WHITE PAPER

How to Boost ATE Power Supply Throughput

KEYSIGHT

Introduction

The test engineer's job is not an easy one. There is constant pressure to improve system throughput. This white paper will guide you on how to increase throughput to reduce costs.

Increased throughput comes from faster programming and command processing times, built-in output sequencing, and arbitrary waveform capabilities. Faster testing speeds will enable more rigorous testing of devices, decreasing false positive and negative rates.

This white paper provides insight on three ways to improve automated test equipment (ATE) power supply throughput:

1. Conduct parallel device testing and use ATE power supplies with fast programming and command processing speeds.
2. Sequence outputs with precise built-in control to accelerate system power-up and power-down testing.
3. Use arbitrary waveforms with fast transient response times to stress test devices under test (DUTs).

As a test engineer, you face a steady stream of new verification requirements that dictate changing your test plans. In addition, there is continual pressure to reduce automated test equipment rack space to minimize costs. This white paper will help you overcome these challenges with the following supplementary sections:

1. Save rack space by using system power supplies with high power densities.
2. Use modular power supplies to adapt to different test scenarios quickly.

Increase throughput with parallel testing and fast processing speeds

Manufacturers can reduce costs by thousands of dollars by eliminating only a second of test time from their test processes. You can reduce test time in your ATE process by using a power supply with fast programming, command processing speeds, and multiple outputs.

Programming and command processing speeds

If you frequently change the input voltage to your DUT or turn the input voltage on and off regularly, you can realize significant gains in test time with the proper power supply. When you choose a power supply with an output voltage that changes quickly, you do not have to wait for the voltage to settle to proceed with your test. Four main power supply attributes directly impact test time: command processing time, output response time, output settling time, and measurement sample rate.

Command processing time

The command processing time represents the time it takes for the power supply to accept and interpret a command sent from the interface bus, such as LAN, USB, or general-purpose interface bus (GPIB). Some power supplies have command processing times of 10 ms, 50 ms, or even up to 100 ms for each command. However, high-performance power supplies can process commands in less than 1 ms to dramatically reduce your test times.

Output response time

Once the command processes and the power supply knows what to do, it must move the voltage (or current) on its output terminals. The output response time, or 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 the new programmed value. Basic power supplies can have programming speeds in the 10s or 100s of milliseconds, while a high-performance power supply can achieve less than one millisecond for up and down programming speeds.

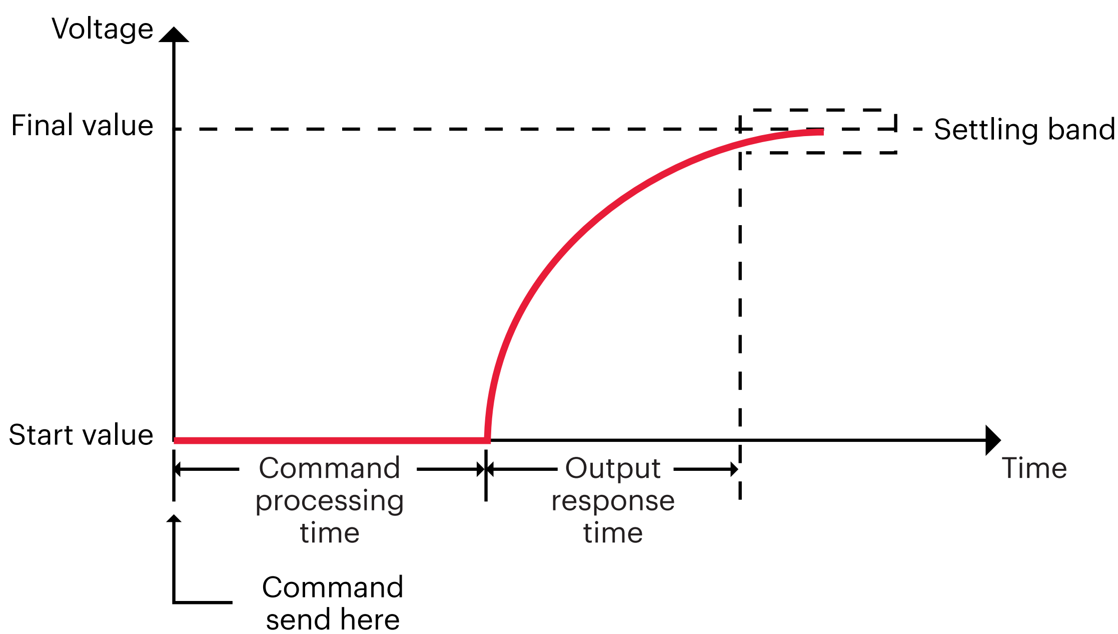

Figure 1. How command processing time and output response time of a power supply impact throughput

Output settling time or settling band

Output settling time represents the time from when the output voltage starts to shift until it settles within a specified settling band around the final value. This settling band could be 1% or even 0.1%, or sometimes within the least significant bit of the final value.

Measurement sample rate

The measurement sample rate represents how frequently a power supply can capture a measurement on the DUT. Speeding up command processing and output response time is only valuable if your power supply can quickly capture measurements at each voltage level. This is where having a fast sample rate is critical. High-performance power supplies can offer programmable sample rates at least 60 times faster than a basic power supply's fixed rate.

Additional power supply attributes will also help further reduce measurement sample rates. For example, the output voltage of a power supply using a downprogrammer moves from a higher value to a lower value more quickly than that of a power supply without one. A downprogrammer is a circuit on a power supply output that actively pulls the voltage down instead of letting it bleed down slowly by itself.

Parallel device testing

Changing from serial to parallel device testing can dramatically increase test system throughput. A substantial portion of test execution activity may involve setting conditions and making measurements using the DC power supply. Configuring the test system so it can simultaneously execute tests on multiple devices using multiple DC sources is a cost-effective way to improve test throughput significantly.

Figure 2 illustrates a sequential device test versus a parallel device test. In the sequential test, you can see that the test loops through the sequence four times — once for each of the four DUTs. By contrast, test execution for the parallel device test system only has to pass once through the sequence for all four DUTs.

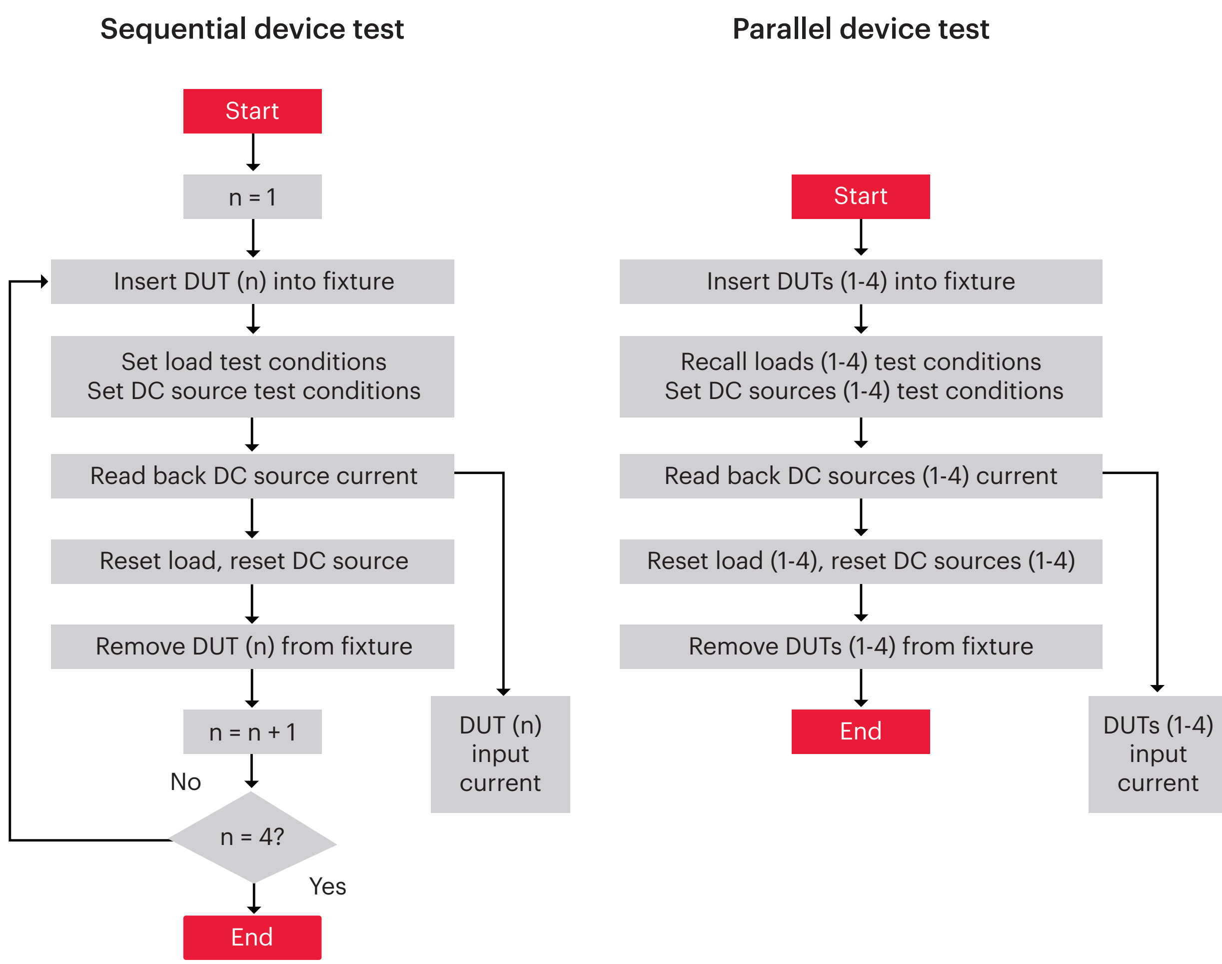

Figure 2. Sequential versus parallel execution for input current test

A parallel device system is likely to strike a balance between various tests you execute in parallel and serial and dictate where multiple system components are necessary. Using multiple power supplies for parallel testing is beneficial since powering up each DUT requires one power supply. But there are still more reasons to use parallel testing for power supplies.

Power supplies often perform most test measurements, can establish operating conditions for all your tests, support parallel program execution when designed to do so, and are relatively low-cost.

By comparison, other ATE equipment does not have this overall impact. The most effective solution is to use a single, higher performance power supply and multiplex its input to each DUT.

Sequence outputs with precise built-in control

It is often difficult, if not impossible, to sequence and ramp up or down multiple bias voltages with specified timing conditions using separate programmable system power supplies. Even most conventional multiple-output system power supplies do not adequately address this need.

For example, suppose your DUTs have multiple power supply inputs, such as satellite payloads. In this case, you need to properly sequence, on or off, each power supply at strictly repeatable times to prevent current surges and latch-up conditions. In addition, you may need to set the ramp rate of each supply to turn on or turn off at a special rate. Advanced power supplies will help you overcome these test challenges by providing a built-in sequencing capability across mainframes and adjustable slew rate control at turn-on or turn-off. These built-in capabilities provide a straightforward way to properly power on or off your DUT during a test.

Figure 3. Example of precise output turn-on sequencing using the Keysight N6700 series

Another option is to use a computer to sequence separate power supplies. However, the problem with using a computer for this application is that it does not have very regular timing. PC operating systems do not guarantee a specific level of performance. Also, you cannot control the slew rate at which the computer turns on the power supply.

Using an advanced power supply, you can test DUTs to their specified bias voltage timing during ramp-up and ramp-down with millisecond accuracy. Many standard power supplies can only support accuracy within the 100s of milliseconds. In addition, it is also possible to determine DUT sequencing and ramping limits by adjusting sequence timing and slew rates of the multiple bias voltages.

Use high-speed arbitrary waveforms to stress test DUTs

During testing, you often need to simulate power waveforms to reproduce the power environment the DUT will face in the real world. This is especially the case with DUTs operating in rugged environments that experience transient behavior from the power source, such as voltage dropouts or surges. Therefore, it is essential to select a power supply that can simulate either voltage or current transients for testing.

Various functionalities can simulate current transients. For example, consider using a one-time event generator that steps the output voltage or current up or down in response to a triggered event. In addition, arbitrary waveforms enable you to generate complex user-defined voltage or current waveforms. The illustration in Figure 4 depicts the arbitrary waveform capabilities of a high-performance power supply. The demonstration in Figure 4 shows an "interrupt" pulse that was generated into a resistive load. The interrupt pulse goes from 20 V to 2 V for 10 ms and then returns to 20 V. The resulting interrupt pulse exhibited a fall time at < 200 μs (Figure 5).

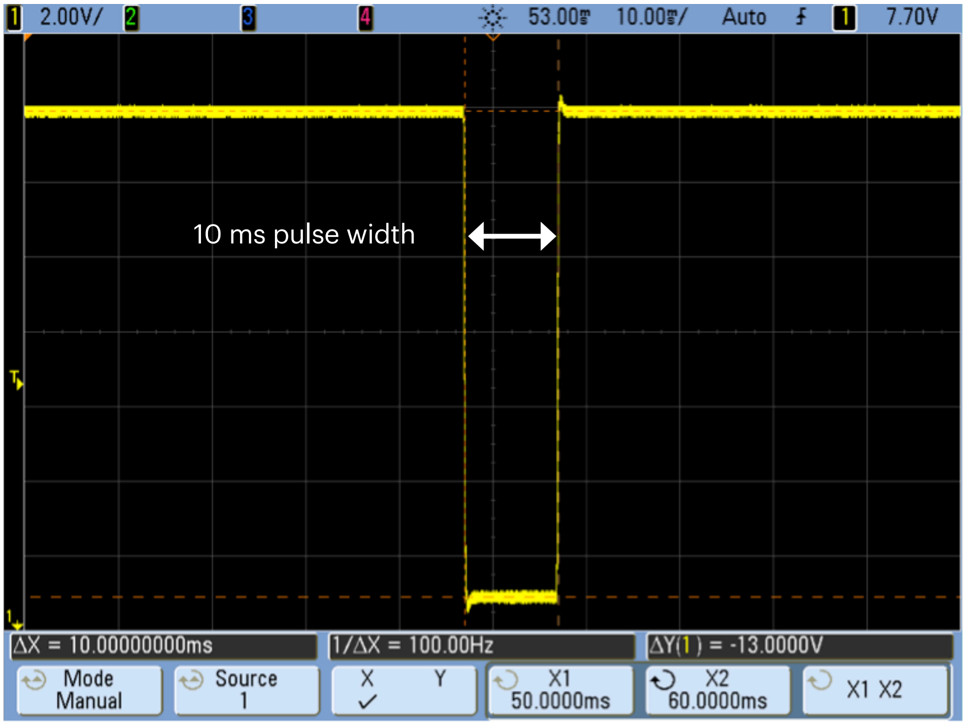

Figure 4. Voltage interrupt pulse generated by N7951A

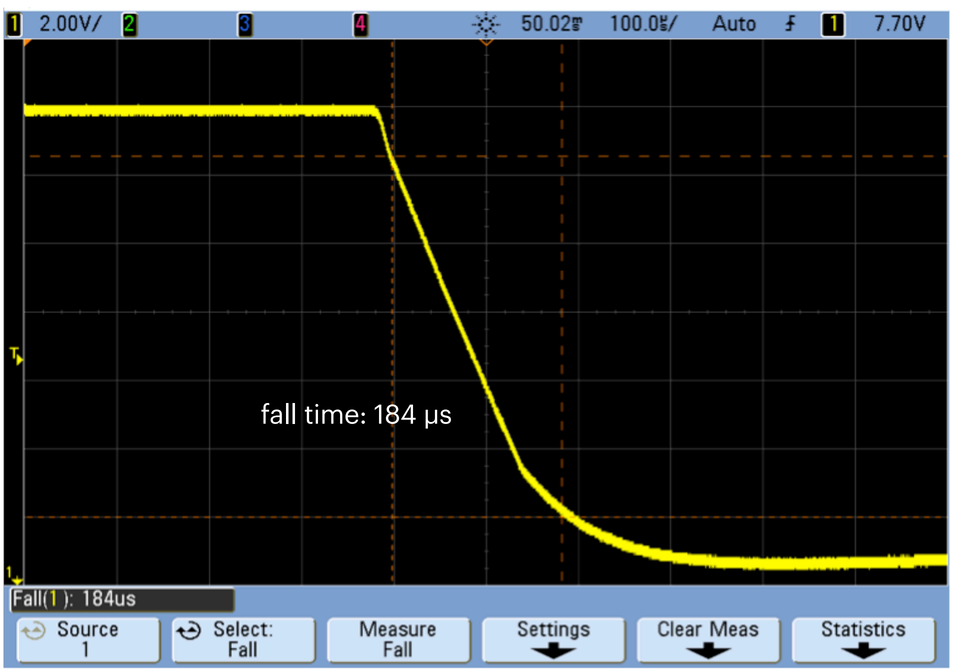

Figure 5. Interrupt pulse fall time measurement of < 200 μs

Another tactic for simulating current transients is using lists containing different current or voltage steps. Lists generate complex sequences of output changes with rapid, precise timing. You can also synchronize lists with internal or external signals. Each step in a list has a unique dwell time associated with it. The dwell time specifies the time in seconds that the list will remain at a specific action before moving on to the next step. You can program lists for trigger-pacing; each list advances one step for each trigger it receives.

When selecting a power supply for its transient response capabilities, it is crucial to consider its timing capabilities. These timing capabilities include rise time, fall time, and dwell time. High-performance power supplies like the Keysight Advanced Power System N6900 and N7900 Series power supplies can generate timings of less than one millisecond.

Learn More

- Keysight ATE power supply product page
- Tips for Integrating and Using an ATE System Power Supply
- Optimize Power Source Integrity Under Large Load Transients
- Power Supply Handbook

Supplementary sections

Save rack space with high power density

Rack space is costly. Consequently, smaller power supplies that reduce rack space can save you money. Typically, many DC power supplies in the medium power range (500 W to 2 kW) come packaged in 2U-high (2-EIA rack units) and even 3U, full rack width chassis representing a space challenge.

Today, power supply manufacturers pack 500 W, 1000 W, and even 1500 W power supplies into 1U-high packages – just 1.75 inches (44.45 mm) of vertical space. The use of modern switching power supply design techniques makes this possible. The low profile is critical in burn-in applications where many, sometimes dozens of power supplies may provide power to single or multiple test points over extended periods to weed out early failures.

Figure 6. Keysight 7953A Advanced Power System - Dynamic DC Power Supply, 1000 W, 1U.

If you are responsible for selecting one of these compact supplies, ensure it is a "true 1U" design with no air vents on the top or bottom. Air vents on the top or bottom of the unit make it impossible to stack these slim products directly on top of each other. Blocking air vents can compromise product reliability by raising temperatures inside the box, contributing to premature failure. With no air vents on the top or bottom of the unit, you can stack these power supplies directly on top of other instruments.

In addition, consider whether the power supply outputs can be configured in parallel or series. This configuration capability enables higher output current or voltage without a higher power supply.

The benefits of modular power supplies

ATE tests can vary in terms of the power required and accuracy. Purchasing power supplies to meet all requirements can be costly. In addition, test criteria can change quickly, and scrambling to buy new power supplies is burdensome.

Using modular power supplies is a solution to both challenges. Modular supplies enable you to easily mix and match power and performance levels with a signal mainframe to optimize your investment. Modular power supplies can have four or more slots for modules to provide you the flexibility you need; today's complex ATE systems often require multiple power sources or electronic loads.

When selecting a modular power supply system, consider the following questions:

1. Are both basic and high-performance modules available? Test requirements can vary greatly; if, for example, a test only requires basic performance, there is no reason to pay for high accuracy.
2. Are source measure unit (SMU) modules offered for applications such as battery run-down testing?
3. Are electronic load modules available? Many tests require both a power source and an electronic load.

Increasing asset use is another benefit of a modular power supply system. Textron Systems, a Keysight customer, purchased extra power modules as excess inventory and distributed them among various systems. The purchase resulted in lowering Textron's overall investment.

Figure 7. N6700 series modular power supply

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.