Testing Circuit Board Power Distribution Using Real World Distortions

The role of a pulse function arbitrary noise generator in stress test applications

Application Note

Situation Analysis

In this digital era, embedded design engineers are using integrated circuits (ICs) to solve electronic challenges. Populated on printed circuit boards (PCBs), the ICs typically receive power from a central supply. With each IC used, its impact on electrical power must be considered. Most ICs draw current only when changing electrical states and this irregular power use introduces distortions to the power supply network.

Such signal distortions potentially interfere with other circuits and raise the electrical noise level. This leads to reduced signal-to-noise ratios and affects the signal integrity on the outputs of the ICs. In a worst case scenario, noise can negatively affect the operation of the IC. Fluctuating voltage levels can interfere with correct IC operation as well.

To limit the effect of these irregularities, hardware engineers use an array of protective circuits. Common methods to safeguard ICs include using a decoupling capacitor to counter voltage fluctuation, and incorporating an inductor to limit the noise level. Unfortunately, every compensation method used to minimize power distortions at the circuit has its limitations.

For example, consider the use of a decoupling capacitor. Material imperfections within the capacitor lead to equivalent serial resistance. Capacitor and packaging lead to equivalent serial inductance. These parasitic effects negatively influence the capacitor's technical characteristics. At high frequencies the capacitor behaves more like an inductor or resistor—defeating its original purpose in the circuitry.

Solution Configuration

Testing components and compensation circuits under real-world conditions is essential. It is this process that allows engineers to assess the PCB's design and power consumption. Testing also provides engineers with the insight necessary to enhance the device's overall performance.

Figure 1 illustrates an effective method for simulating real-world conditions during the design stages. The components of this solution are summarized in Table 1.

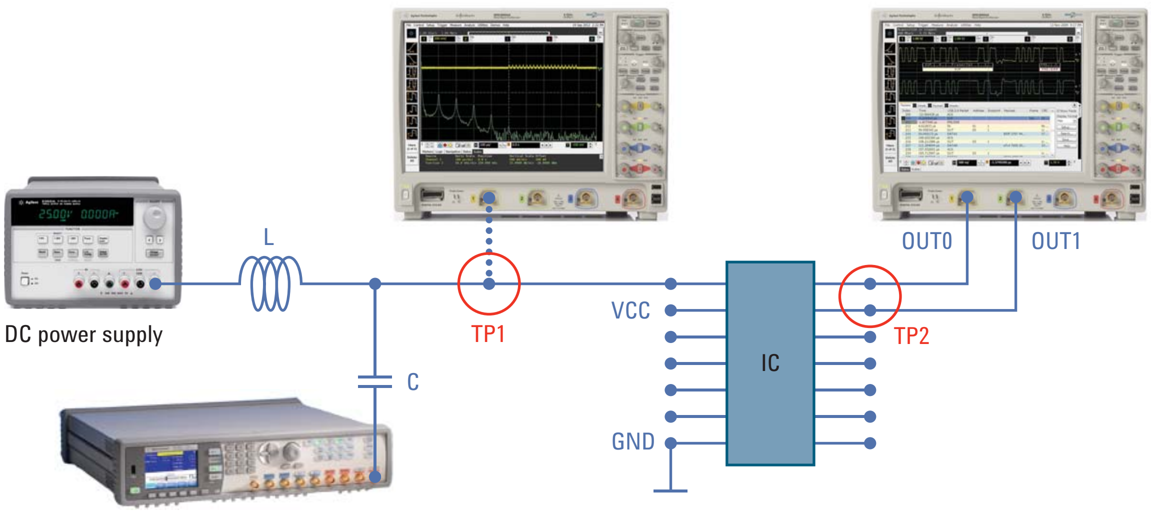

Figure 1. Test setup for simulating real-world conditions

Table 1. Test equipment to simulate real-world conditions

Device Type	Agilent Solution
DC power supply	E3631A 80W triple output power supply, 6 V, 5 A, and ±25 V, 1 A or similar
Generator	81160A or 81150A pulse function arbitrary noise generator
Oscilloscope	9000 Series oscilloscope

In the test configuration shown in Figure 1, an Agilent E3631A DC power supply simulates the voltage source of the final electronic design. The Agilent 81160A arbitrary noise generator is used to simulate the distortions. Output from the power supply and noise generator is combined by creating an electrical network consisting of an inductance and a capacitor. The inductance, L, prevents the RF portion of the signal from entering the DC power supply. The capacitor, C, helps prevent DC loading of the signal generator (the 81160A). This electrical network is often referenced in technical literature as a bias tee because it forms a 'T' and the "DC biasing" of the test sample.

Obtaining Insights

One of the features of an Agilent 9000 Series oscilloscope is its ability to calibrate the test configuration. In other words, the oscilloscope confirms that the correct DC voltage and distortion is applied to the input of the device under test (DUT). (Refer to connection at Test Point 1 (TP1) in Figure 1.)

At Test Point 2 (TP2) in Figure 1, the same 9000 Series oscilloscope is used to analyze IC output signals. Once the distortions added by the 81160A become too high to compensate for the IC will generate errors either on the physical layer or on the protocol layer. Both types of errors can be detected and analyzed with the oscilloscope.

To simulate real-world power distortion, the 81160A is capable of generating fast pulses with rise/fall times of up to 1 ns, random noise, and extensive arbitrary waveforms. Another key feature of the generator is its ability to combine different signal types internally, allowing simultaneous superposition of white Gaussian noise and intermittent glitches in the power distribution network. This Channel Add capability eliminates the need for external wiring while retaining the flexibility to create complex waveforms. The selectable crest factor of the noise generator, and the ability to repeat the noise pattern only after 20[1] days, ensures the noise is close to random and not deterministic (capabilities unavailable in other instruments of this type). Figure 2 shows an example of the Channel Add and noise generation capabilities. In the case, the 81160A generates white Gaussian noise on Channels 1 and 20 and Gaussian pulses on Channel 2. Adding them internally and superposing them with the DC signal of the power supply results in the yellow trace, which is measured in time domain. The green trace shown in Figure 2 is its representation in FFT-mode.

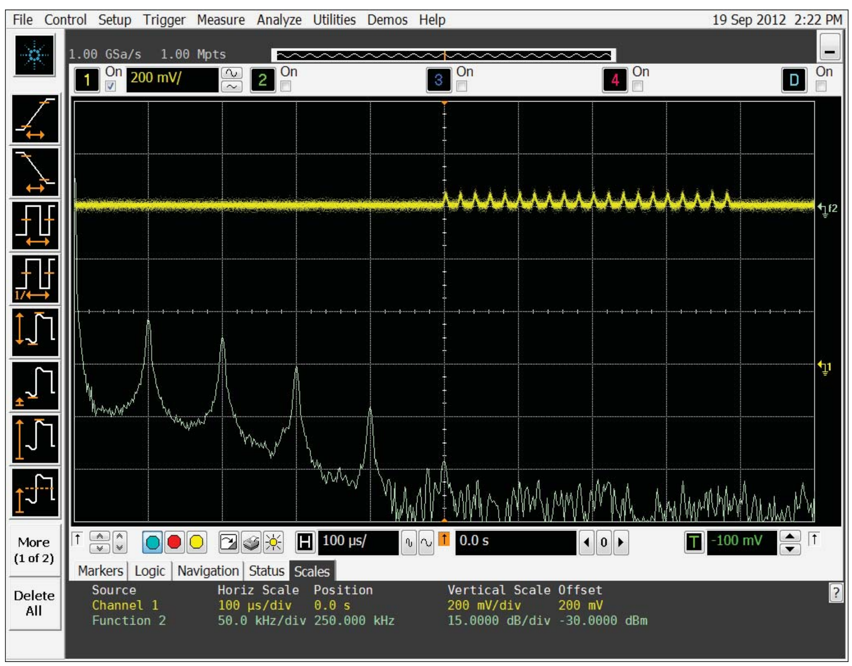

Figure 2. Stress signal example generated with the Channel Add capability of the 81160A in time domain (yellow) and in FFT-mode (green)

All of this functionality allows engineers to gain insight on the output performance of the DUT.

1. 81150A has a noise pattern repetition rate of 26 days.

Conclusion

Engineers face numerous challenges when developing new electronic devices. The increased density of ICs on PCBs increases the importance of evaluating the performance of the DC power supply, and the power supplies' impact on other components in the design. To properly evaluate designs, engineers need test configurations that emulate real-world conditions. The capabilities of each element of the test solution play a key role in providing engineers with the insights to their designs that are necessary to minimize distortions and maximize output signal integrity.

Related Literature

Publication title	Pub number
Agilent 81150A and 81160A Pulse Function Arbitrary Noise Generators, Data Sheet	5989-6433EN
Agilent 81150A and 81160A Pulse Function Arbitrary Noise Generators, Application Note	5989-7860EN
Agilent Technologies Infiniium 9000 Series Oscilloscopes, Data Sheet	5990-3746EN
Agilent Power Products, Selection Guide	5989-8853EN

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