

DC Power Tests: Many Instruments Do the Job

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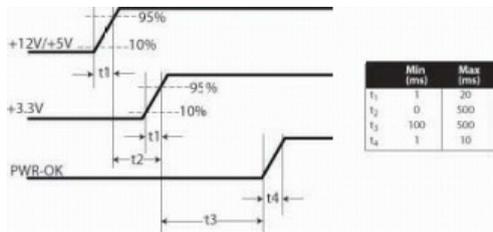


Figure 1. A DC power supply's turn-ON sequence for three sources requires careful timing and attention to the rise time of each voltage.

For simple static-DC source-and-measure tests, familiar instruments such as power supplies, scopes, voltmeters and function generators work well. Dynamic DC-bias tests, though, involve sequencing and sourcing voltage and current, as well as making measurements. These bias tests require complex interactions among traditional instruments, and they can create setup and configuration challenges. Design engineers must test their prototypes and devices on tight schedules. But haste often brings waste and during hurried product development and testing, R&D engineers might damage scarce, complex or expensive circuits. This concern can cause anxiety when tests involve applying DC power to a device under test (DUT). Furthermore, pressure on R&D engineers increases when they test devices such as printed circuit boards and ICs that require multiple input voltages. Apply the improper voltages or apply voltages out of sequence, and one-off development components and boards can die.

DC-sourcing and measurement tasks can involve simultaneously connecting and controlling several instruments. As the number of instruments increases, so does the risk of error. Thus, R&D engineers may choose to automate tests that prove too complex to do manually. Although automation might reduce human error, writing and debugging test programs usually adds more work to already overloaded schedules.

The Conventional Bench Instrument Approach

The following explanations describe how R&D engineers might address DC power tests with conventional bench instruments:

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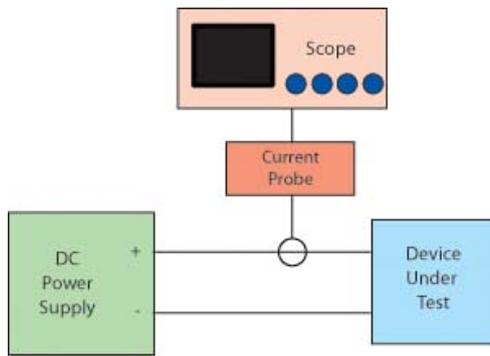


Figure 2. Typical scope measurements of current versus time require a current probe. But these probes can cost much more than voltage probes, and they may not provide the accuracy a test requires.

1. Bias a device with a static DC voltage and measure current. Any power supply with the proper voltage and current ratings can provide a static DC voltage. Most supplies have built-in meters to measure current and voltage. If engineers require better measurement accuracy, they can use a DMM. Most DMMs, however, cannot measure more than 5A to 10A. When tests demand that voltages or currents vary over time, power supplies and DMMs fall short.
2. Establish turn-ON and turn-OFF sequences. To operate properly, many devices require several DC bias voltages. A PC motherboard, for example, could require as many as nine voltages. Furthermore, devices often need a controlled turn-ON that applies voltages in a preset sequence. In some semiconductors, a 3.3V source must apply power before +12V and -12V supplies come on line. Apply power in the wrong sequence, and damaging currents will flow through the device's substrate.

It is nearly impossible to manually turn on several power supplies in a carefully timed sequence. So the simple task of turning on the power supplies in a carefully timed order diverts time and energy into writing and debugging programs for computer-controlled power sources (Figure 1).

3. Measure and display current versus time. When dynamic events occur within a device under test, engineers often need to "visualize" the flow of current versus time. For example, when a GSM handset draws current in pulses from its battery during a transmission, engineers want to observe the relationship of current and time. Although an oscilloscope easily measures and displays voltage versus time, it cannot directly measure current. Current measurements with a scope require a current probe, which can cost a great deal and may provide inaccurate results. In addition, current probes add complexity to a measurement setup (Figure 2).

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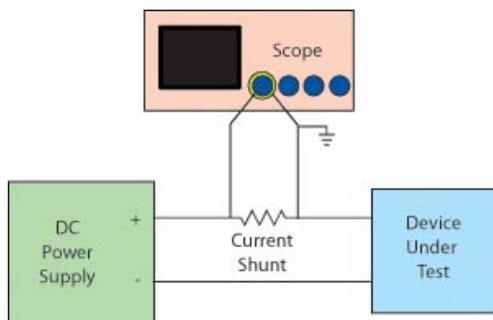


Figure 3. A current shunt measures voltage across a resistance to determine current flow. Most scopes, though, will ground one side of the shunt.

As an alternate, engineers often use a current shunt or a current-sense resistor. Most scope inputs are ground-referenced, so when the scope connects across the shunt, one side of the shunt gets grounded. Depending upon the powered device, this ground connection could cause a problem. Selecting the proper resistance value presents another challenge. A high resistance will produce a large voltage drop, so the powered device will not receive the full supply voltage. Reducing the input voltage to 1.2V DC/DC cell-phone converter, for example, by 50 mV or 100 mV will cause improper phone operation. A low resistance decreases the voltage drop to the powered device, but the shunt may produce such a small voltage drop that a scope cannot accurately measure it (Figure 3).

4. Generate DC-bias supply transients and disturbances. Engineers often need to know what happens to a PC motherboard if the 3.3V line drops to 2V for 50 ms, or what happens when a driver starts a vehicle and the onboard navigation system experiences a drop of supply voltage from 12V to 8V and then an 18V surge. These types of tests require a modulated DC source. So, engineers would have to build a complete test system that would include a PC, an arbitrary function generator, and a DC power supply that accepts an analog modulation input, plus a scope to measure transient behavior (Figure 4).

DC Power Analyzers Provide Immediate Insights

Because power tests have gotten so complex, instrument manufacturers now offer more capable DC power supplies that include enhanced programming capabilities. A new type of instrument -- a DC power analyzer -- combines four power supplies, a voltmeter/ammeter, a digital scope, an arbitrary waveform generator and a data logger in one instrument (Figure 5). This type of analyzer gives R&D engineers immediate insights into a device's power consumption and responses to power changes without the need to assemble, program and calibrate separate instruments.

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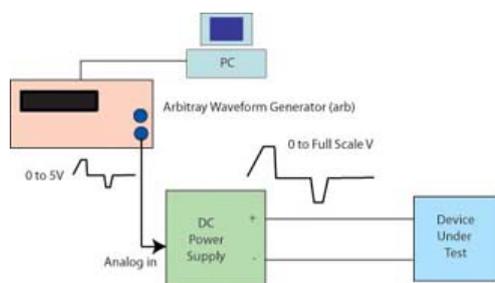


Figure 4. Engineers can use an arbitrary waveform generator (AWG) and a DC power supply to create a transient. The DC supply serves as a power amplifier for the AWG's small signal. A PC can calculate the waveform data and download it to the AWG.

The summaries below illustrate the utility of this type of instrument for DC power analysis as described in the four cases above:

1. Like any other DC power source, a DC power analyzer provides a DC voltage and current. But if you need only a static DC bias, your trusty bench power supply will do the job -- a DC power analyzer would be overkill
2. The DC Power Analyzer shown in Figure 5 can sequence its four DC power supplies based on delays of from one to 1,000 msec with a one-msec resolution. If a test requires more than four sequenced power sources, engineers can synchronize multiple DC power analyzers. Power-source sequencing requires no external PC-based program.
3. The analyzer's scope function can directly measure current and display current values against time for each of the built-in supplies. This type of measurement, performed directly at each power supply, requires no current probe or external shunt resistor.



Figure 5. This DC Power

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Analyzer (N6705A) from Agilent Technologies provides four internal and independent supplies packaged together with the instrument functions needed to perform tests and make measurements.

4. The built-in arbitrary waveform generator has only one job -- to modulate the DC power supplies. Users can program as many as 512 steps or use built-in functions such as sine, staircase and pulse. So, engineers can simulate realistic power disturbances. Each supply can operate with its own waveform.

In many cases, bench instruments suffice for basic power tests performed on prototypes and breadboarded circuits. But, as engineers design ever more complex products that consumers demand, the need for sophisticated yet easy-to-set-up tests will grow. Tools that assist engineers will ease their testing burdens and let them concentrate on improving designs rather than trying to get instruments to work in concert.

Bob Zollo [1] started at Agilent Technologies (Hewlett-Packard) in 1984. During his 23 years with the company, he has been part of Agilent's marketing organization for power supplies, electronic loads, data acquisition equipment and test systems. Bob has also managed Agilent's power supply test systems business, wireless power business, and battery test systems business. He holds a degree in electrical engineering from Stevens Institute of Technology, Hoboken, NJ. For more information, contact Agilent Technologies, 5301 Stevens Creek Blvd., Santa Clara, CA 95051; (877) 424-4536; www.agilent.com [2]

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