APPLICATION NOTE

Selecting the Optimal System DC Power Supply for Performance

KEYSIGHT

Introduction

When designing a test system, you might not immediately consider the DC power supply. You may believe its role is simply to provide a bias voltage to your circuits or that it has little impact on overall system integration and performance.

All of that may be true in simple applications. In most test system designs, however, the DC power supply can significantly affect the overall integration level and performance. By choosing the correct power supply, you can benefit in the following ways:

- lower integration cost
- faster throughput
- better device under test (DUT) protection
- better test integrity
- longer system uptime

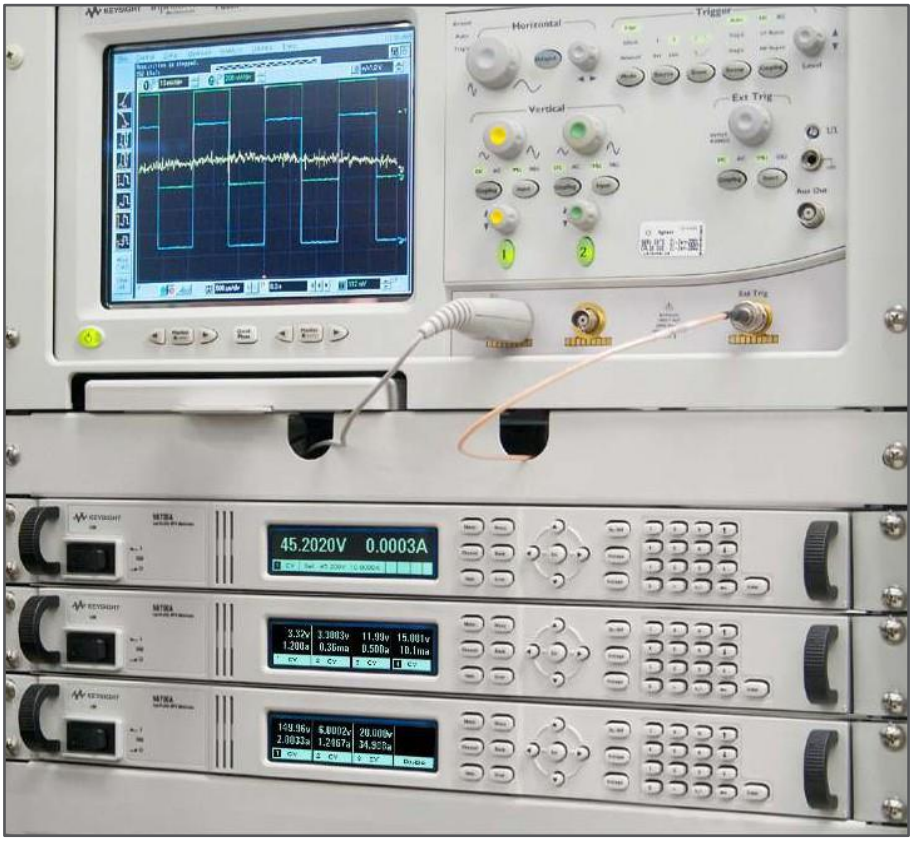

Figure 1. Three low-profile (1U) multiple-output modular power systems installed in a test rack. Each system can hold up to four power supply outputs with its own voltage and current readback

A Closer Look

Let’s examine each factor from a DC power supply perspective.

Integration cost

As a system design engineer, you want to minimize integration cost, time, and effort while maintaining performance. Sometimes, you must trade off one of these attributes against another, but all should play a part when you choose a system DC power supply or any other test instrumentation. You can lower your integration costs by using less hardware (fewer instruments to buy and integrate) and using hardware that is easier to integrate (less time to assemble).

Choosing power supplies with built-in functions avoids the need for additional instruments. For example, some power supplies have built-in voltage and current readback to measure the output voltage and current. By using instruments with built-in readback capabilities, you do not have to buy and integrate voltmeters, switches, and shunts (current monitoring resistors) that would add to hardware cost and system build time.

Choosing a power supply with multiple outputs provides another opportunity to lower integration costs by using less hardware. Some DUTs receive power from multiple input voltages and are sensitive to the order in which you turn these voltages on or off. Designing a method to sequence multiple power supply outputs is time-consuming and costly, and it adds to the system‘s hardware. Instead, choose a power supply mainframe system with multiple output modules and built-in sequencing capability. The mainframe system can precisely sequence the turn-on and turn-off of these outputs to save integration time and money.

You can get system DC power supplies with these features from Keysight Technologies. For example, the accuracy of the output voltage and current readback functions in the Keysight N6700 modular power system (Figure 2) eliminates the need for external voltmeters and shunts. Thirty-four power modules are available, covering different voltage, current, and power ranges, as well as performance levels from basic to precision.

Figure 2. Thirty-nine power modules are available with the 1U-high Keysight N6702C four-output mainframe with built-in voltage and current readback and output sequencing

Some of these power modules can measure current with an error of less than 8 nA. Simplify the integration of multiple-output configurations with built-in precise output turn-on and turn-off sequencing (Figure 3). You can install up to four power outputs in a single 1U-high N6700 mainframe and, in just seconds, set these outputs to meet your power sequencing needs. If your system requires sequencing of more than four outputs, you can use multiple mainframes to achieve your objectives.

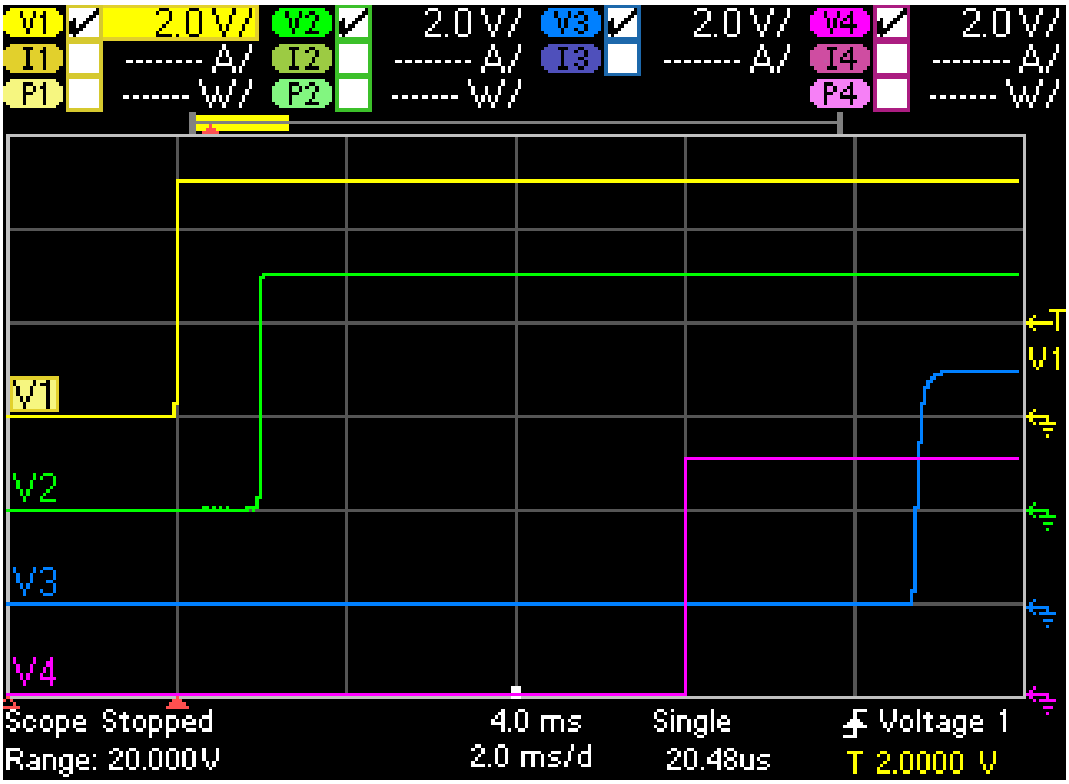

Figure 3. The Keysight N6700 Series provides precise output turn-on sequencing

Throughput

If the power supplies in your test system are primarily at a single voltage (set it and forget it), you have less opportunity to improve throughput with your supply choice. However, suppose you frequently change the input voltage to your DUT or regularly turn it on and off. In this case, you can realize significant gains in test time by choosing the proper power supply. When you select a power supply whose output voltage can change quickly, you do not have to wait for the voltage to settle to proceed with your test.

Two main power supply attributes will directly affect test time (see Figure 4):

- Command processing time is the time it takes for the power supply to accept and interpret a command sent to it over an interface bus, such as LAN, USB, or GPIB.
- Output response time (also known as programming speed or programming time) is the time it takes for the output voltage (or current) to go from its present value to a settling band around a new programmed value.

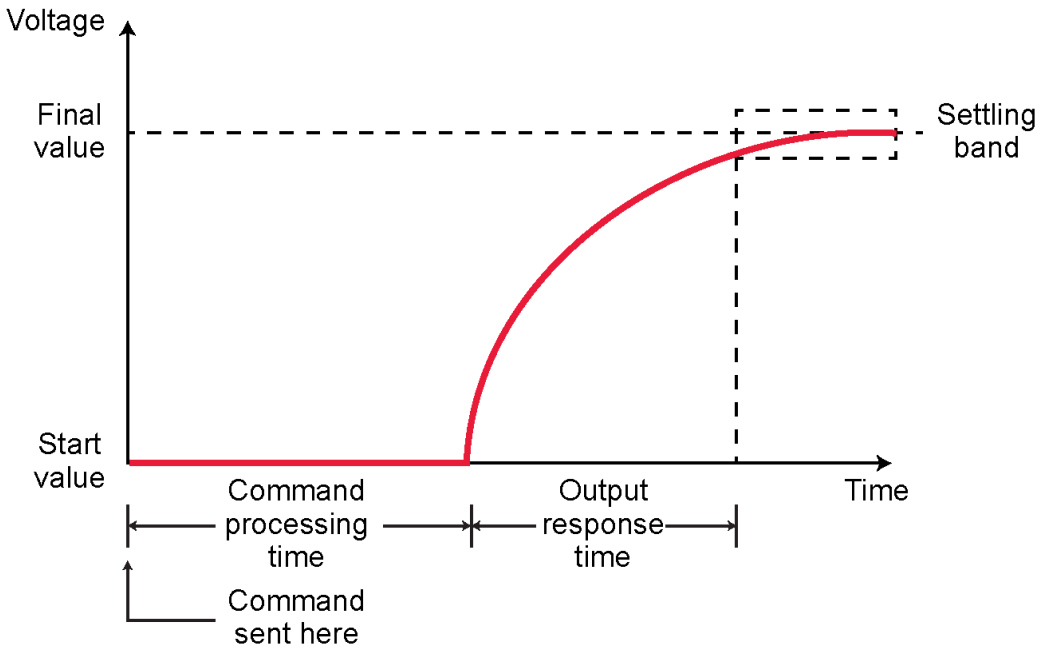

Figure 4. The power supply's command processing time and output response time affect throughput

Other power supply attributes can help reduce command processing and output response times. For example, the output voltage of a power supply with a down-programmer moves from a higher value to a lower value more quickly than one without this capability. A down-programmer is a circuit on the power supply output that actively pulls the voltage down instead of letting it bleed down more slowly by itself.

Some power supplies have processing times of 10 ms, 50 ms, or 100 ms for each command. The N6700 Series power supplies can process commands in less than 1 ms, dramatically reducing test times. Output response time for N6700 power modules depends on the performance level. The output on some modules can go from 0 V to 50 V in less than 1.5 ms. The built-in down-programmer helps bring the voltage from 50 V to 0 V in the same amount of time. Keysight N6700 source / measure units can transition from 0 V to 10 V in as little as 15 µs. If you often change voltages during your test, the N6700 can save time and significantly improve test throughput.

DUT protection

Most system design engineers want to protect their DUTs from damage by preventing exposure to excessive voltage and current. This is especially true when testing a limited number of devices in a design environment or when the DUT is very expensive, such as a satellite. Protecting the DUT in these situations is crucial.

If protecting your DUT is important, choose a power supply with built-in protection that prevents excessive voltage and current on the output. Overvoltage protection (OVP) safeguards your DUT against excessive voltage. If the actual output voltage reaches or exceeds the OVP setting, the power supply shuts down its output.

Overcurrent protection (OCP) uses the constant current (CC) setting. Suppose the actual output current reaches or exceeds the CC setting, causing the power supply to go into CC mode. The output would shut down, protecting the DUT from continuous excessive current. Figure 5 shows an example of an OVP shutdown.

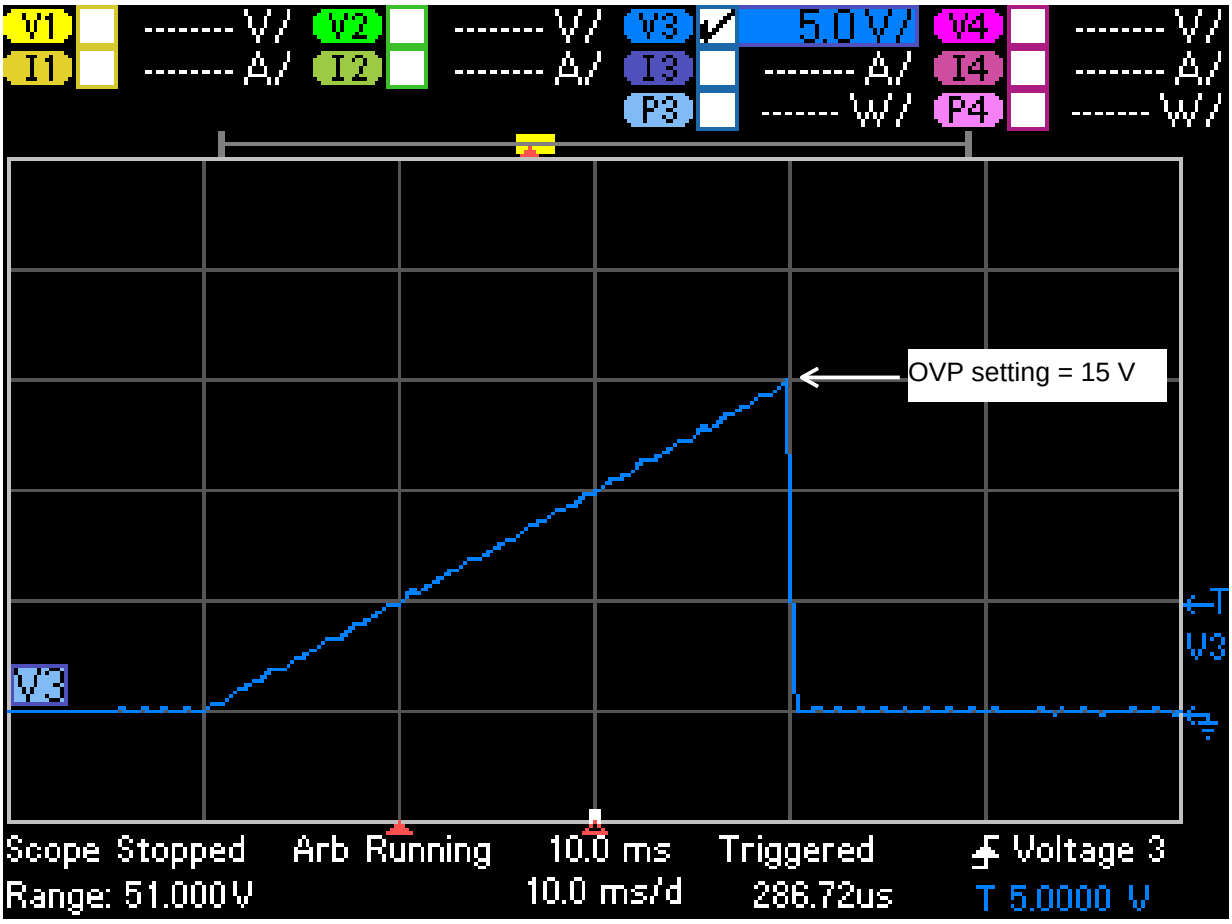

Figure 5. An overvoltage shutdown occurs when the output voltage reaches the 15 V OVP setting, protecting your DUT

Overvoltage, overcurrent, and over-temperature protection features are standard in most Keysight power supplies. The over-temperature feature protects the power supply, safeguarding your DUT. It will shut down its output if the power supply detects an internal temperature that exceeds a predetermined limit. The temperature may rise because of unusually high ambient temperature or a blocked or incapacitated cooling fan. Shutting down the output in response to high temperatures will prevent other power supply components from failing, which could lead to a more catastrophic condition.

Advanced power supplies like the N6700 Series contain additional protection features, such as a watchdog timer. This feature looks for any interface bus activity (LAN, GPIB, or USB). If the system detects no bus activity for the duration you set, the power supply output shuts down. This feature is handy to protect your DUT from a computer program that stops executing and leaves the power in a state that, over time, can damage it.

These advanced N6700 protection features can begin to shut down your power supply outputs in as little as 30 µs from when the system detects the protection event.

Test integrity

Trustworthy sourcing and measurements are keys to successful system deployment. Power supplies provide accurate, stable bias power to your DUT. Look for power supplies with fully specified accuracy to ensure that your DUT will see the voltage you want. Also, it is important to check the line and load regulation specifications to ensure changes to the power supply output with AC input changes or load current changes. And if you are making sensitive measurements on your DUT, choose a power supply with low output noise to minimize measurement interference. A high-quality source will improve the dependability and repeatability of your test results.

The Keysight N6781A source / measure unit in the N6700 Series power supply has a low current measurement range that is accurate to within 0.025% + 8 nA to provide confidence in your measurements. Other supplies in this series have peak-to-peak noise specifications of less than 4.5 mV and RMS noise specified at less than 350 µV, ensuring that the power supply will not interfere with sensitive measurements. Keysight's complete set of performance specifications provides you with worry-free power supply operation.

System uptime

To maximize system uptime, choose a power supply with a long mean time between failures (MTBF). Ensuring adequate local support for the instrumentation in your system, including the power supply, will speed repairs. And pay attention to the power supply calibration method and cycle time because the system will be down during calibration.

The N6700 Series has an MTBF of greater than 40,000 hours (that's 20 years at 40 hours per week) to minimize your system downtime. Keysight provides worldwide support to help you quickly get your system running again if an unlikely failure occurs. Worldwide support also makes it easy to calibrate your supplies on the recommended once-per-year cycle.

Conclusion

Your power supply choice affects your test system's assembly, performance, and longevity. Lower integration costs, faster throughput, better DUT protection, better test integrity, and longer system uptime are some benefits of choosing a power supply suitable for your test system.

To maximize those benefits and the success of your system deployment, consider performance and features when selecting your power supply. Keysight has hundreds of power supply models to meet your needs. The right Keysight system power solution will reduce your integration cost, test your DUT accurately and quickly, protect your DUT, and continue running for many years.