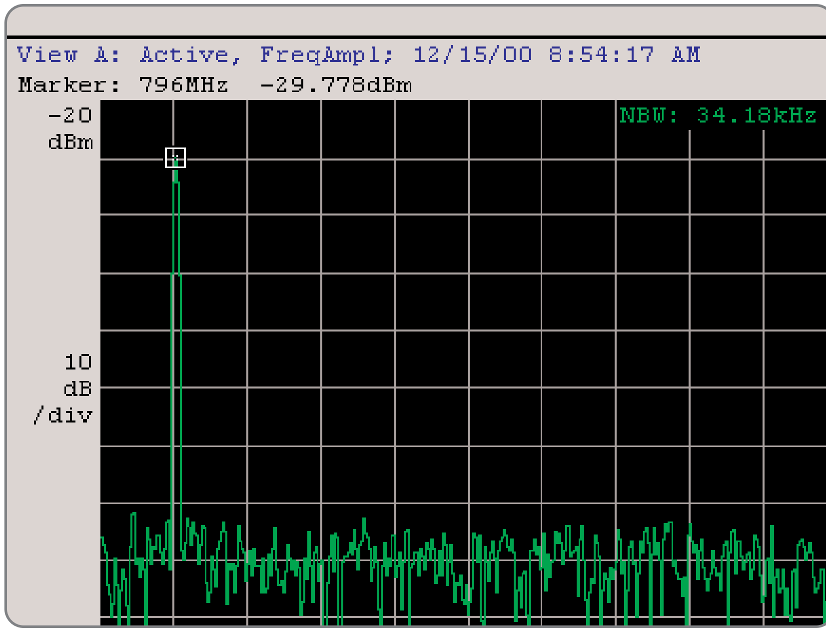
Troubleshooting hardware and software interactions



Things aren't always as they seem

Especially in software controlled hardware systems found in today's RF wireless systems.

Measurement challenge—an intermittent problem in a code-controlled oscillator

Code-controlled systems for applications such as spread-spectrum, frequency hopping and power management are susceptible to "hidden" software routines or obscure hardware circuit paths that can produce misleading test results or crop up as problems weeks later with no apparent cause.

A micro-processor-controlled high-frequency telecommunications system had passed initial tests with flying colors—it had operated exactly as intended under simulated operating conditions. The system's operating frequency was controlled by sending commands to an 800 MHz YiG oscillator, setting the nominal frequency and then monitoring the output to create a feedback signal to control the exact operating frequency.

However, things proved quite different when the system was operated in "real world" conditions. At what seemed to be random intervals, the output signal would first be set to the correct frequency and then suddenly go into an error condition. Repeats of the initial measurements under simulated conditions were misleading—they still showed that frequencies were being set correctly and the system appeared to operate properly. But something was obviously wrong, since the system once again exhibited error conditions when returned to service.

A more sophisticated troubleshooting process was required. A more thorough test with a traditional swept-frequency spectrum analyzer proved inconclusive; other than to reveal that some sort of problem existed. The source of the problem remained a mystery, as the spectrum analyzer was unable to reliably capture the randomly occurring error event for analysis.

The solution

Designers brought in the Tektronix WCA380 Wireless Communication Analyzer, a new measurement system that is designed to capture and analyze complex telecommunication signals—especially those that occur in bursts or at random. The analyzer was set up to monitor the output frequency of the YiG oscillator on a long-term basis, digitizing the information, performing a real-time FFT and storing both frequency and time information simultaneously for further analysis. The display in Figure 1 shows the amplitude vs. frequency spectrum of the oscillator signal in the upper half of the screen. The lower half of the screen displays a spectrogram of the signal—the history of its frequency spectrum over time. The spectrogram displays amplitude on the frequency vs. time plane as differing colors—ranging from dark blue for low amplitude to bright red for very high. In addition, a marker was placed at various points on the spectrum display to read out time values and determine when an error event occurred. The marker and spectrum display are interlocked, so the time readout and the spectrum are always "in sync."

The elusive problem was found by:

- Setting the marker at the beginning of the correct frequency area and noting the time value
- Moving the marker to the end of the correct output and again noting the time value
- Locating the command set in the control software that sets the correct frequency
- Examining the code that occurred within the frequency setting time window

Using this procedure, an incorrect routine was discovered within the time window. The culprit turned out to be a secondary diagnostic branch that had been inserted during the design of the code and had been long since forgotten. This hidden branch was being activated by various combinations of unrelated operating conditions (not replicated in the test environment) and was corrupting the frequency setting—seemingly at random. Once it was revealed, the branch was simply deleted from the control code and the system began to perform exactly as intended.

The ability of the WCA380 real-time spectrum analyzer to trigger on the error condition and capture repeated frames of both time and frequency data in real time was key to discovering the offending code. The analyzer revealed frequency and time domain interactions from the spectrum and histogram displays, and then was able to trace the displayed error to the offending software routine.

If the routine had been a valid, but corrupted, part of the software, the WCA could have been linked to a logic analyzer to examine the code itself so it could be repaired. The WCA frequency-mask trigger capability would keep repeated occurrences of the faulty code in the logic analyzer's window for straightforward troubleshooting.

Conclusion

Leading edge measurement tools are essential to the design of reliable systems that will conform to new standards, operate at peak performance and get to market in the shortest possible time. Tektronix WCA330 and WCA380 Wireless Communication Analyzers provide clear and comprehensive insight into complex new telecommunication systems. These advanced real-time measurement tools capture all of the information faithfully and display it in formats that are easy to interpret and analyze—leading to optimum designs and shorter development cycles.

Tektronix is committed to providing the most advanced measurement solutions. This paper is part of a library of documents for the designer and test engineer who are searching for wireless telecommunication measurement solutions. The library will grow as technology and standards continue to evolve. Complementary copies along with updates and related documents are available at the locations listed below and at our web site (www.tektronix.com).

We welcome your comments and suggestions for improving these documents and your ideas for developing other tools to help you meet the measurement challenges of new wireless systems. Contact us at the nearest Tektronix location or through our web site.

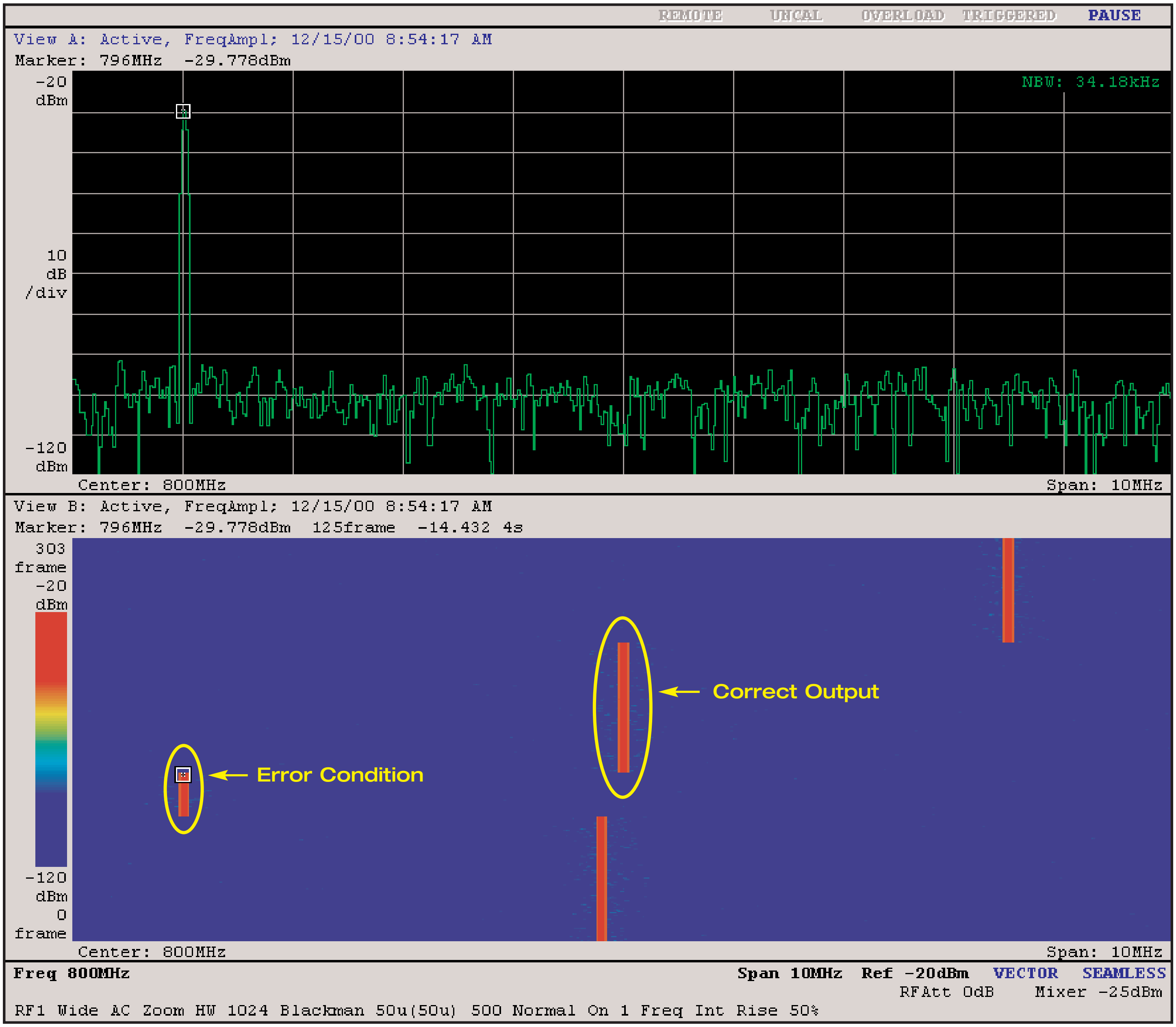


Figure 1. *Spectrogram of correct output and error condition.*

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