
- ABSTRACT -

“VECTOR-SoC, a 1GHz Vectorial Network Analyzer”

Robert Lacoste, July 2002

High-frequency designs can be fun, but can also be real nightmares without some basic test instruments. One of the most useful ones is the RF vectorial network analyzer (VNA). A VNA applies a frequency ramp to a device under test, measures the signal at the output of the device, and plots the corresponding gain and phase transfer curves over frequency. This project, Vector'SoC, is a very low cost VNA built around a Cypress CY8C26443 chip.

Here under some key specifications of the Vector'Soc design :

- ? PC based instrument, with a high-speed 57.6Kbps serial connection
- ? Friendly Windows-based user interface
- ? Real-time refresh of all curves and measurements (2.5 frames/second)
- ? Full coverage from 0 to more than 1GHz in one band with a resolution of 50KHz
- ? Gains/losses measurement from +5dB to -35dB with a 0.25dB resolution (up to -45dB from 0 to 300MHz)
- ? Phase measurement from -90° to +90° with a 3° resolution
- ? 100% factory adjustment free design
- ? Prototype components cost under \$200

These impressive specifications were achieved due to a very simple architecture and the use of highly integrated components : Mini-Circuits's RF modules, Analog Devices' AD8302 RF gain & phase measurement chip, and, last but not least, Cypress semiconductors' CY8C26443 Programmable System-On-a-Chip device.

The Vector'Soc architecture starts with an RF generator module generating the test signal from 0 to 1GHz. This module includes two VCOs. The first generates a 1160 to 2160MHz signal, while the second is set to a fixed 1160MHz. The two outputs are mixed, filtered, amplified and splitted on three 0 to 1GHz outputs. A receiver module gets the reference signal from the generator, as well as the signal that went through the device under test. It scales them, computes the gain and phase delta between the two, and gives them as two analog values read back by the PSoC micro-controller. The third module is a simple prescaler used to measure the actual frequency through the PSoC. Last the main module, built around the Cypress PSoC chip, takes care of everything else, closing the loop between the generator, the receiver, the prescaler and the host PC.

The internal resources of Cypress' PSoC are heavily used in this design.. No less than three DACs and two programmable amplifiers are used to output the VCO control signals, while two ADCs read the gain and phase. Two counters are used to generate the UART clock and a 5ms timer, and another counter is used to measure the prescaler output frequency All within the PSoC chip, using more than 90% of the PSoC's logic and analog blocks !

The embedded firmware executes orders sent by the PC through the serial port, and require only 2KBytes out of the 16KBytes of onboard flash memory. The PC-side software is far more complex. Windows controls allow to select the frequency start and width, the gain scale and the mode. Two graphs show the gain and phase response over frequency, while a last plot give a polar or smith-diagram view. Lastly a "cursor" feature allow to display precisely the gain and phase at a given frequency. This software manages the automatic calibrations and executes in real-time the frequency scans, correcting the results using the calibration datas.

The performances of the Vector'Soc device are more than good. It is able to very accurately measures and displays frequency responses as narrow as a SAW filter, and gives a very accurate and stable display thanks to the automatic calibration routines. The real-time refresh mode is extremely convenient, giving almost the look & feel of a \$10K vectorial network analyzer !

