AMETEK®
PROGRAMMABLE POWER

WHITE PAPER

What to Look for When Choosing a Modern Programmable AC Source or DC Supply

POWERING FORWARD. **TOGETHER.**

Programmable AC sources and DC supplies provide maximum flexibility in your system design-and-test efforts—from the initial R&D phase to product validation, to regulatory compliance verification, to high-volume production testing. Choosing the optimum product for your application extends well beyond choosing AC or DC and a voltage, current, and frequency rating.

A key consideration will be the industry vertical in which you work—aerospace and defense, for example, will have different requirements than the semiconductor or commercial appliances industries. Similarly, automotive and transportation applications will present test challenges that differ from those in energy and power-generation. While all require voltage, current, and frequency, each will impose different requirements concerning relevant standards and operating conditions.

For example, suppose you are testing automotive components that operate on a vehicle's 12-V battery. In that case, you will want a stiff DC supply that maintains its programmed output voltage across the rated current range. If, however, you are using a supply to simulate the output of a photovoltaic panel, you will need a supply with a soft I-V output characteristic that mimics that of a solar-cell string.

Similarly, if you are testing a group of consumer appliances intended to run on standard line voltage, you can use a one-quadrant programmable AC source. If you are using the source as a grid simulator to test a photovoltaic inverter, you will need a regenerative source that can pump power from the inverter under test back to the grid.

Despite all this variation, two features are beneficial for AC sources and DC supplies across all use cases in all industry verticals: high power density and high flexibility with respect to voltage and current ratings.

AC Sources Offer Voltage and Current Flexibility

A programmable power product that offers maximum flexibility in power, voltage, and current ratings helps you meet your immediate needs while future-proofing your equipment. Consider the following example. A hypothetical engineer had a test project requiring 6,000 VA at a 400-V maximum working voltage, for a 15-A current. This engineer purchased a programmable source rated at 400 V at 15 A.

Subsequently, however, the engineer begins a new project that requires 6,000 VA at 230 V. Using the previously purchased 400-V, 15-A supply, the engineer can only obtain:

$$\mathbf{230\ V \times 15\ A = 3{,}750\ VA}$$

which is far short of the 6,000 VA needed. This engineer regrets not having over-specified the original purchase and makes the following calculation:

$$\frac{(6{,}000\ \text{VA})}{(230\ \text{V})} = 26\ \text{A}$$

With this result, the engineer realizes that a 400-V, 26-A programmable source, for a total rating of 10,400 VA, would have sufficed for both projects, albeit at a significantly higher cost, and neither project required more than 58% of the full VA rating.

To alleviate such issues and to provide more flexibility in power-source purchases, AMETEK Programmable Power offers a feature called iX2 current doubling technology on its new AC sources. With i2X, as the maximum working voltage goes down, the current rating increases up to two times the rated current at full voltage. Figure 1 shows the i2X voltage and current curve and the currents available at 400 V (green lines) and 230 V (yellow lines) for the hypothetical engineer's projects. Note that the current available at 230 V is 173% (horizontal yellow line) higher than the current available at 400 V. 173% of 15 A equals 26 A, meeting the engineer's requirements for voltage, current, and VA for both the 400-V and 230-V applications, all in one cost-effective, compact instrument.

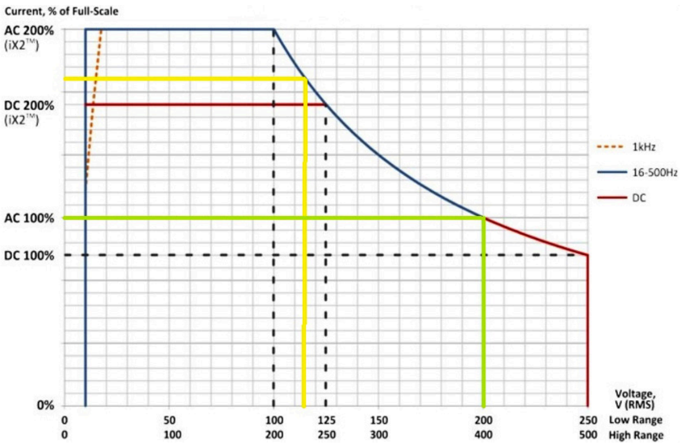

Figure 1. A programmable AC source with i2X current doubling technology and rated 15 A, 400 V (green lines), can deliver 26 A at 230 V (yellow lines).

Renewable Energy Systems Benefit From Regeneration

If you are choosing an AC source and require regenerative capability—an increasing necessity for testing renewable-energy systems—you must ensure you can meet anti-islanding requirements per IEC 62116, "Utility-interconnected photovoltaic inverters—Test procedure of islanding prevention measures." This standard requires that if the grid goes down, the regenerative source must shut down within a specified period to protect utility workers and in-house electricians trying to restore normal operations. Regenerative capability can come into play in various applications, from photovoltaic inverter tests to vehicle-to-grid (V2G) applications.

AC Source Power Growth

One noticeable change over the past decade or two in the AC source market is that power requirements have grown, driven primarily by advances in the renewables space. In the 1990s and early 2000s, 5,000 or 10,000 VA was considered high power. Now, it is common for a customer to look for 360,000 VA. This power increase has several implications. One is that you should choose a scalable AC source—for example, one to which you can add a parallel unit when your power requirements increase.

Another implication is returning your source to the factory for upgrades. A 1U-high rack-mounted source might weigh about 40 lbs., so it is easy to pack and ship it if needed. A high-power floor-standing version, however, can weigh in at 1,600 lbs. or so and is more challenging to ship. Therefore, you should obtain software, firmware, and other upgrades remotely and install them on-site. For example, you might encounter a new test requirement per MIL-STD-794, Aircraft Electrical Power Characteristics. You can purchase the software option from AMETEK Programmable Power and install it at your facility.

AC and DC Options

Keep in mind that many AC sources can also provide DC outputs. These sources can generate an AC waveform with a DC offset. Choosing such a unit can provide considerable flexibility. AC sources do not have the levels of output capacitance that dedicated DC supplies do, and consequently can provide much faster DC slew rates than dedicated DC supplies. However, a dedicated DC supply will provide better precision and signal quality. Most of AMETEK Programmable Power's DC supplies employ switching architectures, yet many exhibit very little noise thanks to techniques such as zero-voltage switching, and they can mirror the noise performance of linear supplies.

DC Supply's Power Density Enables 67% Space Savings

Maximizing power density is critical for rack-mounted test systems because rack real estate is always at a premium. Figure 2 shows the rack savings you can achieve by upgrading to a new product. On the left are three, 1,700-W legacy DC supplies occupying a 3U height in a full-width rack. On the right, a new DC 3-channel supply occupies only a 1U height for the same power ratings, representing a space savings of 67% and freeing 2U height for other instruments.

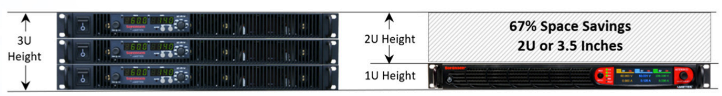

Figure 2. A 1,700-W legacy DC supply that required a 3U rack height (left) can be replaced by a new 1,700-W model that requires only a 1U rack height.

Several factors contribute to increased power density. Fast switching speeds enabled by the latest semiconductor technology, such as silicon-carbide (SiC) devices, can boost overall efficiency, enabling higher performance in smaller packages. In addition, an airflow system that maintains the proper thermal profile within the unit is critical to keeping heat sinks within the unit cool.

DC Supplies Offer Autoranging

AMETEK Programmable Power also provides a constant-power output capability—called autoranging—for many of its DC programmable power supplies. The autoranging 600-W model represented in Figure 3, for example, has a constant-power output characteristic extending from 100 V at 6 A to 400 V at 1.5 A.

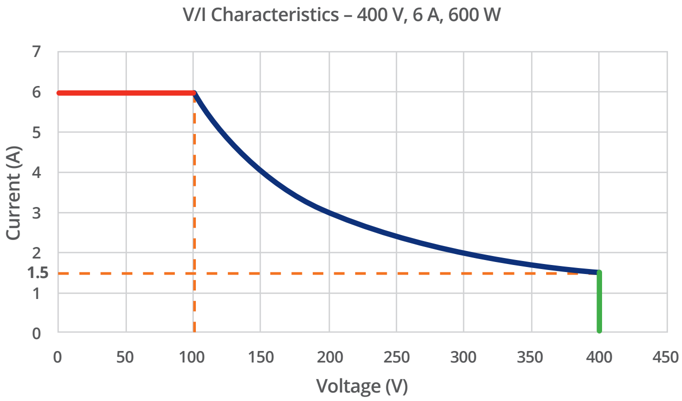

Figure 3. *A 600-W autoranging DC supply exhibits a constant power characteristic (blue curve) extending from 100 V at 6 A to 400 V at 1.5 A.*

Interface Options and Transient Response for AC Sources and DC Supplies

Other considerations when choosing an AC source or DC supply include your interface options. High-speed interfaces such as Ethernet and USB are more common on programmable power products than a decade ago. Of course, suppose you are buying a new power product to upgrade an existing legacy system. In that case, choose an older interface such as RS-232C or GPIB to maintain compatibility with your other instruments in the system and your legacy test programs.

Note, too, that the analog interface remains a useful option, particularly for hardware-in-the-loop test applications (Figure 4), where a programmable source or supply with an analog input can serve as a power amplifier or arbitrary waveform generator driving a motor under test or other equipment under test.

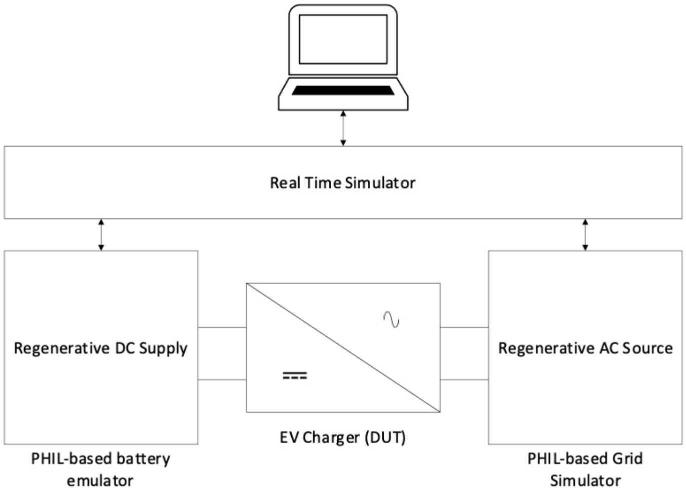

Figure 4. *An analog interface remains a useful option for power-hardware-in-the-loop (PHIL) test applications.*

AMETEK Programmable Power continues to include analog interfaces and, on its newest products, doesn't restrict the full-scale range to a fixed span such as 0 to 5 V or 0 to 10 V. Customers can set the full-scale value to, for example, 0 to 2 V, 0 to 3 V, 0 to 7 V, or any range up to a 10-V maximum.

Transient response is another factor to consider when choosing a programmable DC power supply or AC source, and your choice of an interface can affect transient performance. If you store a transient list within the instrument, transient response can be very fast—with up to 500-µs resolution. If you are sending commands one at a time from your host computer, then transient response is limited by the speed of your interface. If you choose one of these interfaces, you can provide more flexibility on how you program and store the transient lists you need to generate to exercise the device under test. In addition, you will want to consider slew rates and full-load and no-load rise and fall times. No matter how fast you get commands to your programmable unit, it will exhibit physical limits to how fast its output can change.

Distortion, Regulation, and Noise

Other factors to consider include distortion and regulation, which offer price/performance tradeoffs. AMETEK Programmable Power offers AC supplies with less than 1% distortion, even for non-sinusoidal waveforms. As for regulation, you will want to see how quickly the unit recovers in response to a step load change. A high-performance DC supply will recover from a 10% to 90% step load change within one or two milliseconds. You will also want to check line regulation to see how well a unit responds to input disturbances. A supply with better line regulation will have better stability.

As your programmable power requirements evolve over the life of your current products, you may well find that moving to a new programmable AC source or DC supply can offer significant benefits. Upgrades are not without challenges, but AMETEK Programmable Power can work with you to ease the transition. For more transition information, see the white paper [Understanding the Product Lifecycle to Ensure a Smooth End-of-Life Transition].