The HP 89400 Series Vector Signal Analyzers

The HP 89400 Series vector signal analyzers are designed specifically for today's complex signals. They provide insight into a signal's time-domain, frequency-domain, and modulation-domain characteristics. The HP 89440A and HP 89441A analyzers are limited in frequency coverage to 1.8 GHz and 2.65 GHz respectively. Both are limited to a 7-MHz information bandwidth, where the information bandwidth is the widest-bandwidth signal that can be analyzed without any loss of information. The HP 71910A microwave spectrum analyzer and HP 89410A vector signal analyzer can be used together to obtain frequency coverage to microwave frequencies and information bandwidths to 20 MHz.

By itself, the HP 89410A is considered to be a two-channel baseband analyzer. Each input channel incorporates an anti-alias filter, an ADC operating at a 25.6-MHz sample rate, and dedicated hardware to perform digital signal processing. Normally, these channels are used independently. However, when used with a quadrature down-converter, such as the HP 70911A Option 004, the in-phase (I) and quadrature-phase (Q) signals from the down-converter are each connected to an input channel on the vector signal analyzer where they are digitized and then recombined into a single complex signal of the form I+jQ. Fig. 1 shows an example of the measurements obtained when the HP 89410A and HP 70911A are used together. Although the I and Q signals are each limited to 10-MHz bandwidth by the analyzer's anti-alias filters, the combined complex signal has a bandwidth of 20 MHz.

Complex Signals

In any system where the I and Q signals are analog, the accuracy of the system and its dynamic range will be limited by the orthogonality of the signals and by the match between the I and Q signal paths. Calibration routines can be used to measure and improve system performance (see Fig. 2). The system errors observed during calibration are reduced using both hardware adjustments (performed electronically) and digital signal processing techniques. Table I lists the system errors and the action taken to reduce the effects of the errors.

A program has been developed that performs the system calibration and provides some level of instrument control. This program is compatible with the HP 89410A's HP Instrument BASIC Option IC2, eliminating the need for an external controller.

Bibliography

1. *Extending Vector Signal Analysis to 26.5 GHz with 20-MHz Information Bandwidth,* Publication Number 5964-3586E, Hewlett-Packard, 1995.

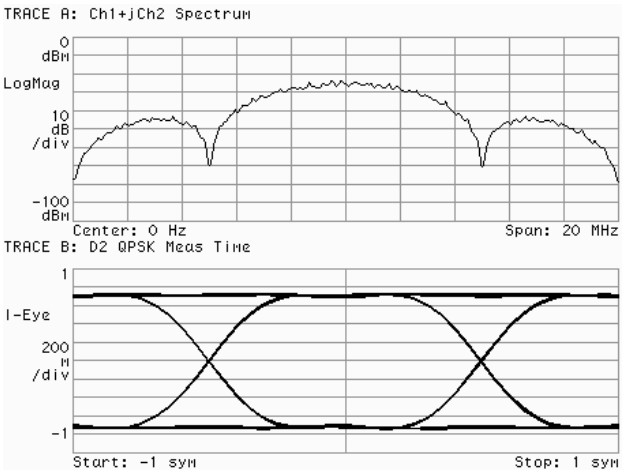

Fig. 1. The upper trace shows the spectrum of a QPSK signal operating at 10 MBits/s. The lower trace is the eye diagram obtained using the HP 89410A's optional digital demodulator.

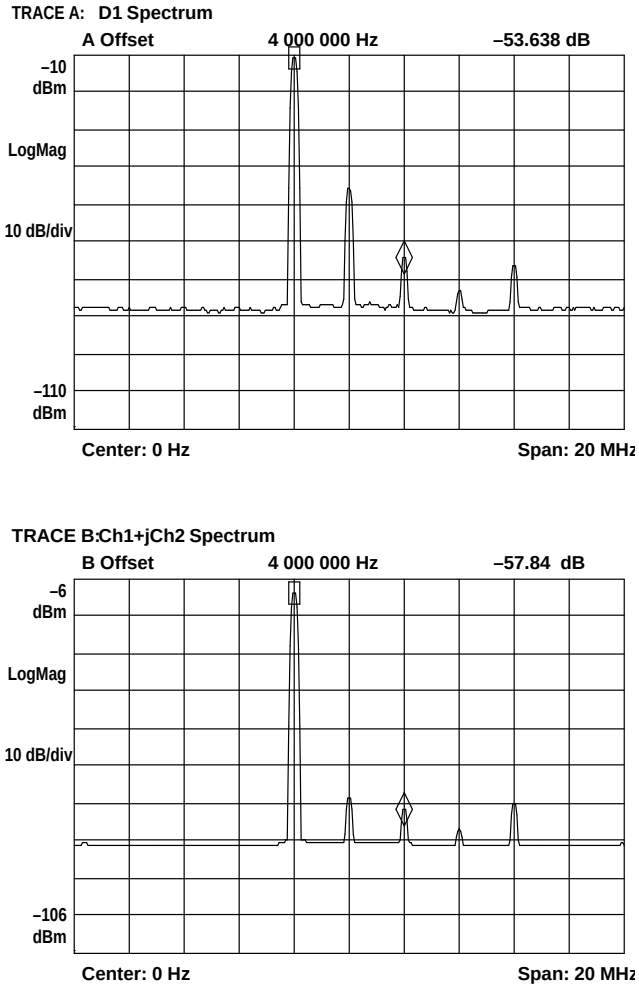

Fig. 2. The upper trace shows the spectrum computed using the I-Q signals without calibration. The lower trace is the same spectrum after calibration. Only the largest component should be present. After calibration the spectral line (center) caused by residual dc on I and Q is substantially reduced. The large spectral component has an image to the right of the center. This image, which has also been reduced in amplitude, is caused by channel mismatch.

Table I
Summary of Analyzer System Errors and Methods to Reduce Them

Source of Error	Method Used to Reduce Error	
	Microwave Signal Analyzer	Vector Signal Analyzer
I-Q Quadrature	Hardware Adjust	
I-Q DC Offset	Hardware Adjust	
I-Q Gain Match		Digital Signal Processing
I-Q Delay Match		Digital Signal Processing

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