Review: Tektronix RSA306 spectrum analyzer (part 2)

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Last month, we discussed some of the basic operations and specifications of the new Tektronix RSA306 USB spectrum analyzer. This month, we’ll cover some of the more advanced features and measurements.

Briefly, the RSA306 is a well-built rubber-covered unit (5 x 7.5 x 1.2 inches) that will slip into a large coat pocket. It is a rugged product designed to meet MIL-STD-28800 Class 2 environmental, shock and vibration for use in harsh environments. The RSA306 is powered solely through the USB 3.0 port. The frequency range is 9 kHz to 6.2 GHz and can measure from +20 to -160 dBm (at minimum resolution bandwidth of 100 Hz). The unit can capture fast transient pulses with its 40 MHz real-time IF bandwidth. There are also external 10 MHz reference and trigger/sync SMA inputs, so you can sync to line frequencies, for example. The measurement input is an N connector with protective rubber cap. With all this, Tektronix has been able to keep the cost down to just $3,490 for the basic unit. Included in this price are a safety/installation manual, USB 3.0 cable and USB flash drive containing the documentation files, user manual, drivers and SignalVu-PC® software.

Figure 1 - The Tektronix RSA306 is a small rugged package that can easily fit into a briefcase, along with your laptop.

One reason for the low cost is that much of the functionality lies in the SignalVu-PC® RF analysis
software. The software includes 17 standard spectrum and signal analysis measurements, with several optional application-specific options available ($995, each). These options include mapping, modulation analysis, standards support (such as APCO P25 and WLAN), pulse measurements and frequency settling. The real time (DPX mode) can detect transient or intermittent signals as short as 100 us, which would aid in interference hunting. The software can also capture streaming and audio demodulation for long-term surveillance monitoring. Because the personality of the instrument lies within the software, upgrades and adding optional measurement capabilities are easy. We’ll demonstrate some of these more advanced measurement features.

Because of the 40 MHz real-time bandwidth and horsepower required to process the “digital phosphor” mode (DPX) and other advanced modes, the PC requirements are pretty demanding. Tektronix recommends a PC with at least the following specs: USB 3.0 port and 64-bit Windows 7 or 8 OS and 8 GB of RAM. For full support of the real time features, an Intel i7 4th-generation processor is needed. Storage of streaming data requires the PC be equipped with a drive capable of streaming storage rates of 300 MB/sec, such as most solid state drives. I tried using the RSA306 on my Macbook Pro with 8 GB of RAM and 500 GB SSD running Windows 8.1 via Parallels 10 and everything seemed to run fine, but adding the DPX (real-time) mode did make the software choke. Running the unit with a high-end PC works fine, though. I suspect running a virtual operating system slows the processing down too much. See my “wish list” at the end of this review.

**OFDM Power Measurement**

Assuming the signal is “noise-like”, it’s possible to measure integrated power and power density measurements of a modulating signal using power markers. When measuring signal density, the measurements are corrected to a 1Hz bandwidth. When power measurement markers are selected, it automatically switches the detector to average RMS for accurate results. This is an easy way to measure the power of a modulated signal without utilizing a dedicated channel power measurement.

![Figure 2 - OFDM measurement in the 2.4 GHz band, showing the readouts of power and power](image)
DPX Mode and Transient Capture

The digital phosphor (DPX) display can help display transient frequency events, such as frequency-hopping signals not easily seen on a normal spectrum display. By using masks, these transient events can trigger automated screen captures and also trigger a “beep” alert. In this next case, we’ll display a CW signal in the 2.4 GHz ISM band and then display and capture a short frequency transient.

Figure 3 - Transient capture setup showing the normal spectrum plot with DPX and waterfall plots to the left. Markers were used to determine the spacing of the transient events at about 1.36 second intervals.

Because the persistence is turned off on the DPX display (lower left in Figure 3) it’s still difficult to capture a screen shot. So, let’s create a mask, which is a very simple automated process using the mask editor, and see if we can capture and display this event.
Figure 4 - Adding a mask test, we’re able to capture the transient event automatically, allowing visibility of fast transients not visible in normal spectral displays.

Once the mask was implemented, we just click on “Run” and as the transient occurs, screen captures will automatically be saved in a file folder of your choosing. Figure 4 was the first of several screen captures. This would allow very easy troubleshooting of glitches impossible to do with a conventional spectrum analyzer. A 100% probability of intercept (POI) depends on the interaction of span (a maximum of 40 MHz for real-time measurements), resolution BW, and FFT length. The minimum POI for the RSA306 is 100 us pulse. **QPSK and FM Modulation**

**QPSK Modulation Analysis**

Let’s do another digital modulation analysis using a QPSK signal in the 2.4 GHz ISM band. Surprisingly, the RSA306 can be configured for vector signal analysis. A wide variety of modulation types are supported, allowing you to view signals using constellation, eye and trellis plots. Other measurements possible include quality of modulation, time-domain waveforms for demodulated I and Q signals, error vector magnitude (EVM), phase error, magnitude error, and much more. Because the RSA306 uses pre-programmed and user-programmed presets, it’s easy to set up the desired measurement. In this example, we’ll display a QPSK signal (one of the optional analysis measurements).
Figure 5 - Measurement of a digital QPSK signal in the 2.4 GHz ISM band. The display includes measurements of signal quality, a constellation diagram and symbol table. After stopping the analysis, clicking on any of the symbols indicates where that symbol lies on the constellation diagram.

Analog Modulation Analysis

In this example, we’ll look at an FM modulated signal in the 2.4 GHz band. Again, there is a preset for analyzing FM modulation and would apply to over the air (OTA) broadcast stations. All you need to do is enter the frequency desired or move a marker to the desired signal and centering it on the display, if displaying more than one signal. By setting the reference marker on top of the FM signal, centering the marker, and selecting Audio Demod, you’ll be able to listen to the station.
EMI Spurious and Wi-Fi Interference

EMI Spurious Analysis

For you EMI engineers, it couldn’t be easier to set up an automated EMI pre-compliance measurement. The base unit includes pre-programmed FCC and CISPR limits from 30 MHz to 6.2 GHz in either linear or logarithmic displays. The limit lines may be adjusted for external gain or loss factors, such as external preamps, antenna factors and cable loss. Up to three gain/loss tables may be added. Normally, you would use this for temporary or permanent 3m or 10m test ranges, however, for the purpose of this demo, I’m just connected to an H-field probe and measuring the emissions on a small embedded processor board.
Figure 7 - A display of harmonics from a small embedded processor board. Note the “failing” frequency at 269 MHz in this simulated pre-compliance test. Normally, you’d use this measurement using an antenna at 3m or 10m from the product under test, using compensated limit lines. Also shown is the table where up to three sets of gain/loss data may be entered in order to automatically adjust the limit lines.

As you can see, all harmonics over the limit line are flagged with a triangle and highlighted in red on the frequency listing. The frequency listing also reads out the margin from the limit. You also have the option to display only the failing frequencies in order of frequency or margin.

**Wi-Fi and Bluetooth Interference Analysis**

The DPX mode is essential for analyzing Wi-Fi and/or Bluetooth (BT) coexistence or interference issues. In this next demonstration, I’m measuring the over-the-air (OTA) Wi-Fi and BT signals in my home office. I’ve enabled persistence mode, so you can easily observe multiple Wi-Fi signals, as well as the frequency-hopping BT signals.
There are several things to note in the display of Figure 8. First is that there are at least three other Wi-Fi signals using channel 1 that I’m receiving. The larger amplitude one (in blue) is the local access point (AP) in my office, the lower level one is an AP in the upstairs living room, and the other two are from neighbor’s homes. The fact you are able to see multiple transmitters in a single display would make interference hunting quick and easy. The second thing to note are the BT frequency hops to the right side of the Wi-Fi signal. Note how the BT signal avoids the Wi-Fi signal through a technique called adaptive frequency hoping (AFH), where BT transmitters “look” for existing Wi-Fi signals and avoid those channels before transmitting. Note, also, that I’ve set two markers on adjacent BT hop frequencies and that the delta confirms the hop frequency separation of 1 MHz. Finally, when examining the waterfall display at the top, you can easily observe the Wi-Fi channel 1 and the BT hopping in the right half of the display, as well as the relative signal amplitude of the various Wi-Fi transmitters.

**Microwave Oven, Wish List, and Summary**

**Microwave Oven Measurement**

Ever wonder why your 2.4 GHz wireless phone or Wi-Fi connection fails when standing near an operating microwave oven? Well, wonder no more. Microwave ovens operate “around” 2.45 GHz in the same ISM band as Wi-Fi and BT. Actually, they wipe out at least half the 2.4 GHz ISM band in a radius of about 10 feet, or more, depending on the power output and leakiness of the door seal.
Figure 9 - The radiated emissions from a large kitchen-grade microwave oven, measured using a short flexible antenna connected to the RSA306 and positioned about a half-meter away from the right side of the door.

Note that in persistence mode, you can see the emissions sweep at least 40 MHz across the same ISM band as 2.4 GHz Wi-Fi and Bluetooth. Note, also, the pulsing of the klystron tube at 16 ms intervals in the tan-colored instant snapshot. Considering the signal level leaking from the oven, I’ve vowed to stand a little further from the oven when heating up a bag of popcorn!

Here’s my wish list for future improvements:

1. I’d love to see a SignalVu-Mac developed, so I can utilize the power residing in my Macbook Pro. I suspect software developed in native OS X would allow use of DPX mode in more recent Macbook Pros. Frankly, I see more and more engineers turning to the Mac for their business needs. Unfortunately, larger company's IT departments still rely on Windows operating systems, but I believe this is beginning to change, based on informal polling at various airport lounges I frequent.

2. I’d like more! More real-time bandwidth, of course. 40 MHz is not bad at all for this tiny gem and for the price point. I’m rather hoping for at least 100 MHz in the future, which would allow a full sweep of the 2.4 GHz ISM band. Is this asking too much? Well, perhaps...let’s see what the future holds.

3. Tektronix informs me there is a built-in preamplifier, but there’s no mention of it in the user manual or indication as to when this “kicks in”. Apparently, whether it's on, or not, depends on the Reference Level setting, but I’d love to see some indication that the function is either on or off. I guess so long as the amplitude accuracy is trustworthy at all reference levels, it’s not that big a deal. My only concern is overload of the preamp and potential harmonic distortion in displayed signals.

Summary

As I mentioned in part 1 of this review, the size, price point, and rugged quality of the RSA306, as well as the functionality Tektronix has built into the SignalVu-PC® software is very impressive. The
RSA306 would be the USB analyzer other manufacturers will need to target, as Tektronix has really raised the bar on price and performance. This is a relatively low-cost analysis solution for companies who wish to perform EMI pre-compliance testing or troubleshooting of their products prior to formal compliance testing. The digital signal analysis features also make this a great solution for analyzing today’s wireless networks and protocols. Because of the low-entry price, I can see it used in university settings (unit includes a security slot) or in training seminars. The built-in (and optional) measurement presets would make this a formidable analyzer for applications, such as wireless troubleshooting or hunting down interference to communication systems. Highly recommended!

For more information:
Part 1 of this review (EDN)
RSA306 web page (Tektronix)
RSA306 Data sheet (Tektronix)
RSA306 User manual (Tektronix)
On-line demo (Tektronix)
Real-time spectrum analysis for EMI diagnostics (Tektronix)
Troubleshooting EMI on your bench top (EDN)
Questions on EMC pre-compliance testing for radiated emissions (EDN)
Identifying emissions sources and propagating structures (EDN)
Temporary RE measurement sites (EDN)