Tektronix RSA306 USB Real Time Spectrum Analyser

Review by JIM ROWE

We have reviewed a number of USB spectrum analysers and now Tektronix has entered the market. Its RSA306 spectrum analyser hooks up to a late-model PC, laptop or tablet via a "SuperSpeed" USB 3.0 cable. Together with Tek's SignalVu-PC software, it offers virtually all the features of a real-time spectrum analyser at a fraction of the cost.

IT WAS ONLY a matter of time before Tektronix decided to take advantage of the computing power of today's PCs. Enter Tektronix' new RSA306 which basically consists of similar signal acquisition front-end hardware as in one of their high-end RSAs (real-time spectrum analyser), housed in a small (190 x 127 x 33mm, 590g) ruggedised box. It's designed to be controlled by Tek's powerful SignalVu-PC software running on a fast PC, linked via a SuperSpeed USB 3.0 cable.

It seems that the SignalVu-PC software is almost identical to the data processing firmware used in Tek's high-end RSAs – simply ported over to run under Windows 7 or 8. As a result, the RSA306-plus-SignalVu-PC combination running on a modern PC can provide a very high order of performance but at a fraction of the cost.

Recently, I had the opportunity to spend a couple of days with an RSA 306 and the Tektronix "self guided demo kit". Here's a quick run-down

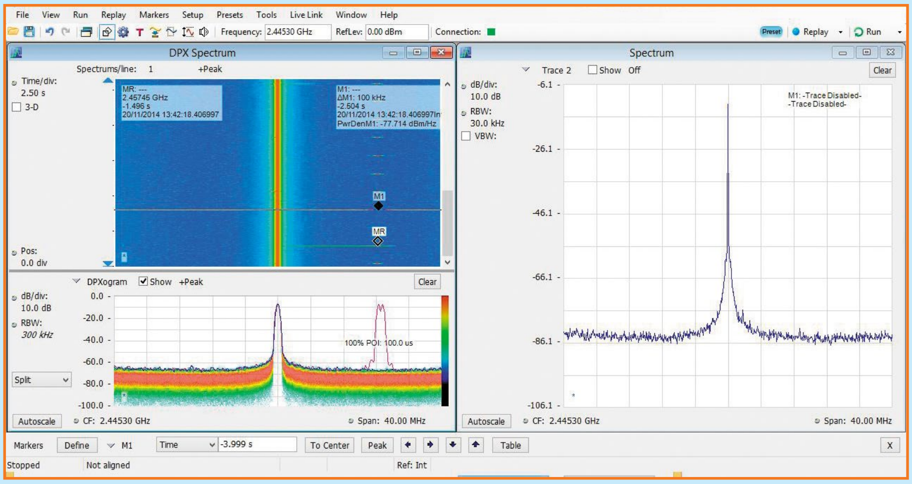


Fig.1: this screen grab shows how a standard swept spectrum display (on the right) can easily miss a brief transient about 12MHz higher than a 2.445GHz carrier, while the transient is easily detected by the real-time DPX spectrum and spectrogram on the left.

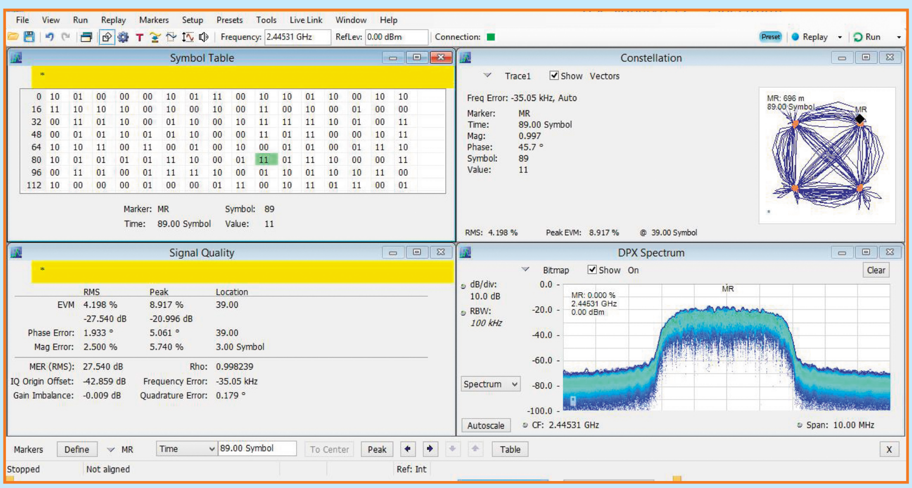


Fig.2: taken from Tek's Demo8, this screen grab shows how the RSA306 and its software can easily analyse a QPSX signal and display its DPX spectrum (lower right), its constellation diagram (upper right), its symbol table (upper left) and signal quality data.

of the main specifications for the RSA306 itself:

(1) Frequency range: 9kHz to 6.2GHz.

(2) Measurement range: from +20dBm down to -160dBm.

(3) Frequency span range: from 100Hz to 6.2GHz in swept spectrum analysis mode; up to 40MHz span in real-time DPX spectrum/spectrogram mode (both modes can be used at the same time).

And these are the main functions of the SignalVu-PC software:

(1) For standard spectrum analysis: three traces (+Peak, -Peak and average), plus a maths and spectrogram trace.

(2) Five measurement markers with power, relative power, integrated power, power density and dBc/Hz functions.

(3) For real-time spectrum and spectrogram displays: 100% POI (probability of intercept) of transient signals lasting for 100µs or more in spans up to 40MHz.

(4) Basic vector analysis functions including amplitude, frequency and phase vs time; also RF I and Q components vs time.

(5) For real-time spectrogram displays: the ability to analyse and re-analyse signals with either a 2D or 3D waterfall display.

(6) Analysis and measurement of key modulation parameters for AM, FM and PM signals, plus the ability to hear and record FM or AM demodulated audio signals to a file.

(7) Spurious signal detection and measurement using user-defined limit lines and masks, across the instrument's entire spectrum range

(8) The availability of application-specific option add-on modules for the SignalVu-PC software, covering areas such as digital modulation analysis (27 modulation types including 16/32/64/256 QAM, QPSK, O-QPSK, GMSK, FSK and APSK); WLAN analysis of 802.11a/b/g/j/p, 802.11n, and 802.11ac; mapping and signal strength; pulse analysis; and AM/FM/PM/direct audio measurements including SINAD and THD.

The demo kit consists of a 194 x 132mm PCB which can be switched to generate a wide range of different RF and baseband signals, with many different kinds of analog and digital modulation. It comes with cables to hook it up to the PC and to the input of the RSA306, plus a 104-page A5 guide book to get you going.

What makes an RSA?

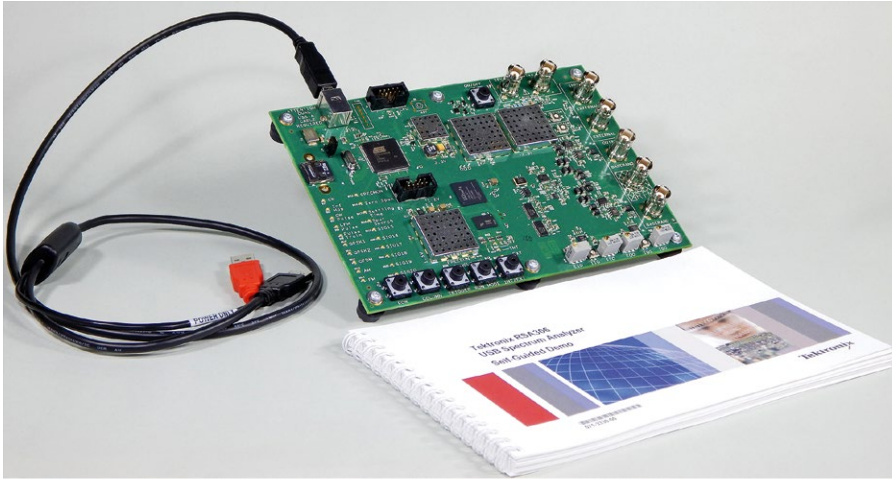
Before going any further, we should note the difference between a conventional "swept" spectrum analyser or SA/SpecAn and a real-time spectrum analyser or RSA.

Basically, a conventional spectrum analyser sweeps over a range of frequencies being examined (the "span") in sequence, taking a finite time for each sweep. This has two significant drawbacks in today's rapidly digitising world, one being that any specific frequency in the span is only examined briefly once per sweep and, of course, none of the individual frequencies is examined at exactly the same time as the others.

These drawbacks were of little consequence a few decades ago, when most of the signals were controlled and relatively static. But nowadays there are many situations where the signals you may want to examine are changing very rapidly in terms of amplitude, frequency or phase.

With a swept spectrum analyser, it can be surprisingly difficult to even find a briefly appearing signal, let alone capture and measure it. You may have to sweep over the frequency range concerned many hundreds of times, until it happens to show up at the exact instant that your analyser is examining that particular frequency.

An RSA gets around these problems by taking advantage of high-speed digital sampling (via an ADC) and



Tek's RSA306 Self-Guided Demo Kit comprises a digital signal generator PCB module with a wide range of selectable outputs and is powered from two ports on your PC. There's also a well-written 104-page guide book.

Because it's fully controlled by the SignalVu-PC software, the RSA306 has only four sockets on its front panel. These are (L to R): the main RF input, an input for an optional external 10MHz frequency reference, an external trigger input and the USB 3.0 socket used to connect it to the PC. Also shown here is the helical whip antenna and N-type/BNC adaptor.

digital signal processing (DSP). This allows it to sample all the signals in the frequency band being examined – simultaneously. It does this continuously, with the resulting time-contiguous stream of samples being stored in memory as well. They can be processed and analysed both during capture in real time and afterwards (from memory).

Because every signal frequency in the span range is being sampled every time, this means that an RSA can capture even very brief signals which appear anywhere in that range.

Nyquist's sampling theorem applies here just as it does anywhere else – in order to capture all frequencies in a certain frequency band, an RSA must use a sampling frequency of more than twice that bandwidth. That is why the RSA306 needs to be linked to your PC using a USB 3.0 cable, to handle the very fast stream of samples (USB 3.0 can pass data at up to 625MB/s).

What is DPX?

DPX is an acronym used by Tektronix in describing the RSA306's real-time spectrum and spectrogram display capabilities. It stands for "Digital Phosphor Analysis", a Tektronix patented technology which is built into their SignalVu firmware and software. It allows modern flat-screen displays to imitate the display persistence of CRTs which relied on a phosphor coating on the rear of the screen.

Each particle of phosphor emitted light or fluoresced when the electron beam scanned across them. And one of the advantages of CRT displays was that at least some of the phosphors could be made to persist – ie, the emitted light faded relatively slowly, allowing you to see events which lasted for a very brief time.

DPX can provide this function digitally, with added advantages like easily variable persistence time, statistical persistence functions and selectable colour schemes. So all Tektronix RSAs, including the RSA306 (or strictly speaking the SignalVu-PC software running with it) incorporate DPX, or digital persistence.

What sort of PC is needed?

The SignalVu-PC software that controls the RSA306 is pretty demanding in terms of computing power. This is the minimum PC specification required to achieve full performance:

- A PC using an Intel Core i7 4th generation processor, running either the Windows 8 or Windows 7 (SP1) 64-bit operating systems;
- At least one USB 3.0 SuperSpeed port;
- 8GB of RAM;
- At least 20GB of free space on the C: drive;
- A drive capable of streaming storage rates of 300MB/s to support the streaming data feature; and
- An internet connection for software activation.

So you do need a fairly "hot" desktop or laptop to get the best out of the RSA306. By the way, the SignalVu-PC software and all the documentation comes not on an optical disc but on a 4GB USB memory stick.

Putting it through its paces

While I've never actually driven an RSA previously and although SignalVu-PC is a complex software package, it wasn't as difficult as might be expected. This is thanks to the many kinds of continuous and semi-random signals that can be generated by the Demo Board and the clarity of the explanations of each graded demo in the guide book.

Most impressive was Demo5, where you learn how the DPX spectrum display can be used to detect and measure brief spurious signals that simply don't show up on the normal swept spectrum display – or only very occasionally. This is an excellent demonstration of the benefits of real-time spectrum analysis coupled with DPX processing.

Another very impressive demo is Demo8. This uses SignalVu's DPX spectrum function to look at a QPSK signal at 2.445GHz (from the Demo Board) and you lets you use its constellation display, symbol table and signal quality measurement displays to examine the signal in depth.

After a session with the demo board, I started using the RSA306 to examine signals from the helical whip antenna supplied with it and then with my wideband VHF-UHF discone antenna outside, the output from my GA1484B signal generator, and also the 10.000000MHz output from a GPS-disciplined PRS10 Rubidium Frequency Standard.

Before I did those tests, I screwed a 50Ω shielded wideband termination directly to the N-type input connector of the RSA306, and used this to carry out DANL/noise floor tests at 100MHz, 1.0GHz, 2.0GHz, 2.45GHz, 3.0GHz, 4.0GHz, 5.0GHz, 6.0GHz and 6.195GHz. All of these tests were done with a span of 10MHz and a resolution bandwidth (RBW) of 10Hz, a reference level of -50dBm, and averaging over 10 traces.

The DANL figures achieved were impressive, varying from -137.10dBm at 100MHz and 1.0GHz up to -136.76dBm at 5.0GHz and then down again to -138.36dBm at the very top of the range (6.195GHz, nudging the RSA306's upper limit of 6.20GHz).

There were a few tiny spurious response "spurs" visible here and there, mainly at ±4MHz points on either side of 100MHz, 1GHz, 4GHz and 5GHz. However, these were very small, varying between +0.5dB and +4.56dB in amplitude (the worst case). So the peak value of the highest spur (at 5.004GHz) was still only -132.2dBm.

When I tried using the RSA306 with its small helical whip antenna to look at the WiFi signals near my ADSL modem/wireless router, there was no trouble finding the router's "anybody there?" interrogating signal, even though there were no WiFi-linked PCs powered up at the time.

Next, I hooked the RSA306 up to the wideband discone antenna outside and tuned its centre frequency to 92.9MHz with a span of 500kHz. This showed the Sydney ABC-FM signal with a peak value of -36.8dBm. When I enabled SignalVu-PC's FM demodulation function, I could not only see the station's audio in the left-hand window but also hear it via the laptop's speakers.

Next I checked the DAB+ signals received from Sydney's Digital Radio Multiplex Transmitter (DRMT). The multiplexed DAB+ signals are in

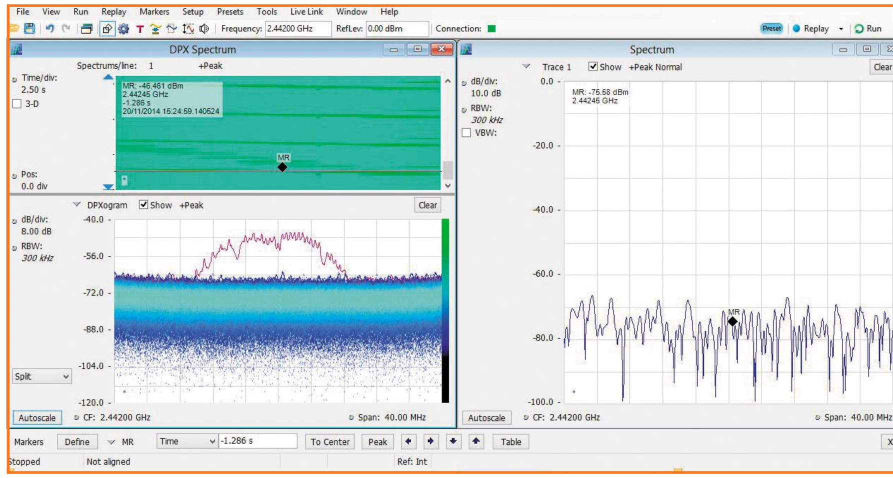


Fig.3: a screen grab taken in the vicinity of a WiFi router, using the RSA306 and its helical whip antenna. Although the "anyone there?" signal was not detected on the swept spectrum display on the right, it's clearly visible in the real-time DPX spectrum at lower left.

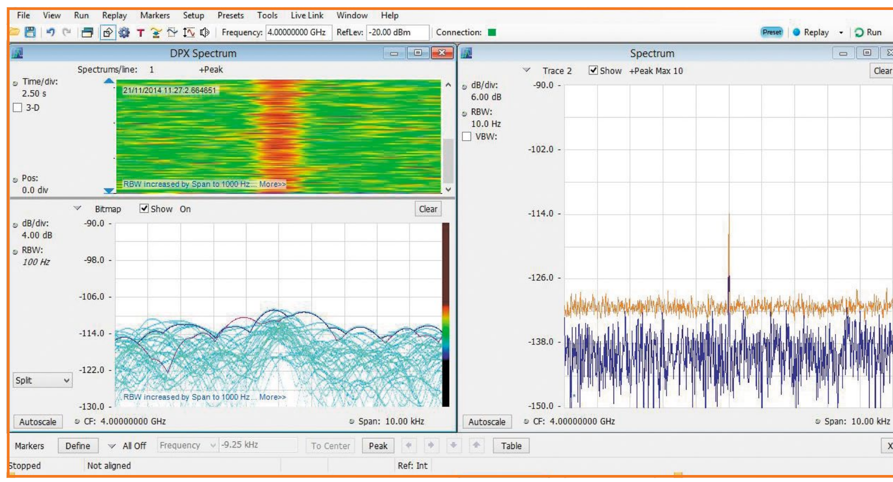


Fig.4: a screen grab showing the 4.0GHz -90dBm signal from a GA1484B signal generator. The swept spectrum display is at right, with the DPX spectrum and spectrogram at left.

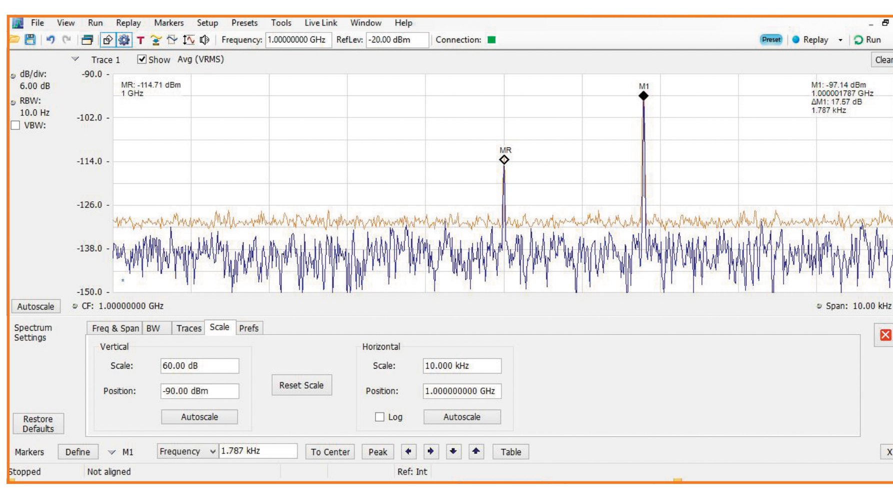
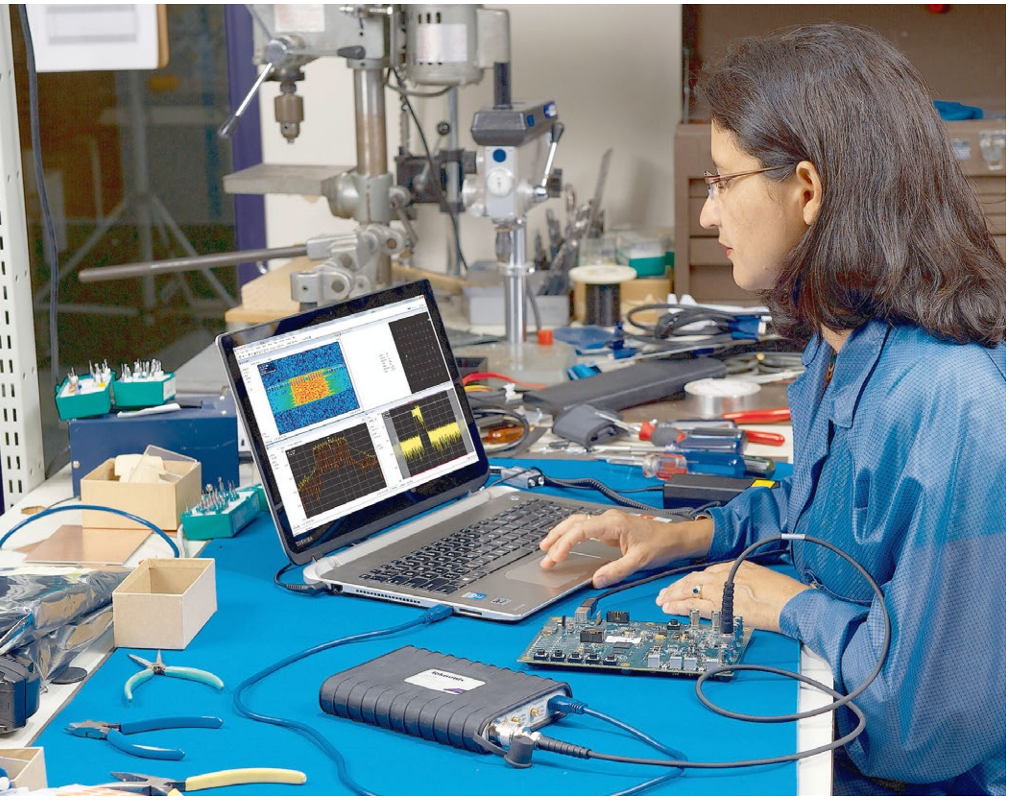


Fig.5: this screen grab shows the 1.0GHz -90dBm signal from the GA1484B signal generator on an expanded swept spectrum. The amplitude is now shown as -97.14dBm, suggesting lower cable losses at this frequency. A small spur is also visible in the centre.



Taken from the Tektronix media website, this picture shows an RSA306 (centre foreground) being used with the Demo Kit and a laptop running the SignalVu-PC software, in a typical workshop.

three 1.536MHz blocks, centred at 202.928MHz (Ch9A), 204.640MHz (Ch9B) and 206.352MHz (Ch9C). I had no trouble finding the three blocks and displaying their peak and average values.

I wasn't very successful in displaying the multiplex constellation diagram for any of the three but this may have been because I wasn't driving the OFDM constellation function correctly.

An unmodulated 4.0GHz signal from the GA1484B signal generator, set to give an output of -90dBm (7.1μV), was very easy to see on both of SignalVu-PC's spectrum displays, although the measured signal level was at -114dBm (446nV). This may be because I was using a 5m-long RG213 cable to connect the two, using SMA connectors and SMA-N series adaptors. At 4GHz, this cable plus the connectors and adaptors could well have significant losses.

Trying the same test at 1.0GHz, I obtained a much closer reading of -97.14dBm (about 3.15μV). However, SignalVu-PC now gave the signal frequency as 1.000001787GHz, or 1.787kHz high.

I'm pretty sure that the GA1484B's accuracy is somewhat closer than this, so I tried checking the 10MHz output from my GPS-disciplined rubidium frequency standard. This time SignalVU-PC told me that the signal frequency was 10.000014MHz. Since the rubidium standard is much closer than this, I concluded that at least part of the error was due to the accuracy of the RSA306's internal frequency reference – specified as ±25ppm + ageing (±3ppm in the first year), after a 30-minute warm-up.

By the way, the RSA306 does have provision for connecting an external 10MHz frequency reference. It also provides an external trigger input. Both of these inputs are via SMA sockets.

Conclusion

Overall, I was most impressed with the Tektronix RSA306 and SignalVu-PC combination. They certainly seem to offer a level of performance approaching that of high-end real-time spectrum analysers but at a much lower price. The SignalVu-PC software is also very easy to use once you get the hang of it.

Finally, the RSA306 Self Guided Demo Kit really helps in becoming familiar with "driving" and using the RSA306 and the SignalVu-PC software. I'm sure that many buyers would appreciate a loan of the Demo Kit, or perhaps rental of one, for a week or two.

The introductory Australian price of the RSA306 is $4770 plus GST. This includes a USB3.0 cable and the SignalVU software.

Call Vicom for information on Tektronix products on 1300 360 251 or visit www.vicom.com.au or email info@vicom.com.au

Handy links:

(1) Vicom Australia: www.vicom.com.au

(2) Tektronix Spectrum Analysers: www.tek.com/spectrum-analyser A free primer titled "Fundamentals of Real-Time Spectrum Analysis" can also be downloaded from this link. SC

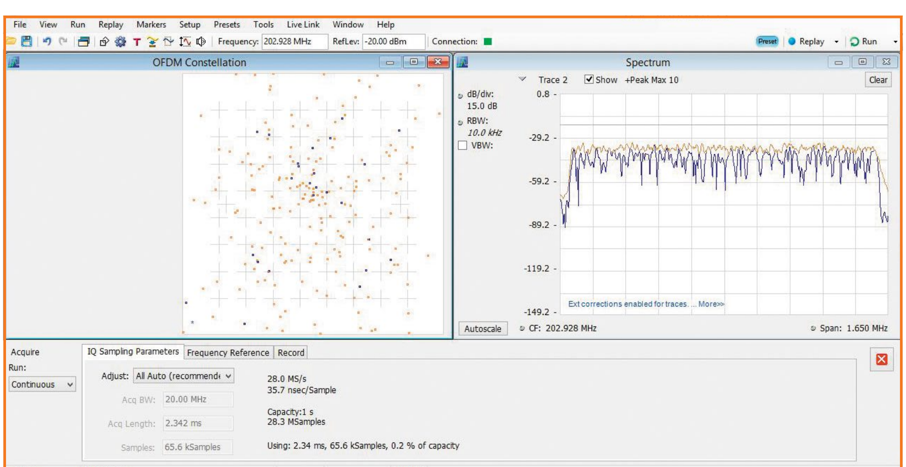


Fig.6: this screen grab was taken while using the RSA306 to examine the channel 9A DAB+ signal block from the Sydney DRMT (Digital Radio Multiplex Transmitter). The spectrum at right is clear but I couldn't get a clear constellation display. I can't blame the RSA306 or its software – just my poor driving!