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LOW-COST 2.7 GHZ SPECTRUM ANALYZER

One specialty I offer my clients is troubleshooting and suggesting potential fixes for their products in order to get them to comply with EMC standards. Ideally, we want to do this prior to going out for compliance verification testing. As I travel a lot in my job, I like to take the minimum amount of test equipment possible. One of the fundamental pieces of gear is the spectrum analyzer, but they usually weigh a ton. Not only that, but they're usually quite expensive!

Figure 1 - The Thurlby Thander Instruments, model PSA2701T. Photo courtesy TTi.

About three years ago, I ran into quite a deal on a handheld spectrum analyzer that truly fit into my hand - unlike so-called "handhelds" that require both hands! This unit was, and is, virtually unknown to the EMC world. The manufacturer is UK company, Thurlby Thander Instruments[1], which I'd previously never heard of in the U.S. Fortunately, it's distributed by well-known Newark Electronics[2], under the Tenma brand (although, the actual unit is still branded TTi?).

There are two models offered and I've had a chance to try both. The PSA1301T covers 100 kHz to 1.3 GHz ($1,500) and the PSA2701T covers 1 MHz to 2.7 GHz ($1,950). The leather case, which I recommend, runs $137. In this review, I'll cover the PSA2701T, which I have used for a couple years now. The PSA1301T is similar in specs; mainly the frequency range is different.

This is one clever little design. If examined closely, you'll actually realize that the entire user interface - controls and screen - is really an embedded Palm TX PDA! In fact, by opening a couple

[1] Thurlby Thander Instruments Ltd., www.tti-test.com.

[2] Newark Electronics, www.newark.com.

side latches and lifting off the top cover, the PDA simply unplugs from the base unit. The PDA includes all the usual Palm applications, including Wi-Fi, so once you're done measuring EMC, you can use the unit to check email and browse the Web! The product even comes with the original packaging and accessories for the Palm.

The spectrum analyzer circuitry resides in a fully shielded base section with an SMA connector for the RF input. The Palm uses special software to turn the unit into a fully-featured spectrum analyzer. The unit even includes AM/FM demodulator circuitry and an earphone jack at the top for evaluating potential commercial ambient signals. There are a few key hardware controls, but most are touch-sensitive soft-keys.

Here are the key specifications:

★Frequency range: 1 MHz to 2.7 GHz (100 kHz to 1.3 GHz for the PSA1301T)

★Resolution bandwidths of 15 kHz, 280 kHz or 1 MHz (PSA1301T lacks 1 MHz)

★Can read out in dBm or dBuV

★Can enter frequency limits of "center-span" or "start-stop" ranges in 1 kHz steps

★-96 dBm typical noise floor at -20 dBm reference level

★Sweep modes of normal, single, peak hold and average

★Zero span mode with AM and FM demodulation (1/8" earphone jack)

★Two variable markers that read out either absolute or differential values

★Marker "peak search" and peak tracking

★Reference waveform display in a contrasting color

★Programmable limit lines with limit line editor and store/recall

★Unlimited storage of waveforms, setups and screens (can store to SD card)

★3.5-inch TFT touchscreen (64,000 colors)

★Display resolution of 320 x 480 pixels (graticule area is 320 x 300 pixels)

★Data transfer to a PC for analysis, documentation or printing (via SD memory card)

★Battery operation of about 4 hours (includes AC power adapter/charger)

The unit is sensitive enough with the 2-turn Beehive loop probes I recommend[3], that a preamplifier is usually unnecessary. By attaching a probe directly to the analyzer, you have the

[3] Beehive Electronics, www.beehive-electronics.com.

perfect handheld emissions detector! While the unit lacks the standard EMI bandwidths (ex. 120 kHz), I don't find this to be a limitation during the troubleshooting process. What you're typically looking for is "how much leakage is there now, and how much is there once I apply this fix?" Once the fixes are implemented, that's when it's time to measure your product in a chamber or OATS with the proper measurement equipment as specified in the appropriate standards.

Troubleshooting with the PSA2701T and attached probe is fast and easy. No heavy instruments to lug out to the measurement chamber or open site and no line cords to plug in. Just turn it on and go! I found I can quickly zero in on an emissions issue, even during characterization or pre-qualification testing.

Emissions can be recorded via screen shots (bmp format) or tables of comma-delimited (or separated) variables (csv), which may be saved and imported into your favorite spreadsheet. What I especially like is the unlimited number of instrument setups I can save. Favorites of include 1 to 30 MHz for conducted emissions, 30 to 200 for low-frequency emissions, 100 to 500 MHz for a lot of my typical troubleshooting and 2.4 to 2.7 GHz for Wi-Fi and Bluetooth sniffing.

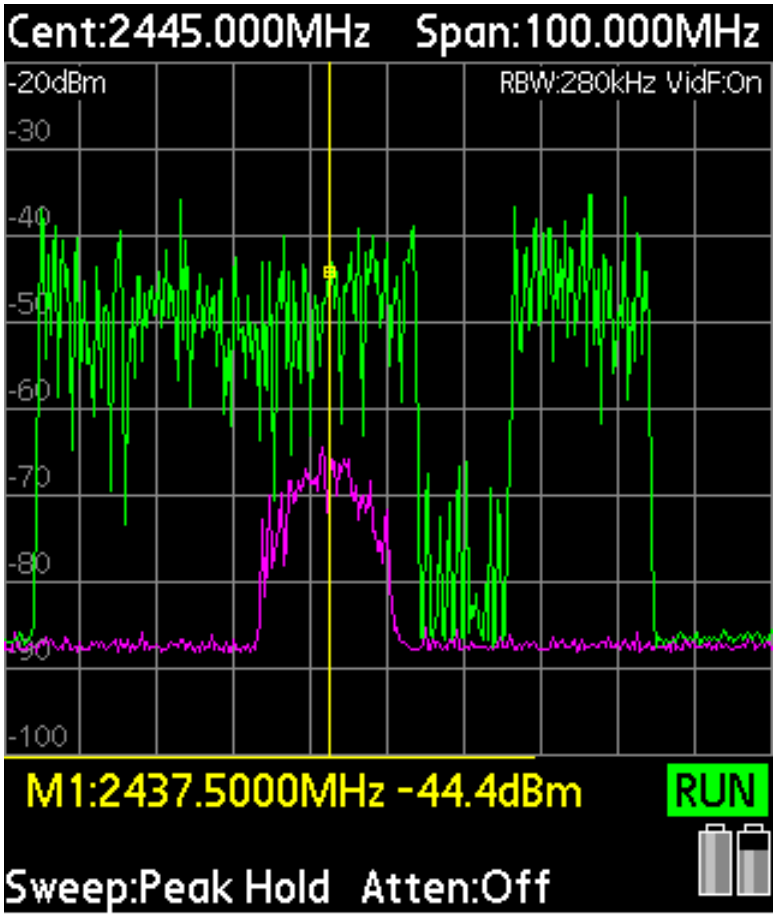

Figure 2 - Screen capture of a Wi-Fi(green) and Bluetooth (violet) signal. peak hold was used to allow the spread-spectrum signals to "fill in" the signal envelope. The Bluetooth signal was saved as a reference waveform.

Troubleshooting with the PSA2701T is fast. Oftentimes, a wide-band preamp is unnecessary, especially when using the 2-turn Beehive probes, however, for some signals, such as a current probe, additional amplification may be required. I use the low-noise Mini-Circuits ZX60-3018G-S+ amplifier module as reviewed in a separate document, "Low-Cost Wide-Band Preamplifier" on this Web site. This amplifier module covers 20 to 3000 MHz with a gain of 18 to 23 dB and noise figure of 2.7 dB.

Figure 3 - Here, engineer Yuan Ma, scans a product for mechanical leakage between adjacent pieces of sheet metal. She's using the PSA1301T (1.3 GHz) analyzer with the Mini-Circuits wide-band preamp and Beehive H-field probe.

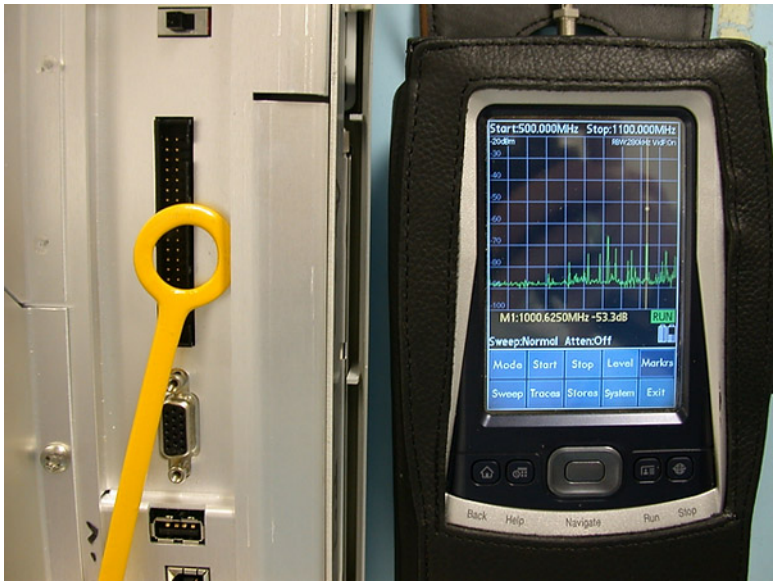

Figure 4 - Closeup showing the Beehive probe and analyzer with emissions.

Recently, I had occasion to troubleshoot an extensive alarm system under development by a contract facility. The system include a dozen different control boxes, door sensors and keypads. Every box had its own micro-controller with associated LAN and RS-485 circuitry and was designed to be interconnected with hundreds of feet of RS-485 or LAN cabling. If that wasn't enough, their client wished the system to meet FCC Class B limits!

During the troubleshooting phase, I was (fortunately) able to move into a shield room to eliminate ambient signals. There was no other facility such as a semi-anechoic chamber available. After doing some preliminary probing with the Beehive H-field probe and FCC F-61 current probe, it became obvious that the interconnect cabling was coupling most of the emissions from the system. At that point, I set up the current probe around a typical cable and started the "probe and implement fixes" process. Using mainly the PSA2701T analyzer and current probe, I was able to quickly implement several potential fixes, as well as probe around the box for leakage areas.

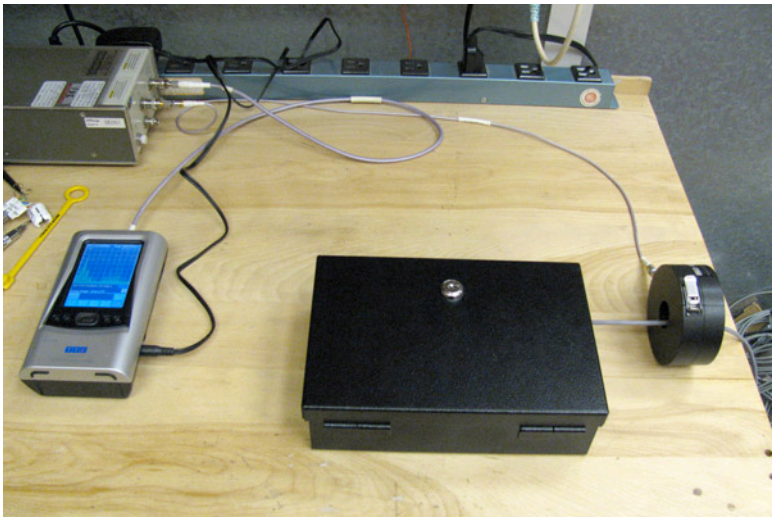

Figure 5 - Troubleshooting setup for the alarm system. The signal from the FCC F-61 current probe was boosted by an older HP wide-band preamplifier.

Once some simple fixes were implemented to the cable egress method and the PC board layout was improved, they were able to meet the desired FCC-B limits.

While the PSA2701T does not offer the typical EMI bandwidths or quasi-peak detection, it does include a number of very handy features for general EMC troubleshooting. Things like markers, peak search, averaging, peak hold, waveform memory, amplitude scale in dBm or dBuV, screen capture and instrument setup memory - not to mention the portability - are very powerful tools for the EMC engineer. Using this low-cost instrument to perform the initial troubleshooting prior to moving the product out to a compliance test facility will save both money and time. This truly handheld spectrum analyzer may be purchased for about the monthly cost of renting a bench-top analyzer. Highly recommended.