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A Practical Guide for EN 61000-4-11: Testing and measurement techniques

Helping you solve your EMC problems

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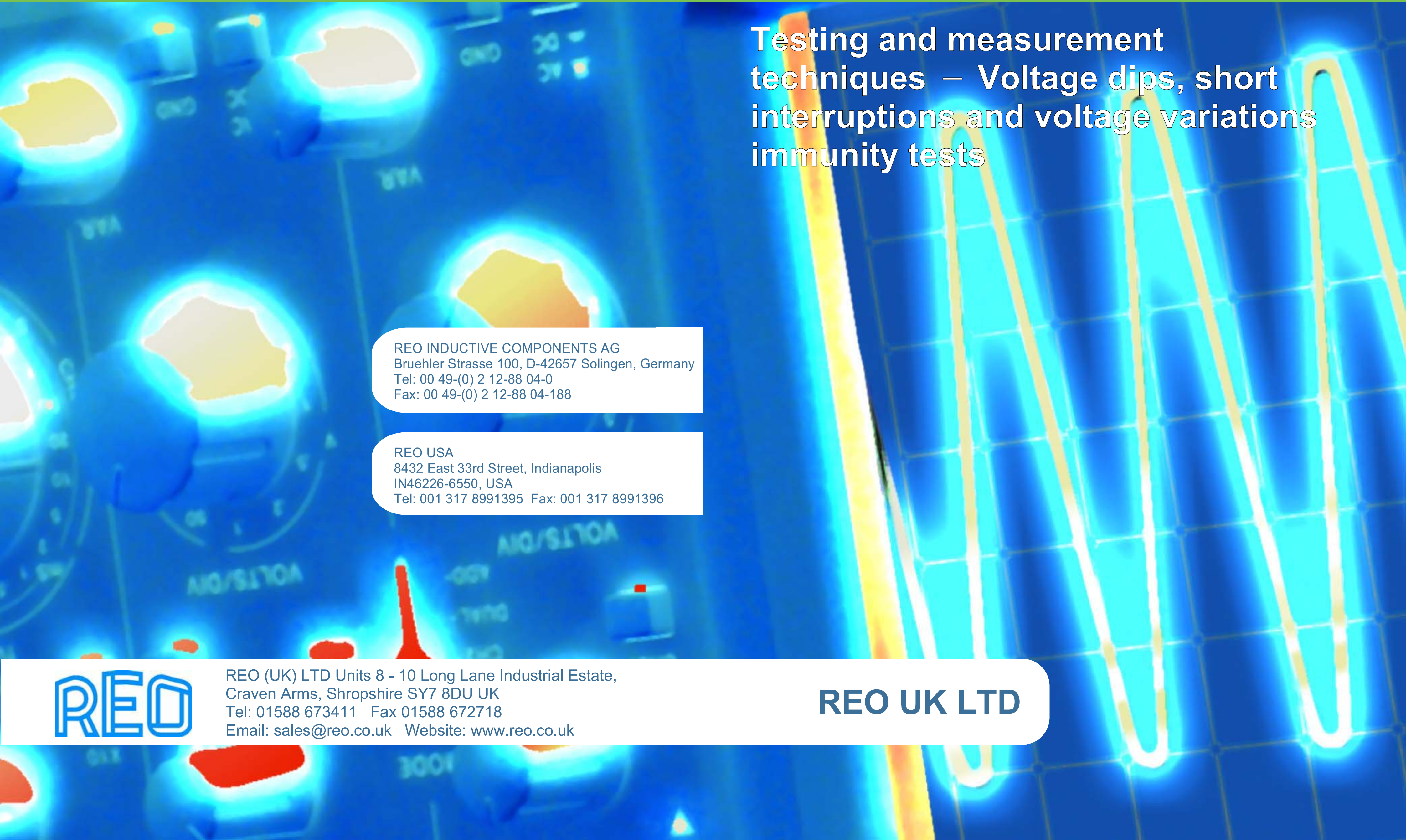
A Practical Guide for EN 61000-4-11



Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests

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Power-quality and EMC compliance

The basic immunity test method for voltage dips, dropouts, interruptions, sags, brownouts and swells in the mains supply is IEC 61000-4-11 [1]. This has been adopted as the harmonised European standard EN 61000-4-11, which is often called up as a basic test method by immunity standards listed under the Electromagnetic Compatibility (EMC) Directive [2].

This handbook describes how to apply EN/IEC 61000-4-11. Unlike many EMC tests, it is easy and low-cost to 'do-it-yourself'.

Since disturbances in the mains supply voltage are commonplace, and since they can interfere with every kind of electrical and electronic device, equipment or system (called products in the rest of this handbook) that operates from the electrical mains supply, it makes good sense to test products to ensure they will work as intended in their intended operating environment. This is especially important in safety-related electronic applications.

According to some experts, poor AC mains supply quality on electrical and electronic products is one of the most significant causes of downtime and financial loss world-wide. Dips, sags, brownouts, swells, voltage variations, dropouts and interruptions are the chief causes of poor mains supply quality. In some areas waveform distortion is also becoming an important power quality issue, but that is not covered here. Long-term voltage variations are not generally considered to be an EMC issue, and although they are important for product operation and reliability they are not covered here either.

EN 61000-4-11 is a basic test standard, so - when following the self-declaration to standards route to conformity - EN 61000-4-11 should not be listed on the EMC Declaration of Conformity. Only the relevant generic or product-family harmonised EMC standards should be listed. These will usually call-up EN/IEC 61000-4-11 as a test *method*, but it is always the generic or product-family standard that sets the minimum test *levels* which allow conformity to be claimed.

The tests and test levels required by the generic or product-family immunity standards are often a lot less comprehensive than those recommended by EN/IEC 61000-4-11 itself. Looking beyond simply complying with the minimum requirements of the EMC Directive, applying *all* of the tests and levels suggested by EN/IEC 61000-4-11 is a way of helping to make products more reliable and improve customer satisfaction.

When using the Technical Construction File route to conformity with the EMC Directive it is possible to use EN/IEC 61000-4-11 directly, in which case it *should* be listed on the EMC Declaration of Conformity. In such cases the product manufacturer should assess the electromagnetic environment of his product and see to it that it is designed and/or tested accordingly so as to comply with the EMC Directive's essential 'Protection Requirements'. This is good practice anyway, whether the TCF route is being followed or not.

Where a product has a safety-related function, mere compliance with the EMC Directive is insufficient for ensuring that its EMC-related functional safety is designed correctly. Additional and/or tougher immunity tests may be required. Refer to the IEE's guide [3] for more on this topic.

What are dips, dropouts and interruptions?

Dips are short-term reductions in supply voltage caused by load switching and fault clearance in the mains supply network (in either the low, medium, or high voltage distribution systems). They can also be caused by switching between the mains and alternative supplies in uninterruptible power supplies or emergency power back-up systems. Dips are specified by their reduction below nominal 230V mains, and their duration in milliseconds or number of cycles. So a dip of 40% is equivalent to a reduction in supply voltage to 60% of its nominal value.

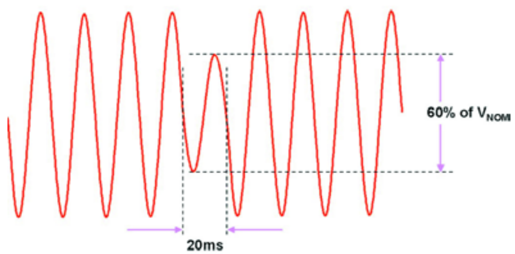
Dip testing to EN 61000-4-11 applies dips abruptly, starting and finishing at a zero crossing, and a long recovery time is allowed between each dip. But real-life dips can have gentler rates of change, and start and stop at any point in the mains cycle, and can sometimes occur in a fast sequence.

A dropout is a dip that is between 95 and 100% deep that lasts for up to 1 minute, and the term short interruption is commonly understood to mean the same thing. Interruptions in the mains supply of more than one minute are simply called interruptions or power failures; are not covered by EN 61000-4-11, and are not discussed here.

Like dips, dropouts (short interruptions) are caused by load switching and fault clearance in the mains power networks (in the LV, MV, or HV distributions). Also like dips, they can be caused by switching between mains and an alternative supply in uninterruptible power supplies or emergency power back-up systems.

Example of a 'dip'

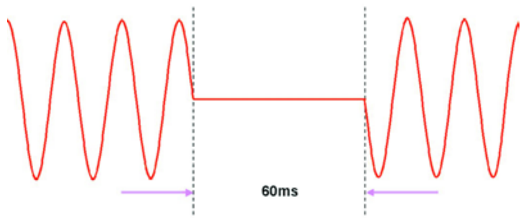
A 40% dip with a 20ms duration



The dip started and finished at zero-crossings (as in most tests using IEC 61000-4-11) but real life dips can happen at any phase angles

Example of a 'dropout' (or 'short interruption')

A 60ms interruption in the mains supply



This interruption started and finished at zero-crossings (as in most tests using IEC 61000-4-11) but real life drop outs interruptions can happen at any phase angles

What dips, dropouts and short interruptions can we expect?

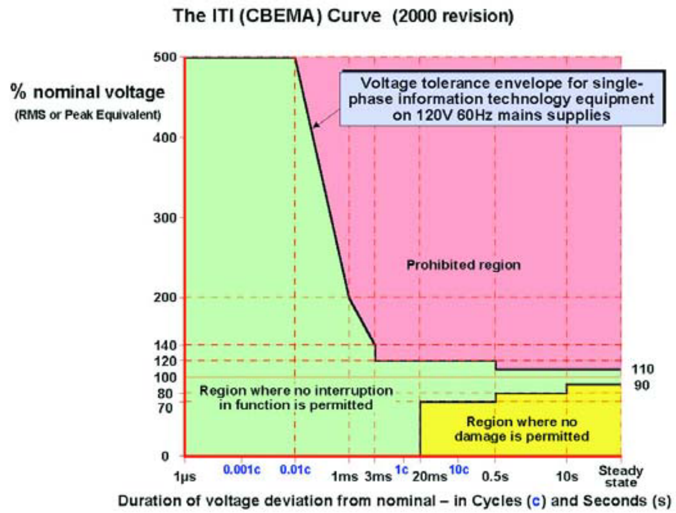
IEC 61000-2-8 [4] is an attempt to determine the dips and short interruptions that can be expected in real life, and a lot of data was gathered and analysed to create its 41 pages. It describes the types of dips and short interruptions that can occur, how they are caused, the effects they can have on a variety of electrical and electronic devices, and it also describes remedial measures that can be applied.

After reviewing many pages of data from at least four countries, it says that: "*The most important conclusion to be drawn from the results is that voltage dips and short interruptions are a reality in the electromagnetic environment. They can be expected at any place, at any time and at levels involving voltages down virtually to zero and durations up to and above one second. The frequency of their occurrence and the probability of occurrence at any level are highly variable both from place to place and from one year to another.*"

The "ITI (CBEMA) Curve" and its Application Note [5] describe an AC input voltage envelope for 120V 60Hz power systems, which typically can be tolerated (no interruption in function) by most Information Technology Equipment (ITE). The ITI Curve and its Application Note are not intended to serve as a design specification for products or AC distribution systems. However, IEC 61000-2-8 describes the ITI Curve as representing the minimum immunity objectives concerning dips, and this is how it is often employed.

But don't lose sight of the fact that [1], [4] and [5] are only relevant for equipment operated from the public AC mains supply - if your product is likely to be operated on a private mains supply you should find out what it is likely to be exposed to, then design and test accordingly. Standards exist for the power supplies used in land, sea and air vehicles, although they are not listed under the EMC directive.

EN/IEC 61000-4-30 [6] describes some power quality measurement techniques.



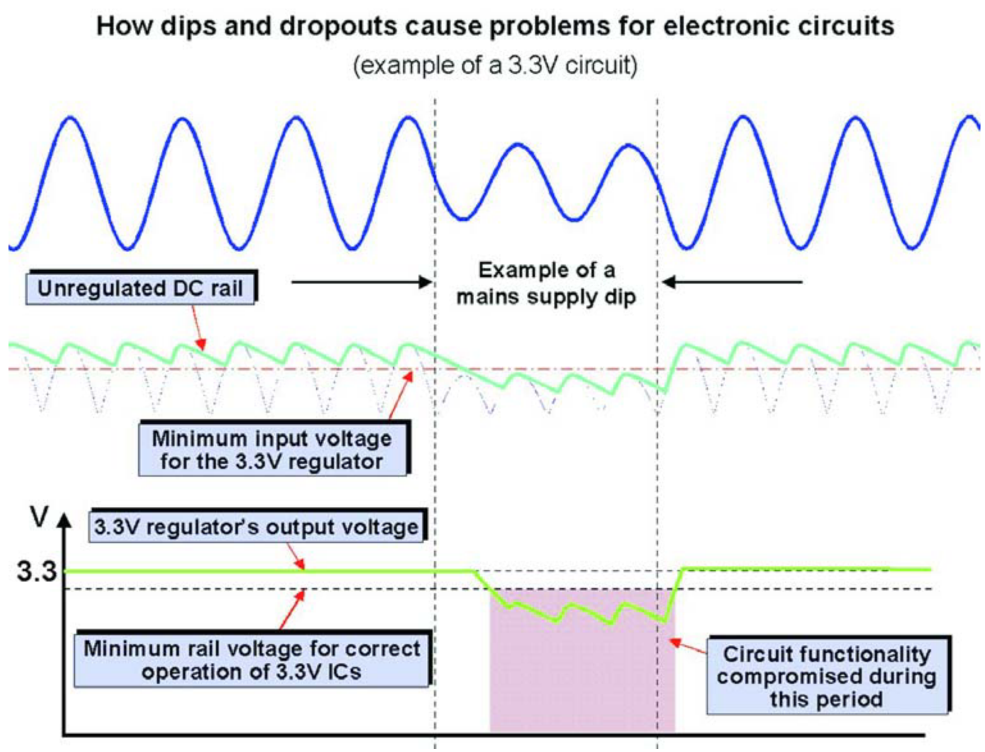
How do dips and dropouts cause problems ?

Electromechanical devices such as relays, contactors and solenoids can 'drop-out', and their drop-out voltage varies with temperature, vibration, shock and the age of the device. Where they are 'held-in' at reduced voltage to minimise power dissipation, they might not pull back in again after the dip or dropout. Few 'relay logic' designers seem to consider the effect that random dropouts of individual relays might cause for the functioning of their circuits, with possible safety consequences for 'hard-wired' safety systems. Discharge lamps often won't re-illuminate for minutes after a short mains interruption.

Some electronic circuits rely on counting mains cycles, and these can be fooled by dips and dropouts, but the biggest problem is the hold-up time of products' mains power supplies. The figure shows an example of a 3.3 volt supplied digital circuit. The mains supply dip causes the unregulated rail to discharge to a level lower than the minimum input voltage for the 3.3 volt regulator, so the regulated 3.3 volt DC rail can fall to below the level required for the ICs to function as specified. In this situation the ICs can do almost anything, and memory corruption is a real possibility along with 'illegal' functioning that could cause problems for whatever the circuit is controlling.

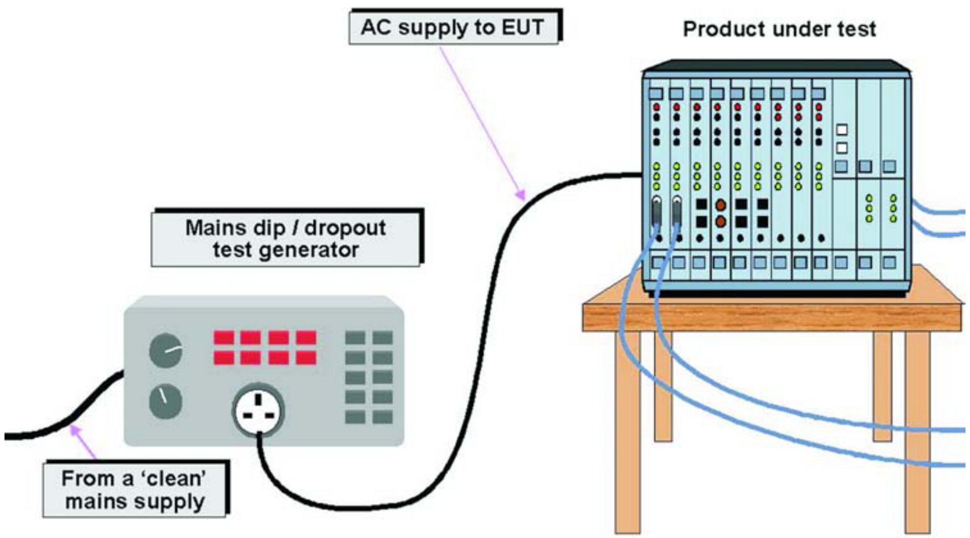
It is for the above reason that digital circuits employ power supply monitors and software 'watchdogs'. But there is usually so little margin between the minimum possible value of the regulated rail and the minimum specified IC operating voltage that very high-precision (hence costly) monitors can be required. Old-fashioned digital circuits would often be fitted with nothing more than a simple watchdog, on the assumption that if the regulated power was going to fall below specification, it would go all the way down to zero. Such designs will produce unreliable products which will not pass tests to EN/IEC 61000-4-11.

A momentary drop in the regulated rail for an analogue circuit can cause functional errors, but they are usually self-recovered after the dip or dropout is over. However, power amplifiers can suffer transient glitches or short 'squeals' of instability, either of which can sometimes damage the loads they drive (or in the case of loudspeakers or headphones cause objectionable sounds).



Full compliance testing of voltage dips, dropouts and short interruptions

Dips and dropouts test set-up (from EN 61000-4-11)



EN 61000-4-11 specifies the characteristics of the dips and dropouts test generator in its section 6.1.1, and has specific requirements for inrush current capability of the product under test (often called "EUT"). The inrush current capability should not be limited by the generator - damage due to inrush is often the most severe consequence of a voltage interruption, so it is important that it is adequately tested. A maximum capability of 500A for 230V mains supplies is required, but can be less if the actual inrush current of the product has been verified to be less than 500A and provided that the product's actual inrush is less than 70% of the generator's capability. Annex A of the standard gives procedures for measuring both the peak inrush current and the generator's capability, and for full compliance you need to pay attention to these requirements.

A number of commercial products are available for testing dips and dropouts.

There are no special requirements for the test environment, except that the electromagnetic environment should allow the correct operation of the product and the mains voltage must be monitored and be within 2% of the desired value. The temperature, humidity and air pressure requirements are also very loose (15-35°C, 25-75%, 860-1060mbar respectively), allowing full compliance tests to be carried out in most places.

Each dip or dropout test (defined by its dip level and duration, as specified in the relevant generic or product-family harmonised standard) shall be repeated three times with 10 seconds between each, for each representative mode of EUT operation. If 0.5 cycle dips or interruption tests are specified: two sets should be done - with 0° and 180° starts.

It is normal for the tests to start and finish at mains supply voltage zero-crossings, in which case the zero-crossing accuracy of the test should be ±10%. Product-family standards could specify starting and/or stopping at other phase angles, although none that have such requirements are known at the time of writing.

The product under test must be operating in its normal modes, with all of its normal loads, and its functions must be monitored with sufficient accuracy and resolution to identify any performance degradations during and after each test. After each group of tests a full functional check must be performed. The relevant generic or product-family harmonised standard will specify the performance degradation criteria to be applied in each case. In many cases a momentary dimming of displayed images or illumination is permitted during the test.

Example of a REO test unit for EN/IEC 61000-4-11

Examples of REO Loads - REO can create custom loads to meet any requirements

Where the product's rated supply voltage range does not exceed 20% of its lowest voltage, any voltage within that range can be used for the test. But where it has a wider voltage range, two sets of tests are required with different values for the nominal mains voltage: one at the lowest rated voltage and one at the highest.

The typical mains supply these days is likely to have a waveform that is not a pure sine-wave, it is often 'flat-topped'. This can reduce the product's inrush current and power supply charging voltage, and so can affect the dips and short interruptions test results. But EN 61000-4-11 does not specify the waveform distortion for the mains supply, so where the EUTs test supply is derived from the public mains supply it is probably best to ensure that the supply meets the requirements of EN 61000-3-3:1995…

- The test voltage is within ±2% of the nominal voltage.
- The test frequency is 50Hz ±0.5Hz.
- The percentage total harmonic distortion (THD) of the supply voltage is less than 3%.

Safety Note: When checking the AC supply waveform, use all necessary safety measures and equipment and leads compliant with the safety standard EN 61010-1 for 230Vrms measurements.

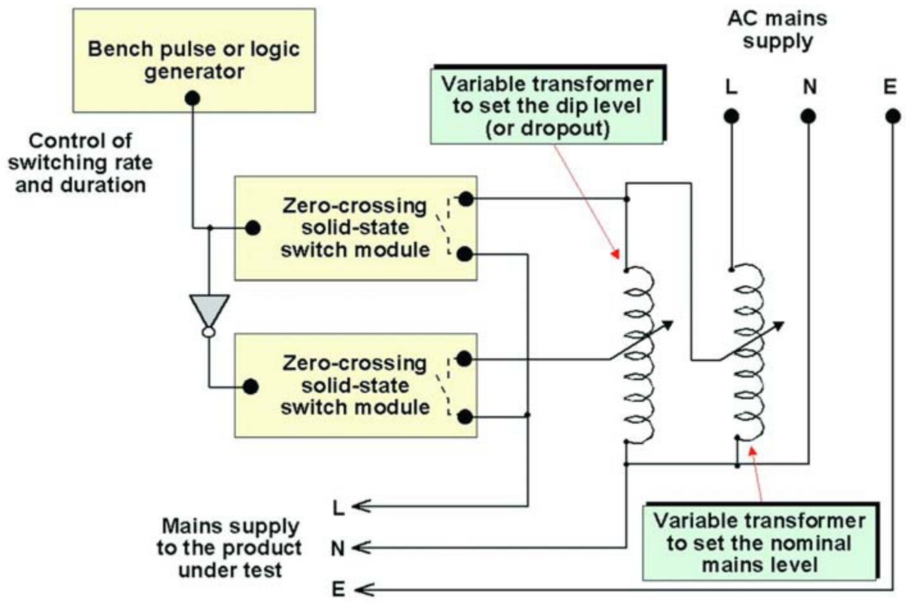
Where the mains supply has a poor waveshape it may be possible to regenerate it with a motor-generator set. Other alternatives include petrol or diesel powered AC generators and continuous double-conversion uninterruptible power supplies. These alternatives can suffer from poor waveshapes and transient noise, inability to supply the product's inrush current, and internal combustion powered types can have very poor frequency regulation, so careful selection and dimensioning is required.

There are also certain types of AC mains 'waveform correctors' or active power factor correction equipment that can be used to improve a mains supply's waveform. Any such regeneration or waveform correction equipment may need to be rated for much greater VA or wattage than the product, so that they can supply the specified peak EUT inrush current.

Examples of variable transformers from REO

Constructing a dips and dropouts test generator

Block diagram of a dips and dropouts tester



Because high frequencies are not involved in this test it is fairly easy to construct your own supply dips and dropouts tester using a pair of solid-state switches, two variable transformers and a timing generator, as shown in the block diagram.

Safety Note: All the safety issues associated with mains power must be dealt with correctly! Always apply all the relevant parts of the latest issues of the relevant safety standards, such as IEC (or EN) 61010-1, *in full.*

It is easiest to control the switches if they are modular zero-crossing types - they may then be able to be controlled from a standard free-running laboratory pulse generator (driving the switches in antiphase). The block diagram given here is not a schematic, so more detailed design is required before commencing construction. Because it uses zero-crossing devices this generator is only capable of switching whole numbers of half-cycles, which is enough for most (if not all) of the generic and product-family standards at the moment.

Replacing the 'solid-state relays' with IGBTs or power MOSFETs (with appropriate voltage and current ratings, and surge protection if necessary) allows the start and stop of the dips and dropouts to be at any phase in the mains waveform. In this case the control circuitry needs to be more sophisticated than a simple free-running pulse generator, so that repeatable switching phase angles can be achieved.

If both power switches could be turned on at the same time (maybe one is slow turning off whilst the other is just turning on) and if the variable transformer is set to a low voltage, there could be a sudden surge of current from the mains supply. So if this is a possibility that hasn't been prevented by the design; a fuse is required, rated to protect the power switching devices.

To handle the inrush current in a home-made tester where full compliance testing is not required, it should be enough to make sure that the power switches have single-cycle surge current ratings *at least* 50 times the product's maximum mains current consumption, and the variable transformers continuous power rating is *at least* five times its maximum VA rating.

With the 'dip level' variable transformer set to a given percentage of the supply, the block diagram is a dips tester. With the variable transformer set to zero (or switched out of circuit by not operating the second power switch at all) it is a short interruptions tester.

There are a number of reasons why dips and dropout testing may be required to use a different frequency to the manufacturer's mains supply, e.g. ….

- The country where the testing is being carried out has a different mains frequency to that of the target market.
- Uninterruptible power supplies and stand-by generators can have a much wider tolerance band for their output frequencies than is usual for the mains supply. Products operated from such mains supplies (e.g. all of the medical equipment in a hospital) could benefit from being tested at its maximum and minimum mains frequencies.

It is possible to use test generators which synthesise the product's mains supply. These can use an internal sine-wave source and a large power amplifier; or pulse-width-modulation of a DC voltage followed by filtering to leave only the fundamental. A motor-generator set can also be a source of mains power at a different frequency. If specified by their manufacturers as being compatible with [1] these should provide the specified EUT supply voltage and inrush currents even where the utility supply has a poor waveform - and their frequency stability should be excellent.

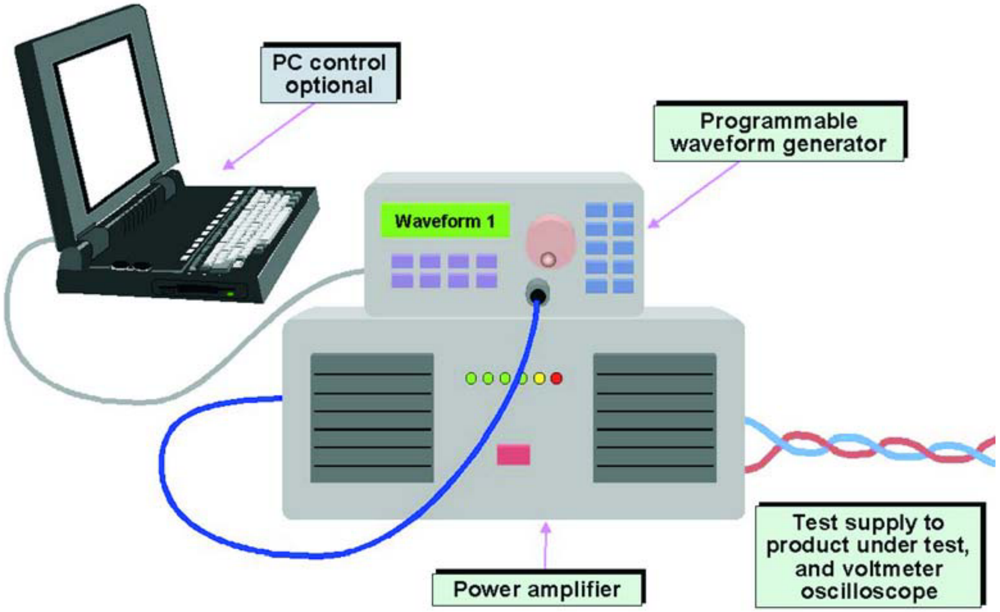
An example of a variable frequency, variable voltage power supply with a sine-wave power output from REO.

Programmable dips and dropout testing

Typical dips and dropout testing assumes that the ordinary mains supply is of good enough quality (but it may be unsafe to rely on this, as described above) and is based on the use of variable transformers. Automatically-regulated and remotely controllable variable transformers are available which allow the testing to be automated. At the very least, the use of an automatically regulating variable transformer would avoid the need to constantly adjust the nominal test level as the mains supply voltage varies during the day.

There is nothing in EN/IEC 61000-4-11 to limit the technology used for the test generator, as long as it meets the necessary specifications. So an alternative to using the mains-powered tester described above could be to use a programmable waveform generator to drive an audio power amplifier which is capable of providing the required mains supply voltage and product inrush current. Many standard product audio amplifiers will fall short because of insufficient output voltage or inadequate current, or because they can't handle the non-linear loads typical of product's power supplies. The voltage requirement may be able to be achieved by 'bridging' the outputs of two amplifiers.

Another type of dips tester (from EN 61000-4-11)



The advantage of a tester based on a mains synthesiser (or signal generator + amplifier) is that it can be easily programmed for automatic testing, can test with different mains supply frequencies (see below), and can also perform more exotic tests. For example: if measurements at a site reveal that its mains supply suffers from a particular type of power quality problem, such as a complex pattern of dips and dropouts caused by the operation of a high-power machine, a tester with a programmable waveform could replicate this to allow proper immunity testing of products destined for that site, or help to assess the cause of reliability problems.

Example of a REO three phase variable transformer that can be remotely controlled

On-site testing of dips and short interruptions

The test set-up and other requirements do not require a special test site and so are easy to meet in many locations.

It is often possible to perform full-compliance tests on-site when using appropriate test instrumentation. If there are some out-of-specification issues with the mains supply or other parameters it is often possible to perform pre-compliance tests with reasonable accuracy.

Testing dips and dropouts by toggling the mains switch

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It is tempting to test for immunity to dropouts by manually toggling the product's mains on/off switch OFF and then quickly ON again. In the absence of any more suitable test gear this can sometimes be a useful thing to do. Few low-cost EMC tests cost less than this!

However, such testing is very unrepeatable because it suffers from

- Uncontrolled phase angle at the OFF and ON transitions;
- Sparking at the switch contacts which can cause quite severe bursts of fast transients;
- Hard to control durations for interruptions lasting under 1 second (and probably impossible to get below 100 milliseconds);
- Inability to test for dips; can only test dropouts and interruptions.

It is important to understand that the use of power supply monitor circuits and 'watchdogs' in microprocessor circuits means that they can be immune to both very small/short and large/long dips and dropouts, yet fail when exposed to middling dips or dropouts. So the fact that a product reboots correctly with no loss of operating state or data if its mains switch is toggled, with durations longer than 250 milliseconds, does *not* mean that it is immune to lesser dips or dropouts.

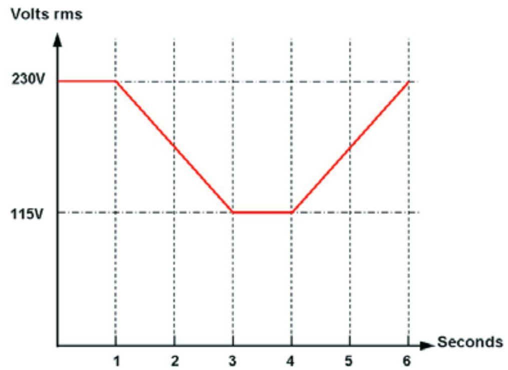
Where a product's DC power supply has sufficient 'hold-up time' or 'ride-through' that even an X-second OFF-ON mains switch toggle duration has no effect at all *during* or after the test (with no rebooting, momentary display freezing, or erroneous status indications), then - except for products using uninterruptible power supplies - it can *usually* be assumed that any/all dips and dropouts lasting less than X seconds will not cause a failure either.

But take care when trying to apply such a crude test to a product using an uninterruptible power supply (UPS). Something designed like a laptop PC - where the battery automatically takes the load when the mains power supply falls below spec - is perfectly acceptable, and products operating from continuous on-line double-conversion UPS's are also acceptable. But many smaller or lower-cost UPS's use a relay to switch between the mains and UPS supply when the mains goes out of specification. The 'mains switch toggling test' might trigger their relay changeover, whereas a dip (or a dropout of shorter duration than the OFF-ON toggle) might not. For such products the mains switch toggling test proves very little.

What are sags, brownouts and swells?

Sags/brownouts and swells are slowly-varying changes in voltage, sometimes over periods of hours. EN/IEC 61000-4-11 calls these disturbances "voltage variations" and many people are surprised to learn that they are covered by the EMC directive. A brownout is another name for a sag, and is the term most often heard in the USA and Canada. Sags can go right down to zero volts.

A typical 'sag' test
(example of a 50% sag for 1 second)



Swells are slow increases in voltage which can last up to a few seconds, as opposed to surges and transients which are fast increases in voltage and usually last less than 1 millisecond. Swells are sometimes called "surges" by electrical power engineers, but this can be confusing in the EMC world where the term 'surge' is reserved for a different type of disturbance.

What kind of sags and swells can occur?

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Typical mains supplies are specified at ±6% voltage tolerance (sometimes ±10%, as in the UK) and it is not unusual to experience these ranges daily. Safety tests apply ±15% for long periods of time, so voltage variations of ±15% (or more) are clearly not impossible. It is often claimed that European mains supplies don't suffer from the traditional US-style brownout where the voltage falls by a large amount for minutes or even hours - but 60% nominal voltage for an hour or two every weekday used to regularly occur in parts of Spain in the late 1990s - and a mains supply of 115V occurred for 8 hours in a part of the UK in July 1998.

An extreme example of sags and swells has been seen on a North Sea oil exploration platform. Its 230V mains supply had sags and swells of 100% (0V to 460V rms) caused by the effects of starting and stopping its huge drill motor on its diesel generator. These enormous voltage variations would last for several seconds each, and much of the equipment on the platform was required to keep functioning normally at all times, and certainly not to be damaged by the sags and swells.

17 What effect can sags and swells have?

Sags can cause all of the problems that dips and dropouts can cause (see earlier). But because sags often last for significant periods of time they can have additional effects. A significantly lowered supply voltage is a particular problem for all AC motors and some types of DC motor, because they can stall, overheat, and damage their insulation. This can lead to an increased risk of fire, fumes and electric shock, never mind the damage to the equipment. Industrial plant AC motors are usually protected by undervoltage trips which are usually incorporated with other protective functions into motor control circuit breaker devices (MCCBs) - but although the motor is protected the process that it is a part of suffers downtime, and possibly damage to the product as well.

Swells are a problem for different reasons. Insulation breakdown and fire hazards should not be a problem for products that meet their respective EN safety standards. But mains surge protection devices such as Metal Oxide Varistors (MOVs) are often designed to start conducting as close to the maximum expected mains voltage as possible, to protect the equipment better. Consequently their leakage currents at voltages more than a little above nominal mains range can cause overheating and damage and possibly fire if the swell lasts for more than a few seconds.
EN 61000-4-11 does not suggest doing any swell testing at all. Maybe it assumes that safety testing would discover such problems.

18 Full compliance voltage variation (sags only) testing

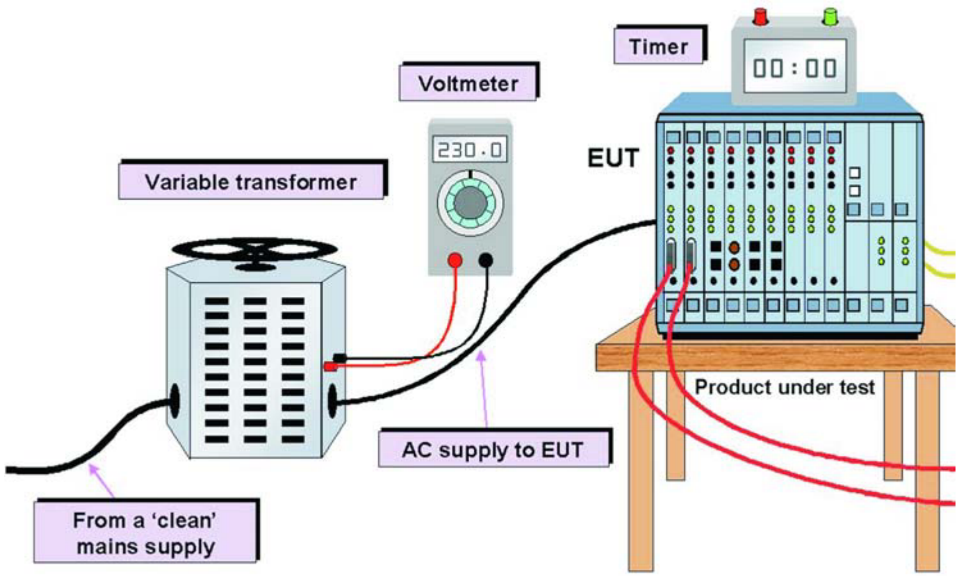
The test set-up for sag testing according to EN/IEC 61000-4-11 is very simple, and the test conditions are exactly the same as for dips and interruptions testing described above.

These tests can easily be done manually by operating a variable transformer under stop-watch control, although many test laboratories will prefer to use a programmable test instrument that complies with the generator specification in EN 61000-4-11. The mains voltage during the test can be varied smoothly, or it can be varied step-wise providing the steps are no greater than 10% of the nominal mains voltage and occur at the mains waveform's zero-crossings.

For each sag test specification (voltage duration, ramp-down and ramp-up durations) three tests are done, with 10 seconds between each.

The functions of the product must be monitored adequately to identify any degradations during and after each test, and after each group of tests a full functional check shall be performed. The relevant generic or product-family harmonised standard will specify the performance degradation criteria to be applied in each case. Dimming of displayed images or illumination may be permitted during the test.

Sag test set-up (from EN 61000-4-11)



Where the product's rated supply voltage range does not exceed 20% of its lowest voltage, any voltage within that range can be used for the test. But where the EUT has a wider voltage range two sets of tests are required: one at the lowest voltage in the range and one at the highest.

EN 61000-4-11 suggests doing two sags tests: 40% and 0% supply voltage each lasting for 1 second with the supply voltage ramped down and then up again over a period of 2 seconds in each case. But most (if not all) generic and product-family harmonised EMC standards don't specify any testing at all for sags (or swells), making it *possible* to declare conformity to the EMC directive without doing these tests.

Swell testing

EN/IEC 61000-4-11 does not describe testing for voltage variations that are above the nominal mains voltage, so we can't talk about full-compliance swell testing.

It seems straightforward enough to follow the sag test method in EN/IEC 61000-4-11 and simply increase the EUT supply voltage instead of decreasing it. This may require a special variable transformer to get the swell range required, or else follow a standard variable transformer with a step-up transformer.

Most test laboratories would prefer to use a programmable mains synthesising test instrument which met the requirements of EN/IEC 61000-4-11, but it is likely that proprietary products will not be able to provide outputs much higher than nominal mains.

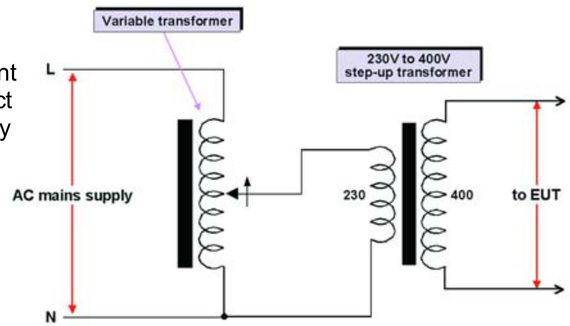
Testing sags and swells may be a good way to improve product reliability in the field. In real life, sags can last for minutes or hours at a time so where an assessment of the components and design of a product reveals possible susceptibilities (especially likely where AC or DC motors are concerned) it may be best to test for a longer time than merely 1 second, to ensure reliable operation in the field.

Constructing a sags and swells tester

Since full-compliance sag testing can be done with just a variable transformer and manual control, it is hard to suggest a lower-cost method. A stopwatch with a clearly visible seconds display is a useful aid to maintaining the correct ramp-up, hold, and ramp-down timings. Remember that the dial of the variable transformer may not be very accurate, so check that the actual voltages meet the requirements using a reasonably accurate true-rms voltmeter, whilst loaded by the EUT.

Safety Note: All the safety issues associated with mains power must be dealt with correctly! Always apply all the relevant parts of the latest issues of the relevant safety standards, such as IEC (or EN) 61010-1, *in full.*

A possible sags and swells tester
(for nominal 230V supplies)



Both transformers should have their 230V winding current rated higher than the fuse rating of the 230V supply that the EUT is intended to be used on

Swell testing could be more difficult though. Most variable transformers only give a limited 15% increase from their nominal voltage, so it may be necessary to follow the variable transformer with a step-up transformer, such as a standard 230V:400V type. Because failure modes during swell testing could draw large currents, the variable and step-up transformers used should have continuous 230V current ratings that are higher than the fuse rating of the 230V supply that the EUT is to operate from.

Following calibration (when loaded) with a true-rms voltmeter the variable transformers dial could be marked-up with stick-on labels as an aid to easy use.

On-site testing of sags and swells

The test set-up and other requirements do not require a special test site and are easy to meet in many locations. It is often possible to perform full-compliance sag and swell tests on-site, as long as the power requirements aren't too high. If there are some out-of-specification issues with the mains supply or other parameters it is often possible to perform pre-compliance tests with reasonable accuracy and repeatability.

Full-compliance testing for three-phase equipment

Three-phase equipment is tested for dips, dropouts and voltage variations using three sets of single-phase test equipment. Phase-by-phase testing is preferred by EN/IEC 61000-4-11, although some equipment may require simultaneous testing instead (or as well) and this requires common control of the three single-phase test systems. Three-phase variable transformers are available from manufacturers such as REO. The relevant harmonised standard for the EUT will specify whether phase-by-phase or simultaneous control is required.

Note that when using simultaneous control for dips and interruptions testing, the ±10% specification for the zero-crossing performance can only be met for one phase, so the test generators must be of the type that can switch at any phase angle.

References

[1] EN or IEC 61000-4-11:1994 *"Electromagnetic Compatibility (EMC), Part 4. Testing and measurement techniques. Section 11. Voltage dips, short interruptions and voltage variations immunity tests."*

[2] European Union Directive 89/336/EEC (as amended) on Electromagnetic Compatibility. The Directive's official EU homepage includes a downloadable version of the EMC Directive, a table of all the EN standards listed under the Directive, a guidance document on how to apply the Directive, lists of appointed EMC Competent Bodies, and progress on the 2nd Edition EMC Directive:http://europa.eu.int/comm/enterprise/electr_equipment/emc/index.htm.

[3] The IEE's 2000 guide: *"EMC & Functional Safety"* can be downloaded as a Core document plus nine Industry Annexes from http://www.iee.org/Policy/Areas/Emc/ index.cfm. It is recommended that everyone downloads the Core document and at least reads its first few pages. Complying with this IEE guide could reduce exposure to liability claims.

[4] IEC 61000-2-8:2002 *"Electromagnetic Compatibility (EMC) Part 2-8: Environment - Voltage dips and short interruptions on public electric power systems with statistical measurement results."*

[5] ITI (CBEMA) Curve and Application Note:http://www.itic.org/technical/iticurv.pdf

[6]EN 61000-4-30 *Testing and measurement techniques Power quality measurement methods*

EN and IEC standards may be purchased from British Standards Institution (BSI) at: orders@bsi-global.com. To enquire about a product or service call BSI Customer Services on +44 (0)20 8996 9001 or e-mail them at cservices@bsi-global.com.

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This guide is one of a series. E-mail us if you would like to receive all of our mini guides and to be entered onto our mailing list at main@reo.co.uk

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