be called a 'ringing wave', because a tuned circuit is said to 'ring' like a bell, as it produces such a decaying transient when prodded with a suitable pulse. Indeed, the basic test signal generator uses this technique. The tuned circuit resonates at 100 kHz, and is prodded by the voltage on a charged capacitor. This voltage may be as low as 250 V or as high as 4 kV, depending on the conditions set in the product standard. The test generator Is a powerful beast ; it can deliver up to 333 A.

IEC 61000-4-13
This is about immunity to harmonics and interharmonics, including mains signalling, at a.c. power ports for products rated at 16 A per phase or less. The 'mains signalling' concerned is 'ripple control' which is not used in Britain, but is used in many countries. An on-off modulated signal at a frequency in the range 105 Hz to 1995 Hz (125 Hz to 2395 Hz in 60 Hz systems), unrelated to the mains frequency, is used to control remote equipment in the distribution system. Most, but not all, of the recommended voltage test levels are well below 10 % of the supply voltage.

IEC 61000-4-14
IEC 61000-4-11 is about immunity to, amongst other things, voltage dips and variations. IEC 61000-3-14 is about immunity to voltage fluctuations. So, what's the difference? We have to look at the definitions in the standards.

In Section 11 (i.e. IEC 61000-4-11), we have:

> ***voltage dip***
> *a sudden reduction of the voltage at a particular point of an electricity supply system below a specified dip threshold followed by its recovery after a brief interval*

Curiously, 'voltage variation' is not formally defined and we have to look at the test conditions to find out what it is:

> ***Voltage variations (optional)***
> *This test considers a defined transition between rated voltage U_T and the changed voltage.*
>
> *NOTE The voltage change takes place over a short period, and may occur due to change of load.*
>
> *The preferred duration of the voltage changes and the time for which the reduced voltages are to be maintained are given in Table 3. The rate of change should be constant; however, the voltage may be stepped. The steps should be positioned at zero crossings, and should be no larger than 10 % of U_T. Steps under 1 % of U_T are considered as constant rates of change of voltage.*

The description 'optional' is curious; it should really be for product standards to specify which tests should be done.

Table 3 – Timing of short-term supply voltage variations

Voltage test level	Time for decreasing voltage (td)	Time at reduced voltage(ts)	Time for increasing voltage (ti) (50 Hz/60 Hz)
70 %	Abrupt	1 cycle	25/30[b] cycles
X[a]	X[a]	X[a]	X[a]

[a] To be defined by product committee.
[b] "25/30 cycles" means "25 cycles for 50 Hz test" and "30 cycles for 60 Hz test".

In Section 14, we have:

> ***voltage fluctuations***
> *series of voltage changes or a cyclic variation of the voltage envelope [IEV 161-08-05]*

So, we see that variations are assumed non-repetitive, whereas fluctuations are repetitive. Well, maybe.

IEC 61000-4-15
Like IEC 61000-4-7, this is not a Basic standard but the specification of a measuring instrument – in this case, the Flickermeter. The instrument is designed to output numerical values consistent with the subjective effects of rapid voltage variations on the light output of a 60 W coiled-coil incandescent lamp, which is, of course, now nominally an extinct species. However, it was agreed not to revise the standard to change the reference device to a compact fluorescent lamp, because these products will quite soon be superseded by affordable LED lamps. At the same time, lamp manufacturers are being encouraged to make lamps which are no more sensitive to flicker than the 60 W lamp.

Flicker can be very disturbing to people of an anxious disposition – they fear that the power will go off or even that a fire or explosion might occur. Unfortunately, on rare occasions, they might be right.

IEC 61000-4-16

This is one of the few Basic standards about low-frequency phenomena; in this case it's immunity to conducted, **common-mode** disturbances in the frequency range 0 Hz to 150 kHz. So it's also one of the few standards that crosses the 'great divide' at 9 kHz, between 'low' and 'high' frequencies. The Scope clause admits that it is of limited applicability - to equipment including cables more than 20 m long, mostly in industrial plants. The disturbances are launched on the power system cables, in common-mode, i.e. line and neutral voltage fluctuate together with the same polarity. However, they may couple to other cables, especially in the case of the higher-frequency disturbances produced by power electronic equipment using switching techniques.

The tests are divided into three categories:

- mains frequencies (16.67 Hz, 50 Hz and 60 Hz) short-term;
- mains frequencies long term;
- other frequencies (15 Hz to 150 kHz).

No tests are specified below 15 Hz, except at d.c. (0 Hz). A d.c test signal generator is specified, with an output voltage adjustable between 1 V and 30 V and an output source impedance of 50 ohms.

A very significant consideration is that the means for injecting the disturbance to balanced communication ports may seriously degrade the common-mode rejection by applying unequal source impedances to the two inputs. This is acknowledged, but the relevant Note has an unfortunate omission of the word 'not':

> *NOTE It may [NOT] be possible to produce T networks suitable for use with common mode rejection ratios greater than 80 dB, in which case the product standard should define an alternative coupling method.*

IEC 61000-4-17

This Section defines test methods for immunity to ripple at the d.c. input power port of electrical or electronic equipment, and applies to low-voltage d.c. power ports of equipment supplied by external rectifier systems, or batteries which are being charged. The disturbance level is specified as the ratio of the peak-to-peak ripple voltage to the d.c. voltage, and test levels are from 2 % to 15 %. The waveform is the 'sine cap and linear decay' typically produced by a rectifier.

IEC 61000-4-18

This deals with another rare phenomenon – the damped oscillatory wave, to be carefully distinguished, of course, from the 'ring wave', which is a damped oscillatory wave! So, what's the difference? IEC 61000-4-12 specifies only a damped 100 kHz signal, where as IEC 6100-4-18 specifies signals at 100 kHz and 1 MHz, described as 'slow' signals, and 3 MHz, 10 MHz and 30 MHz, described as 'fast' signals. The whole standard is oriented to these disturbances being produced by switching and other operations in power stations, or caused by a high-level electromagnetic pulse (HEMP) (which we hope is of natural origin!). However, text in the Scope (which it appears should have been deleted in favour of other, similar text), refers to 'electrical and electronic equipment intended for residential, commercial and industrial applications'. The skeleton test signal generator circuit is more complex than that specified in IEC 61000-4-12.

IEC 61000-4-19

This has not yet been published, being still at the CD stage ((but is available as BSI Draft for Public Comment 12/ 30258875). It is about immunity to conducted, **differential** mode disturbances in the frequency range 2 kHz to 150 kHz. (IEC 61000-4-16 is about immunity to conducted, **common-mode** disturbances.) Test signals are either 60 second 'tone bursts' of sine-wave signals, the frequency incrementing by 2% for each burst, or tone bursts, in the same frequency range, of increasing duration from 1.6 ms to 330 ms (for 50 Hz mains). The switching instants are not synchronized to the mains frequency.

IEC 61000-4-20

This Section is about emission and immunity testing in transverse electromagnetic (TEM) waveguides. Unlike most standards, it includes a lot of mathematics. It may be better to follow the instructions of the TEM test device rather than the more generalized treatment in the standard.

There are at present thirteen more Sections of IEC 61000-4 to look at, before we go on to other delights later this year.

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