How to Select an AC Power Supply

By Grady Keeton

Today's electronic products must work under all types of conditions, not just ideal ones. That being the case, AC sources used in test applications must not only supply a stable source of AC, they must also simulate power-line disturbances and other non-ideal situations.

Fortunately, today's switching AC power sources are up to the task. They offer great specifications and powerful waveform-generation capabilities that allow users to more easily generate complex harmonic waveforms, transient waveforms, and arbitrary waveforms than ever before. Some can even provide both AC and DC outputs simultaneously and make measurements as well as provide power. This level of flexibility is making it easier to ensure that electronic products will work under adverse conditions.

When choosing an AC source, make sure to consider the following criteria:

- Current requirements for your device under test
- Worst-case input current (including transient demands, such as inrush)
- Crest factor of your load's current
- Power factor
- Regulation and distortion
- Response time and slew rate
- User and test-system interfaces
- Facility requirements

Current Requirements

When selecting an AC source for your test application, you must consider both much current your unit under test (UUT) will draw. Be sure to include inrush current and transient currents that may occur during intentional input voltage swings and during different modes of operation your device may use.

Worst-Case Input Current

Rectifier-type power supplies and motors are notorious for drawing high inrush currents. These devices have inrush currents anywhere from two to ten times the nominal run current, and they will draw this current anywhere from a few cycles to several seconds.

The response of the AC power source to inrush current is dependent on the method that the source uses for current-limiting. AC power sources are designed to protect themselves from excessive loads current by either folding back the voltage (current limiting) or shutting down the output (current-limiting shutdown) and in many cases, this is user selectable.

In some instances, it may not be practical to have an AC source that can supply the full inrush current demanded by the load. If the test does not require the stress test from this current, it may be possible to use the current-limiting foldback technique for these tests. AC motors can draw up to seven times the normal operating current when first started. How long the motor will draw this current depends on the mechanical load and the motor design.

For loads such as motors and rectifier-type power supplies, an AC source that is folding back its output voltage to limit current will result in a longer start up time for the device under test. A source that is not capable of supplying the proper level of voltage and current may remain in the current-foldback state too long, causing the device under test to not start correctly or shut off altogether.

If you must measure the inrush current or your test call for supplying the full inrush as part of the test, you will need an AC source that can supply the full peak inrush current, so that the source never reaches the foldback state.

Crest Factor

Crest factor is the ratio of the peak current amplitude to the rms amplitude of an alternating current or pulsating direct current waveform. For UUTs that draw an input current with a high crest factor, it is important to select an AC source with low impedance and high peak instantaneous current capability. Low source impedance facilitates the quick transfer of current to the load. High peak current is provided from these sources for pulse widths ranging from 60° to 30°. The narrower the pulse width, the higher the crest factor capability of the high peak current source.

Switch-mode, or rectifier-type power supplies that are not power factor corrected, are an example of a UUT that has a high crest factor. They draw current from a power source in narrow pulses at the peaks of the voltage waveform. These pulses can be from 3 to 4 times the value of the rms current.

Many AC sources can only support a crest factor of 1.414 (the peak of a sinusoidal current waveform). If your source is not capable of supplying a load that exhibits a high crest factor, it may reduce its output voltage to unacceptable levels, have a distorted output, or shut down completely. In either case, the UUT will not be tested properly. With a crest factor rating of up to 3.25:1; the AMETEK CSW Series AC source, for example, can drive difficult nonlinear loads with ease. This translates into driving a rectifier for instance, has a 52A peak current at 13Arms at a 120/208 three phase output.

Power Factor

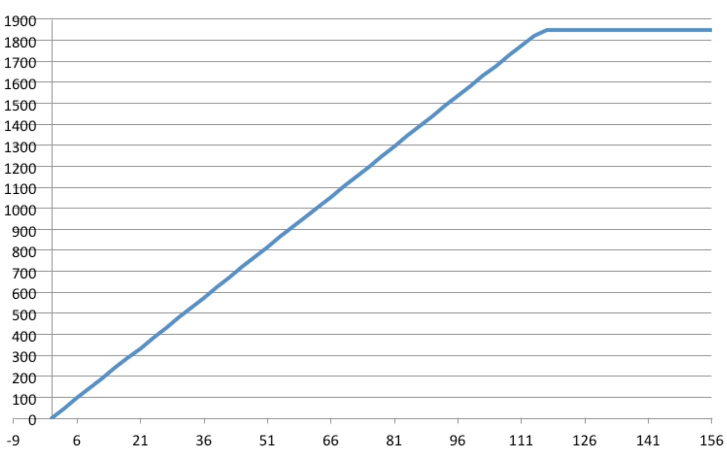
If your load has a low power factor, this will cause a derating of the output capacity of most linear AC sources. This is due to both the added reactive power being dissipated by the source and the current being drawn much closer to zero crossing of the voltage waveform. The graph shows a typical curve that you would use for derating a linear source's output capacity.

Switching AC power sources, on the other hand, need not be derated for power factor since they operate much differently with reactive loads. The power devices dissipate much less power and therefore operate much cooler as a result.

You do, however, have to derate the VA rating of both switching and linear sources when performing tests at low voltage settings. Make sure to take this into account when testing a device at its worst-case, low voltage input. For an example, on the CSW series, each phase amplifier is rated for 1,850 VA maximum. The amplifier has a maximum current rating of 16A FROM 0-115 V AND a maximum voltage rating of 156 V. The current derates in a linear manner above 115 V to maintain the maximum limit of 1,850 VA. (i.e. 1850 VA/146 V = 12.67 A).

When operating at voltages below 115 V, the current is the limiting parameter. At 5 V output you have 16 A available providing 80 VA. In other words, you can't obtain 1,850 A at 1 V.

VA



Regulation and Distortion

Load and line regulation should be tight, and distortion low. Poor regulation and distortion can lead to faulty test data that may not be discovered until units are in the field, or lead to false failure in testing. Typically, quality AC sources will have a voltage accuracy of +/- 0.1% and a maximum total harmonic distortion (THD) of no more than 0.25%.

AC power sources with poor regulation are sometimes called "soft sources." A soft source has a high output impedance and low peak current capability and cannot provide the peak currents that may be required for stress testing components properly. This leads to a higher failure rate. For example, if you used a soft source to perform the tests specified by IES LM-41-1985, "IES approved method for photometric testing of indoor fluorescent luminaires" to test a fluorescent lamp and ballast, the source would produce a distorted waveform and invalidate the test results.

Response Time

Another consideration is the load response time, or the time it takes an AC source to respond to a change in the load. AC sources with fast load response times generally have low source impedance and tight regulation. AC sources with these characteristics are sometimes called "stiff sources" because their outputs remain constant, even when switching from no load to full load.

Typically, stiff sources have used analog technology to provide tight regulation and low source impedance, but sources that use switching technologies now perform just as well as linear sources. An example of this type of AC source is California Instruments' CSW Series. It has a voltage accuracy specification of +/- 0.1%, a THD specification of 0.25%, and very fast load response times.

Slew Rate

For many tests that require that you simulate real-world conditions, such as fluctuations in voltage, sags, surges, dropouts, or spikes, you need a source with a fast slew rate. An AC source's slew rate is the time it takes the source to respond to a change in the programmed voltage or frequency. High performance AC sources typically have slew rates of less than 50 μs.

User and Test-System Interfaces

AMETEK offers many different interfaces, including RS-232, USB, GPIB, and Ethernet, for integrating an AC source with your test system. In addition to the hardware, AMETEK also supplies IVI drivers with each AC source for use with National Instruments LabVIEW and LabWindows/CVI. Other user-developed systems are readily supported due to the use of SCPI programming syntax. This eases the tasks of ATE system programming and integration.

In addition, a Graphical User Interface application is supplied to provide a means of remote operation. Figure 1 shows how you use this application to easily create a test waveform with harmonic content.

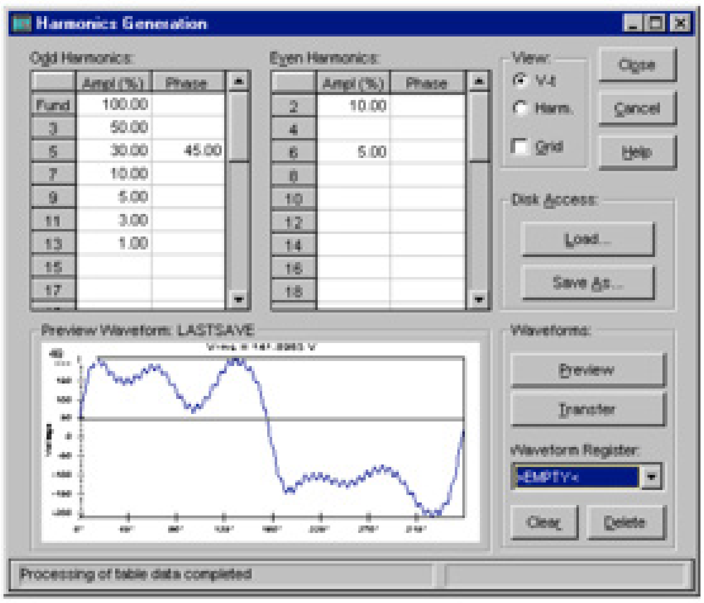


Fig. 1

Facitlity Requirements:

If the AC source must supply a lot of power, you may have to plan for a new power distribution and disconnects at your facility. Physical and environmental requirements must also be taken into account. Large AC sources can require significant floor space, and will require a high volume of airflow within a specified temperature range.

Cleanliness is also a consideration. Airborne contaminates from some manufacturing processes can result in conductive particulates drawn into the cooling air flow, and cause the source to fail. In order to avoid these failures, you need to locate your AC sources in clean areas with temperatures and humidity held within the ratings required for the prospective source

Switching Sources Offer Many Advantages

For your next test system, you really should consider selecting a switching AC source. The digital technology used in modern switching AC sources not only improves the performance of the sources, but also offer users a number of other features that make testing with complex waveforms easier. The California Instruments' CSW Series can, for example, be used as an AC source, DC source, or provide a combination of AC and DC sources.

Using the latest digital signal processing (DSP) technology, modern switching AC sources can easily be programmed to provide whatever kind of waveform you need to test your products. These include waveforms with harmonic content to test for harmonic susceptibility and AC and DC transients. And because these waveforms are digitally generated, the user has complete control over when these events happen.

In addition to these powerful waveform-generation capabilities, the CSW Series also offers advanced measurement capability. Its measurement system digitizes voltage and current waveforms in real time and provides detailed information on both voltage and current waveforms. This includes detailed harmonic information on acquired waveforms.