

# Keysight Technologies

Choosing System DC Power Supplies to  
Optimize System Integration and Performance

Application Note



## Introduction

If you are designing a test system, one of the last things you may think about is the DC power supply in your system. You may believe the role of the DC power supply is to simply provide bias voltage to your circuits. And you may think that simple role should have very little impact on overall system integration and performance. In some simple applications, this may be true. But in the vast majority of test system designs, the DC power supply can have a noticeable and sometimes significant impact on the overall integration and performance of your test system. 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

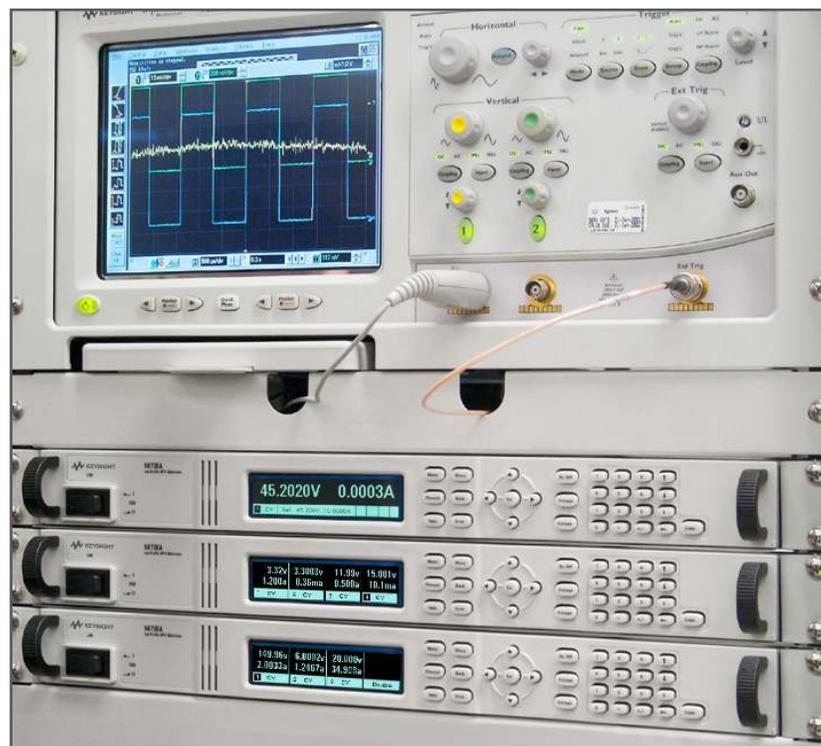


Figure 1: Three low-profile (1U) multiple-output modular power systems are shown installed in a test rack. Each of the three power systems can hold up to four power supply outputs, each with its own voltage and current readback.

Let's take a look at these benefits one at a time 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 piece of test instrumentation that will be integrated into your system. You can lower your integration costs by using less hardware (fewer instruments to buy and integrate) and by using hardware that is easier to integrate (reduces time to assemble).

You can use less hardware by choosing power supplies with built-in functions that otherwise would have to be added with additional instruments. For example, many power supplies have built-in voltage and current readback (measurement). These power supplies measure their own output voltage and current. If you use the built-in readback, you do not have to buy and integrate additional voltmeters, switches, and shunts (current monitoring resistors) that would add to hardware cost and system build time.

When you need multiple bias supplies and the outputs need to be sequenced, you have another opportunity to lower integration cost by using less hardware. Some DUTs are powered from multiple input voltages and are very sensitive to the order in which these voltages are turned on or off. Designing a method to properly sequence multiple power supply outputs is time consuming and costly and adds to the system hardware. Instead, choose a power supply mainframe system that has multiple output modules with 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.



Figure 2. Lower your integration costs by using Keysight's 1U-high N6702A multiple-output mainframe with built-in voltage and current readback and output sequencing. Thirty-four different power modules are available.

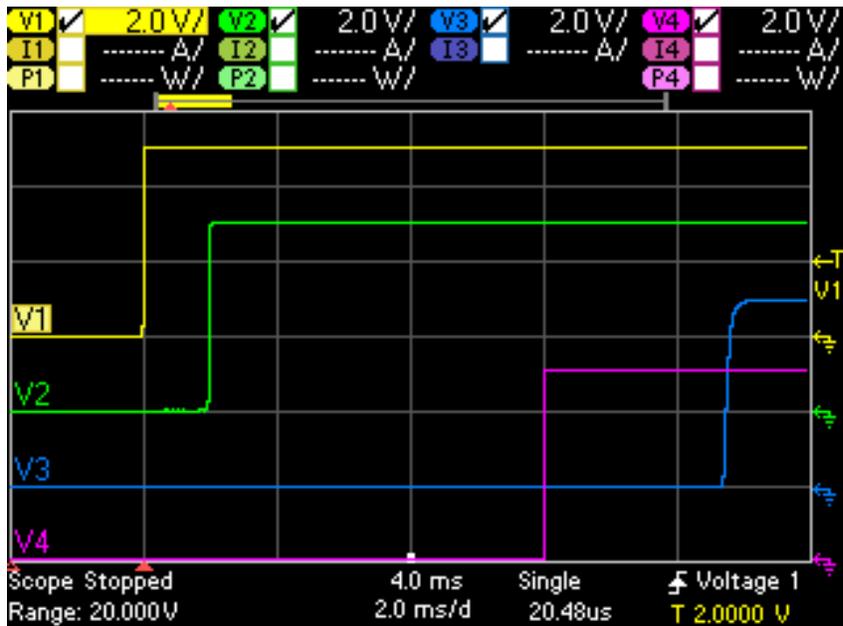


Figure 3. Precise output turn-on sequencing is simple with Keysight's N6700 Series, and it saves you integration time.

You can get system DC power supplies that contain features supporting all of these benefits from Keysight Technologies, Inc. For example, the Keysight N6700 Modular Power System power modules' accurate output voltage and current readback eliminates the need for external voltmeters and shunts to lower your integration cost. There are 34 different power modules available covering different voltage, current, and power ranges in addition to different performance levels from basic to precision.

Some of these power modules can measure current with an error of less than 8 nA. Simplify integrating your multiple-output configurations even more with built-in precise output turn-on and turn-off sequencing. 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.

## Throughput

If the power supplies in your test system are used primarily at a single voltage (set it and forget it), then there is probably not much opportunity to improve throughput with your choice of supply. However, if you are frequently changing the input voltage to your DUT, or simply turning the input voltage on and off regularly, you can realize significant gains in test time by choosing the right power supply. When you choose a power supply whose output voltage can change quickly, you don't have to wait for the voltage to settle to proceed with your test.

There are two main power supply attributes that will directly impact test time:

- Command processing time – this 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) – after the command has been processed and the power supply knows what to do, it has to move the voltage (or current) on its output terminals. The output response time is the time it takes for the output voltage (or current) to go from its present value to a settling band around the new programmed value.

See Figure 4 for an example.

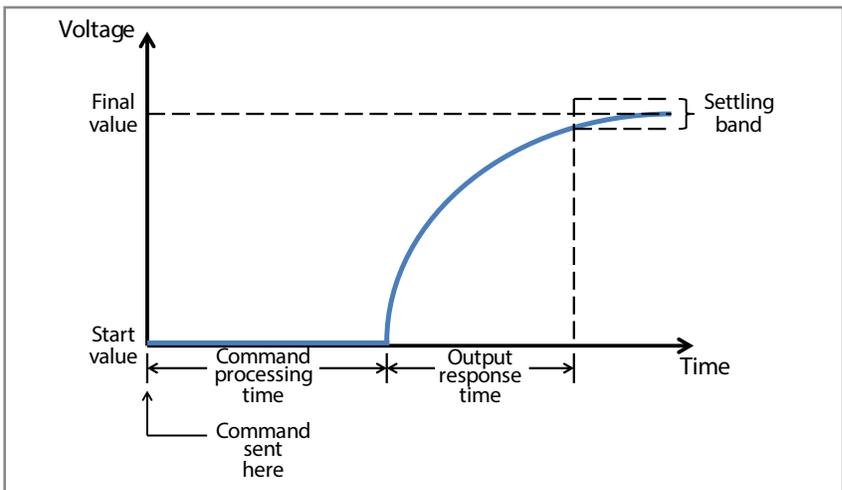


Figure 4. Power supply command processing time and output response time affect throughput.

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

Some power supplies have command processing times that are 10 ms, 50 ms, or even up to 100 ms for each command. The Keysight N6700 Series power supplies can process commands in less than 1 ms, dramatically reducing your test times. Output response time for the 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 downprogrammer helps bring the voltage from 50 V to 0 V in the same time. Keysight's N6700 Source/Measure Units can traverse from 0 V to 10 V in as little as 15  $\mu$ s. If you frequently change voltages during your test, the N6700 can save you a lot of time, significantly improving your test throughput.

## DUT protection

Most system design engineers want to protect their DUTs from damage by preventing DUT exposure to excessive voltage and excessive current. This is especially true in a design environment where there are limited numbers of devices to be tested, or when the DUT is very expensive, such as a satellite. Protecting the DUT in these situations is extremely important.

If protecting your DUT is important to you, choose a power supply with built-in protection that prevents excessive voltage and excessive current on the output. Over-voltage protection (OVP) is a feature in many power supplies that protects your DUT against excessive voltage. If the actual output voltage reaches or exceeds the OVP setting, the power supply shuts down its output, protecting the DUT from excessive voltage. Over-current protection (OCP) is a feature that uses the constant current (CC) setting. If the actual output current reaches or exceeds the constant current setting causing the power supply to go into CC mode, the power supply shuts down its output, protecting the DUT from continuous, excessive current. Refer to Figure 5 for an example of an OVP shut down: With the OVP set to 15 V, the output voltage quickly turns off when it

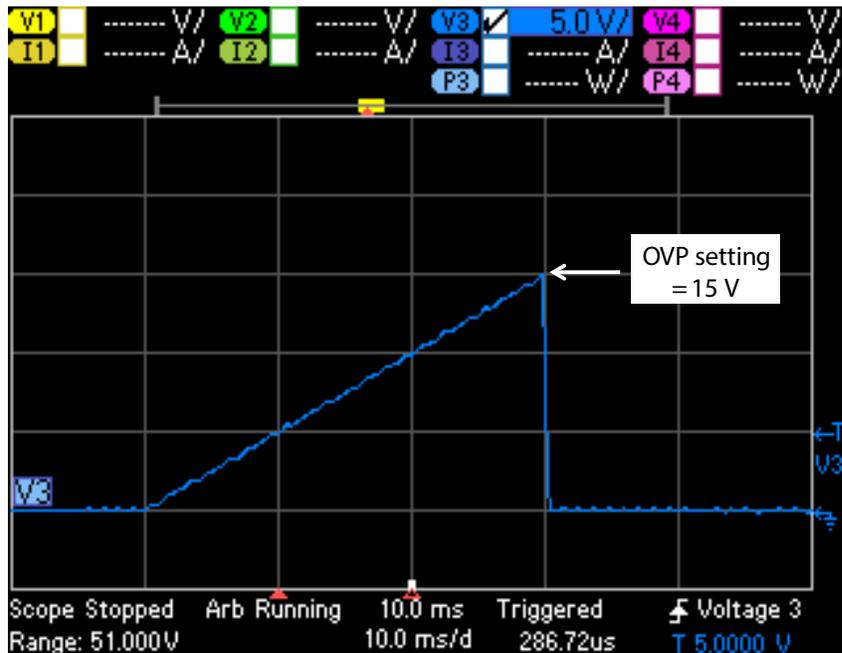


Figure 5. An over-voltage shutdown occurs when the output voltage reaches the 15 V OVP setting, protecting your DUT.

reaches the OVP setting. Over-voltage, over-current, and over-temperature protection features are standard in most Keysight power supplies. The over-temperature feature protects the power supply itself, ultimately protecting your DUT. If the power supply detects an internal temperature that exceeds a predetermined limit, it will shut down its output. The temperature may rise due to an unusually high ambient temperature, or perhaps due to a blocked or incapacitated cooling fan. Shutting down the output in response to high temperature will prevent other power supply components from failing, which could lead to a more catastrophic condition.

More advanced power supplies, such as Keysight's N6700 Series, also contain additional protection features such as a watchdog timer. This feature looks for any interface bus activity (LAN, GPIB, or USB) and if no bus activity is detected by the power supply for a time that you set, the power supply output shuts down. This feature is especially useful to protect your DUT from a computer program that stops executing and leaves the power in a state that, over time, can damage your DUT.

These advanced N6700 protection features can begin to shut down your power supply outputs in as little as 30  $\mu$ s from the time when the protection event is detected.

## Test Integrity

Trustworthy sourcing and measurements are keys to successful system deployment. Power supplies are responsible for providing accurate, stable bias power to your DUTs. Look for power supplies with fully specified accuracy to ensure your DUT will see the voltage you want. Also check the line and load regulation specifications to ensure changes on the power supply output are minimized 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 N6781A Source/Measure Unit in the N6700 power supply series has a low current measurement range that is accurate to within  $0.025\% + 8\text{nA}$ , which gives you 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  $\mu\text{V}$ , ensuring the power supply will not interfere with your sensitive measurements. Keysight's complete set of performance specifications provides you with worry-free power supply operation.

## System Uptime

Of course, to maximize system uptime, you want to choose a power supply with a long mean time between failures (MTBF). You also want to be sure there is adequate local support for the instrumentation in your system, including the power supply, to speed repairs. And pay attention to the power supply calibration method and cycle time, since 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/week) to minimize your system downtime. If an unlikely failure does occur, Keysight provides worldwide support that helps to quickly get your system running again. Worldwide support also makes it easy to calibrate your supplies on the recommended once-per-year cycle.

## Conclusion

Your power supply choice affects the assembly, performance, and longevity of your test system. Lower integration costs, faster throughput, better DUT protection, better test integrity, and longer system uptime are just some of the benefits you will realize by choosing the right power supply for your test system. To maximize those benefits and the success of your system deployment, be sure to 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 DUTs accurately and quickly, protect your DUT, and continue running for many years.

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