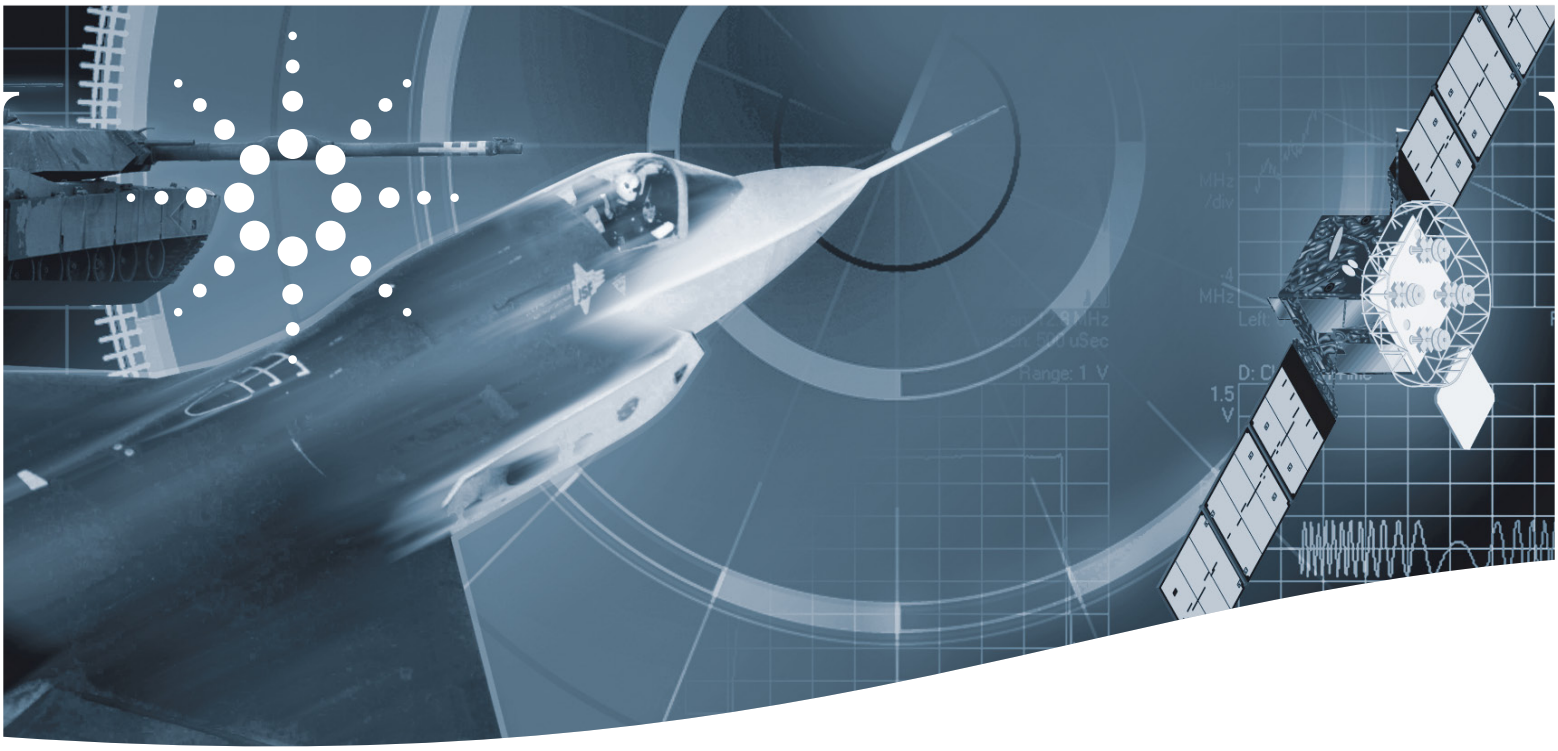

Simulating Power Supply Transients and Noise in the Development and Validation of Satellite and Defense Systems

Application Note

On the lab bench, a typical power supply is often viewed as "a battery with a knob" that provides power to a system or subsystem under development. However, fully exploring, assessing and troubleshooting the behavior of the assemblies used in a satellite or defense system will benefit from a more advanced instrument that can emulate a variety of potential electrical disturbances.

The Agilent N6705 DC power analyzer is equipped to simulate the transients and noise that can crop up on power supply lines in an aircraft, a ship, a ground vehicle or a satellite. Examples of transients include those that may be produced by engine startup, power source switchover, load changes, lightning strikes, electronic warfare (EW) impulses, solar flares, and high energy particles. Examples of unwanted noise include AC line ripple (e.g., 400 Hz) and spurious coupling from electromechanical devices.

This application note describes the potential problems, outlines the potential shortcomings of typical solutions, sketches a proposed solution, and presents example results.

Problems: Transients and noise

When carried on the power supply lines, transients and noise can induce unexpected and unwanted behavior in a system or subsystem. In this note we'll use a distinct definition of each:

- **Transient:** A power supply transient is an unintended variation in voltage or current. It is a one-time, non-periodic signal or event. These are often called surges, spikes, dropouts or interrupts.

- **Noise:** Power supply noise is the modulation of one or more unwanted signals onto the DC level. It is typically an on-going, periodic signal. This is often called ripple.

Transients may come from predictable and unpredictable sources. One example of a predictable source is a sudden change in load impedance (Z_{load}), as in when a high-power system is either turned on (Z_{load} suddenly decreases) or off (Z_{load} suddenly increases). Another example is the sharp, dynamic variations that occur in devices and systems that emit pulse-based signals. Transients also occur when, for example, an aircraft switches over from ground-based power to engine-driven power.

Unpredictable sources include natural events such as lightning strikes and solar flares. Man-made sources include the startup of electromechanical devices such as motors and generators, or transmissions from EW systems.

Noise is typically caused by either internal or external sources. For devices that use AC power, inadequate filtering may allow the line frequency at 50, 60 or 400 Hz to be coupled onto the DC lines.

Problems: Typical DC power solutions

In a typical situation, the simulation of power supply transients and noise requires multiple instruments: one or more DC power supplies, a digital multimeter, an oscilloscope, and an arbitrary waveform generator (AWG). Also, it often requires a PC equipped with waveform-creation software that can download files to the AWG.

Although this approach is highly flexible, it suffers from complexity in multiple dimensions: connecting the instruments to each other and to the DUT, setting up every instrument, creating the waveform in the PC and transferring it to the AWG, and so on. If there are problems with the measurements, it can be difficult and time consuming to pinpoint the causes within either the test system or the DUT.

The N6700 Series modules

The N6700 Series includes four types of DC power modules: basic, high-performance, precision and source/measure units (SMU). Basic sources for the N6705 include 50, 100 and 300 W modules at up to 150 V and up to 20 A. The N6750 high-performance sources include 50, 100, 300 and 500 W models at up to 60 V and up to 50 A. The N6760 precision sources include 50, 100, 300 and 500 W units at up to 60 V and up to 50 A. The N6780 source/measure modules provide 20 W capacity at up to 20 V and up to 3 A.

Proposed solution

The N6705 DC power analyzer was designed to simplify this type of complex test scenario. The core of the instrument is a four-slot, 600-W DC power supply that is compatible with all the Agilent N6700 Series power modules (see sidebar).

Built-in digitizers support voltage and current measurements without requiring current shunts, current probes or current-sense resistors. The included oscilloscope capability displays digitized data on the large color display.

The AWG capability enables simulation of transients and noise within the N6705. Waveform creation is simplified with an easy-to-use interface, and signal quality is enhanced by the wide waveform bandwidth.

With the N6705, waveforms can be generated by specifying just a few points because it uses run-length encoding: each point of the waveform is defined by a voltage setting and a dwell time. For example, it takes just three points to define a pulse. Table 1 presents the complete list of waveform choices in the N6705. Each waveform can be set to repeat continuously or for a specified number of times. User-defined waveforms can be entered through the front panel or downloaded into the instrument as a comma-separated variable (CSV) file.[1]

Waveform	Number of Points Per Waveform
Sine	100 points
Step	2 points
Ramp	100 points
Pulse	3 points
Stepped ramp (staircase)	Determined by number of steps
Exponential	100 points
User-defined voltage waveform (output behaves like a voltage source)	Up to 512 points with point-by-point adjustable dwell
User-defined current waveform (output behaves like a current source)	Up to 64,000 points with programmable dwell (same duration for all points)

A companion application, the Agilent 14585A control and analysis software, enables control of up to four N6705 mainframes from a single PC screen. Through a graphical user interface, the software provides improved data visualization and management. It also supports creation of complex arbitrary waveforms through capture and download of real-world signals for playback of up to 16 signals (requires four N6705 DC power analyzers). For more information, please see www.agilent.com/find/14585.

[1] *Files can be downloaded through a remote I/O connection or a USB memory device.*

Results: Generating a transient waveform

As an example, you can use the N6705 to simulate a power interrupt as defined by RTCA DO-160F, which is a standard for the testing of electronic equipment used in aircraft. Here are the key parameters:

- Nominal voltage = 28 V
- Minimum voltage = 4.2 V
- Ramp-down time (T_f) = 17 ms
- Dwell time (T_i) = 8 ms
- Ramp up time (T_r) = 4 ms

These parameters can be entered through the instrument interface and the built-in "trapezoid waveform" function, as shown in Figure 1. The N6705 was used to capture the resulting waveform shown in Figure 2.

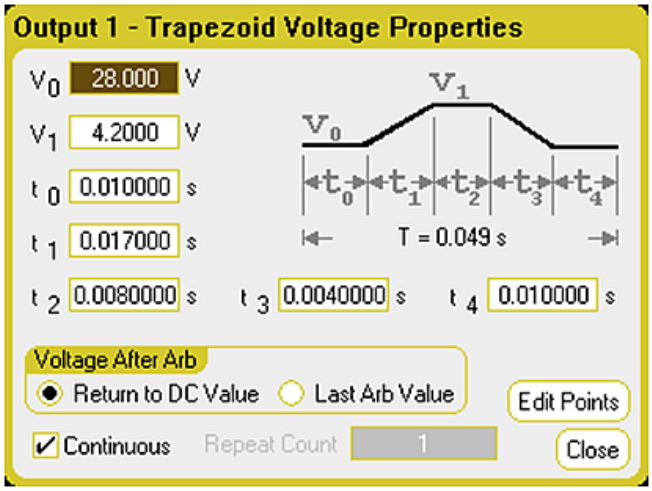

Figure 1. The front-panel interface facilitates creation of various waveform types

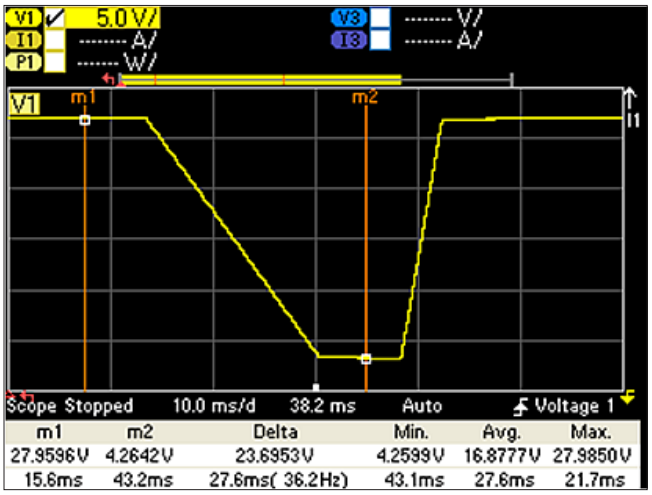

Figure 2. Measurement markers show the amplitude levels of the interrupt waveform

Highly complex transient signals can also be created with the AWG function. For example, an oscilloscope could be used to capture a power transient generated during engine startup. The captured, real-world waveform can then be saved as a CSV file in a USB memory device and transferred to the N6705 for playback as a test signal.

Results: Generating a noise waveform

AC line ripple riding on a DC level is easy to simulate. As shown in Figure 3, an example waveform was defined through the front panel of the N6705. The DC-plus-ripple waveform shown in Figure 4 was captured and characterized with the N6705.

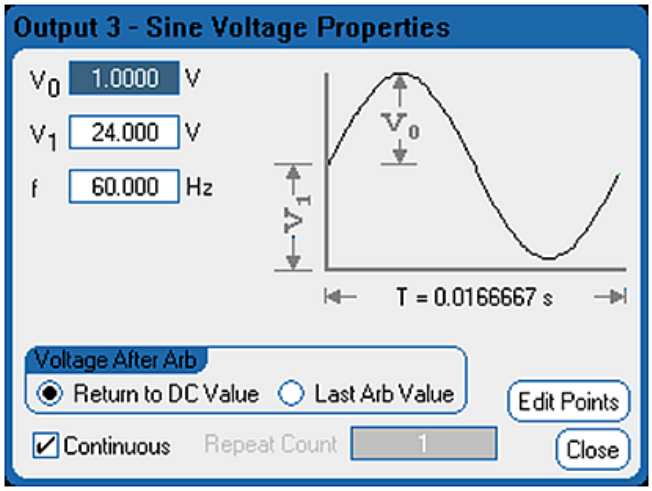

Figure 3. As defined here, a 1 V, 400 Hz sine wave rides on a 24 V DC signal

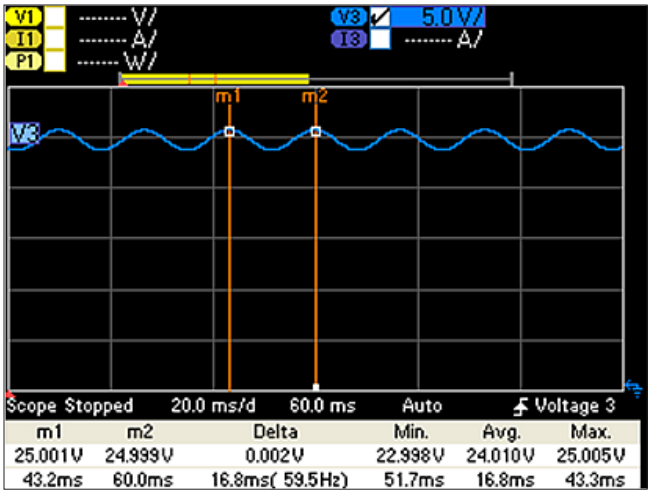

Figure 4. Delta markers show the amplitude and period of the AC line noise

Summary

The N6705 is a single, multi-function instrument that makes it easy to simulate a wide range of transients and noise signals, from simple to complex. A variety of simple signals can be quickly defined through the front-panel interface, and highly complex arbitrary waveforms can be loaded as CSV files—without writing any code. These capabilities simplify the process of thoroughly testing, exercising and verifying the power performance of assemblies and subassemblies used in satellite, aerospace and defense systems.

Related literature

- Agilent DC Power Analyzer technical overview, publication 5989-6319EN
- Agilent N6700 Modular Power System Family brochure, publication 5990-9550EN
- Agilent 14585A Control and Analysis Software quick start guide, available from www.agilent.com

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Revised: January 6, 2012

Product specifications and descriptions in this document subject to change without notice.

Published in USA, June 19, 2012
5991-0655EN

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