Exclusive Technology Feature

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Troubleshooting EMI: Use Versatile Instrument And Preamp To Search For Embedded Noise

by Steve Sandler, Picotest, Phoenix, Ariz.

Nearly every electronic product is required to conform to electromagnetic compatibility, or EMC requirements. These requirements relate to a product's tendency to produce or or be susceptible to electromagnetic interference (EMI), also known as radio frequency interference (RFI.) You may see any of these three terms (EMC, EMI, or RFI) used in connection with standards governing the operation of electronic equipment.

A number of different EMC standards have been developed to address the needs of different applications. For example, there's MIL-STD-461 for military products, DO-160 for aircraft, EN 61000 and CISPR standards for European approval as well as CE, VDE and FCC standards, just to name a few. Each of these standards contains sub-requirements defining the limits for conducted and radiated emissions from the product as well as the products susceptibility to radiated and conducted signals.

Most engineers do not have convenient access to the equipment necessary for EMC testing. Certified test labs, while readily available, and necessary for conformance testing, are a very expensive solution for troubleshooting EMC issues that ought to be addressed during product development. Complicating the EMC issues a bit further, all of the standards require that the certification testing be performed on a production unit, built in accordance with the production drawings. Any changes to the design after the certification testing is completed can require retesting of the product. The cost of testing and retesting can become quite expensive.

The environment in which the EMC conformance-style testing is performed is very well controlled. Testing takes place inside a screen room, eliminating all signals other than those produced by the product being tested or the signals that are introduced into the screen room for the purpose of susceptibility testing. Additionally, the antennas are calibrated, located in a particular position (generally reflecting far-field performance) and measured using an EMI receiver. The EMI receiver looks and acts very much like a spectrum analyzer; however an EMI receiver has many characteristics specific to EMI testing.

Despite these details and complications, there are tools and methods available that can help to ensure a successful design, while minimizing program cost. The tools required may cost less than a trip or two to a certified test lab and will fit on the average lab bench, making the testing very convenient as well.

A few disclaimers are necessary before we actually start troubleshooting. First, we will be using near-field handheld probes to identify the EMC sources in our product being tested. The result of near-field test may not correlate with far-field measurements made in a test lab. However, this is not an issue at this stage of product development as we have several simple goals:

- Locate the significant conducted and radiated signal sources.
- Identify key characteristic that we can use as markers in the final certification testing.
- Consider possible EMC reduction techniques for each signal source, so that you will be prepared to implement fixes as necessary.
- Wherever possible, provide implementation schemes for the predefined fixes.

The equipment we will use for our EMI troubleshooting demo includes the LeCroy Waverunner 610Zi oscilloscope, which includes a 4-channel oscilloscope, a logic analyzer and a wideband spectrum analyzer. We will also use a Picotest J2180A 0.1-Hz-100-MHz low-noise 20-dB preamp (with a J2170A power supply), a J2130A dc bias injector for dc blocking and an Electro-Metrics near-field probe kit. The test setup in Fig. 1 shows the smallest near field H probe, the J2180A preamp, the J2130A dc bias injector, and the device under test (VRTS02).

Before describing this test set-up in further detail, a few words about the choice of instruments for this EMI troubleshooting demo are in order. In particular, why use the Waverunner spectrum analyzer and the Picotest pre-amp?

If designers have a standalone spectrum analyzer (SA), they may wish to use it to perform EMI troubleshooting, as it may offer a lower noise floor and additional features such as those specifically geared to EMI testing. However, standalone SAs tend to be big and bulky. Moreover, most engineers don't have the bench space or budget for a dedicated SA. On the other hand, the LeCroy Waverunner 610Zi is a reasonably priced, multi-purpose instrument, so its usefulness goes beyond the tests described here.

As for the J2180A pre-amp, it adds sensitivity to the measurement, while improving the effective noise floor by 20 dB. The preamp's high-impedance input makes it compatible with scope-probes (good for probing power supplies), yet its 50-ohm output allows it to connect directly to an SA. This pre-amp is relatively inexpensive and can be used with many other test instruments. If you can find a pre-amp with similar characteristics to the J2180A, you may use it for EMI troubleshooting. However, we found the options are very limited.

The near-field probe kit includes both E-field probes for measuring voltage induced signal and H-field probes for measuring current-induced signals. At these close distances, the signals will generally show up with either E- or H-field probes. The kit also includes different sizes of probes. A larger probe offers greater sensitivity and lower selectivity. A smaller probe allows more precise location of the noise source, but often requires additional gain to recover sensitivity. The J2180A preamplifier is used for this purpose.

The dc input power for our device being tested is provided by the oscilloscope via USB cable. The device under test in this demo is a Picotest VRTS02 voltage regulator test standard. Still images of the measurements taken in this demo are shown below in Figs. 2 through 4. Fig. 2 shows harmonics of the local Colpitts oscillator. Fig. 3 shows a point-of-load (POL) regulator operating at 2.8 MHz, while Fig. 4 shows some of the harmonics of the 10-MHz clock.

Now, to begin viewing the EMI troubleshooting demo, [click here](#).

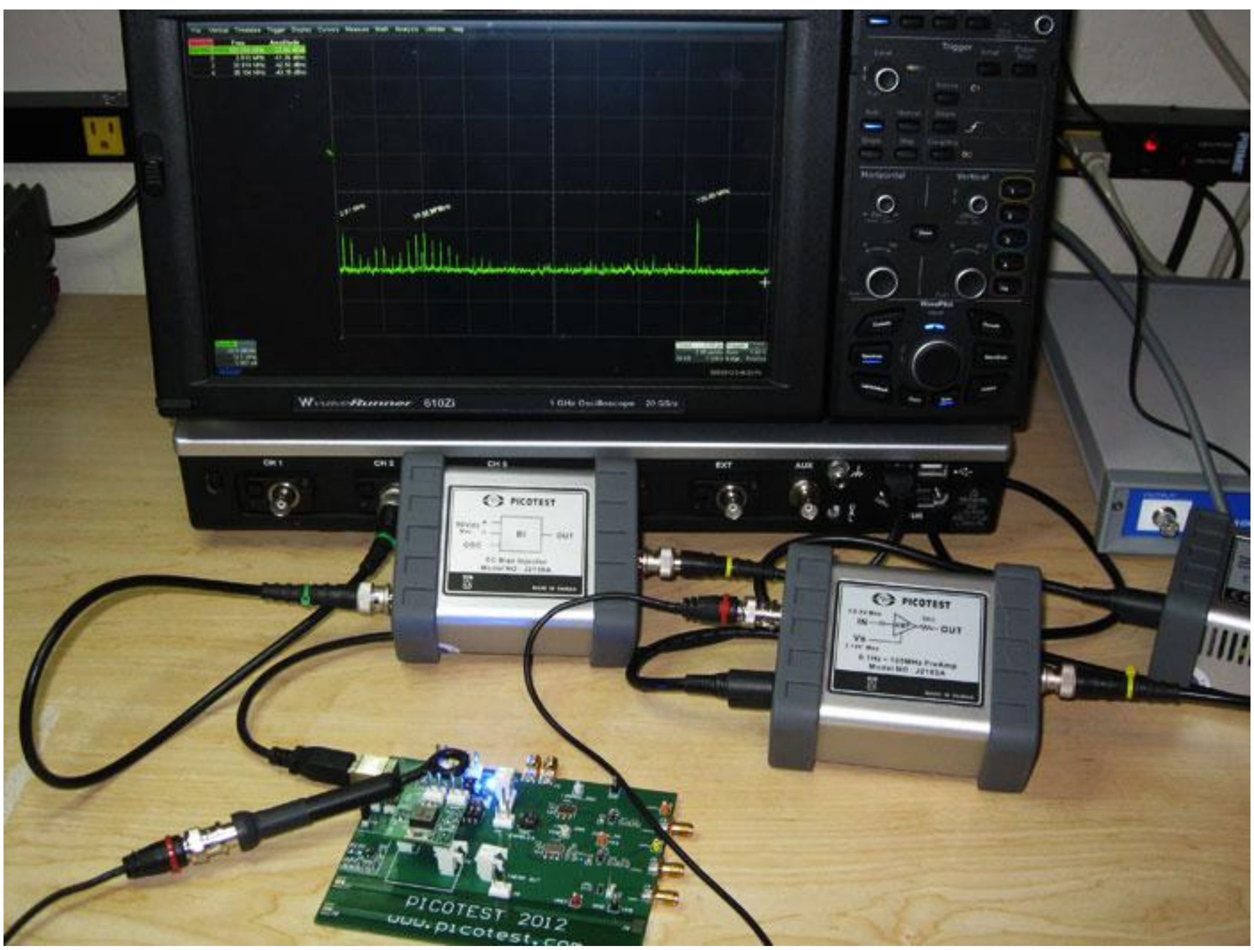

Fig. 1. Test set-up for EMI troubleshooting demonstrated in the video.

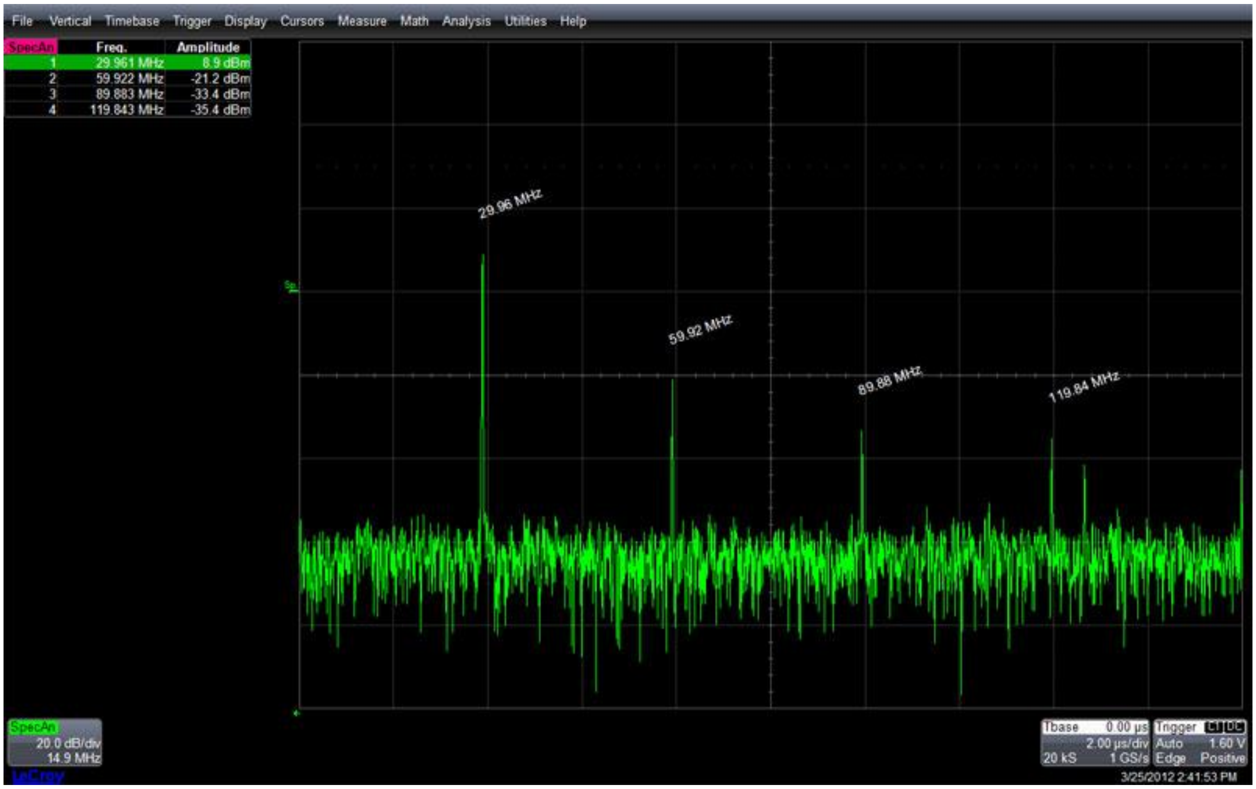

Fig. 2. Harmonics of the Colpitts oscillator.

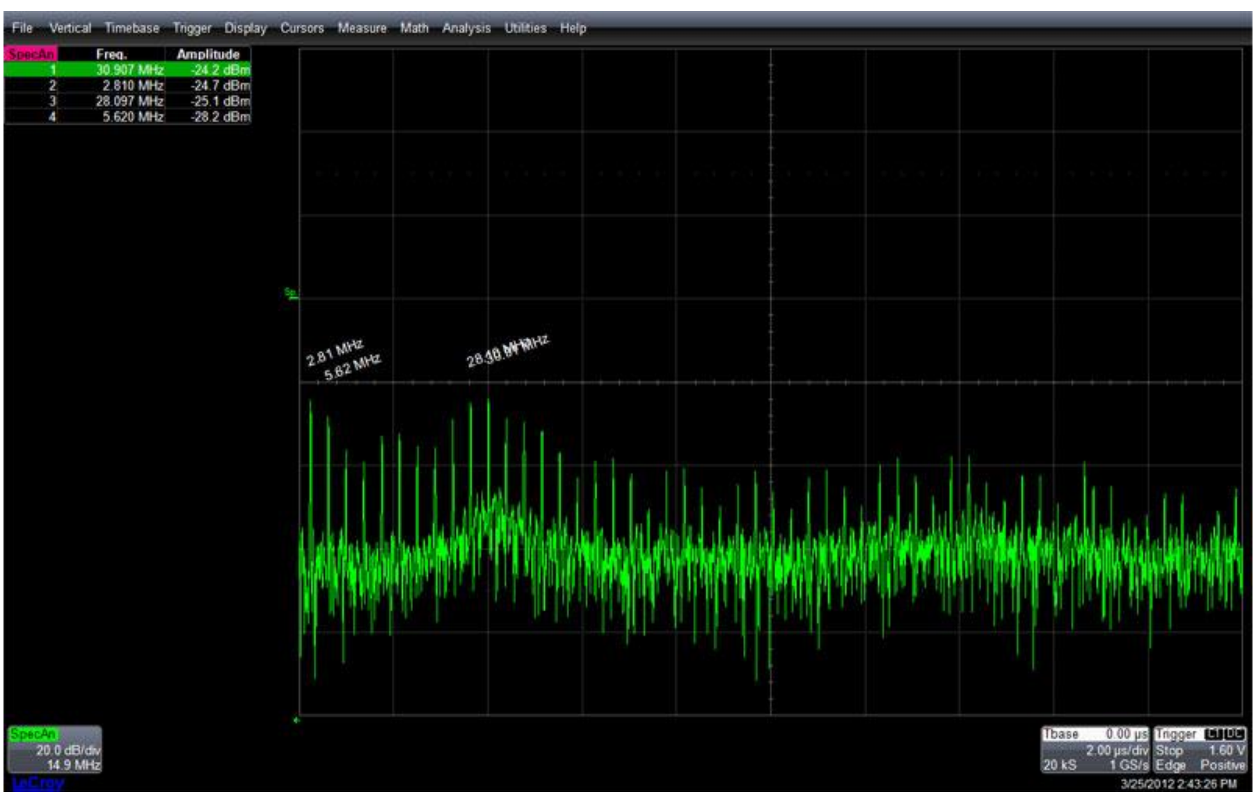

Fig. 3. A point-of-load regulator operating at 2.8 MHz.

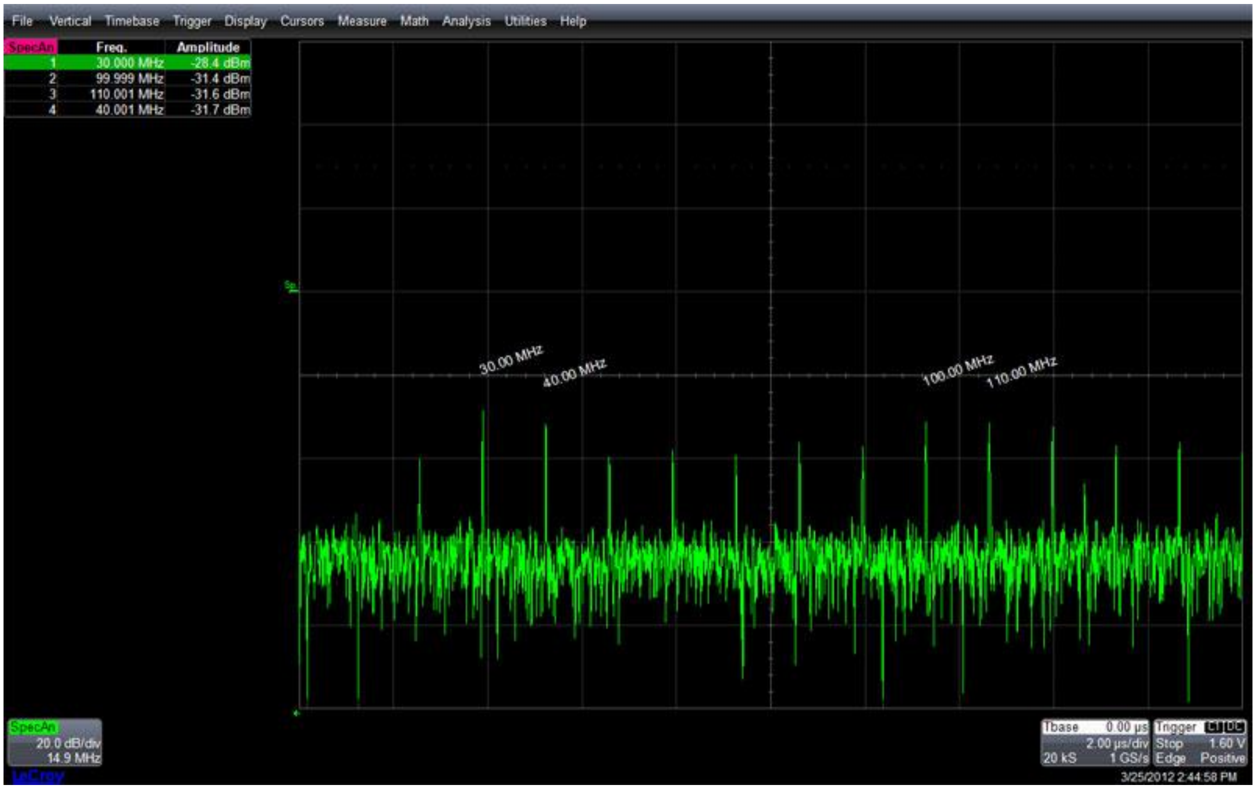

Fig. 4. Harmonics of the 10-MHz clock.