

Application Note

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What you should expect from your Radio Test Set

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If you are thinking about the purchase of a new Radio Test Set (RTS), this application note should help you to identify a good RTS from one that does not perform up to expectations.

Introduction

Radio Test Sets are useful tools for any engineer working with radio equipment. These multi-functional instruments, known in the industry for more than 30 years, include a number of measurement functions, which replace stand-alone instruments into one unit and save space on the radio engineer's workbench.

Nowadays, these instruments are used for manufacturing and servicing radio equipment for professional applications. The users of such devices are almost 100% dependent on the performance and availability of their radios, especially in police operations where radio performance can mean the difference between life or death.

For test systems, this means that its measurement precision has a direct influence on the safety of PMR users. This also implies some minimum functional requirements that an instrument should be able to fulfill. During the last few years, a variety of low-cost instruments from different vendors have been introduced into the market, offering colorful lights, big screens and promising data sheets. But will that equipment be able to perform what the data sheet promises?

Think about a meter which does not fulfill your basic requirements in precision or features: you won't accept it. An electric meter, which does not indicate the live wire correctly, is even not only useless; it is dangerous, because it makes you believe you're safe while, in fact, you are in danger. The same applies to an RTS: If it shows you good test results and does not detect a fault, it will fail whenever it is needed most and could bring users like police officers into a dangerous situation!

RTS REQUIREMENTS – WHAT YOU SHOULD CONSIDER:

1. Generator Quality is Measurement Quality!

When you want to measure the quality of a radio test set, look at the quality of its signal generators for RF and Audio. Use a good spectrum analyzer to have a close look at the RF CW signal and watch the noise shoulders (sideband noise) of the generators at all level ranges. With some generators the sideband noise was not less than 20 dB below the carrier signal, and that could cause major measurement uncertainty on the device under test. With such high levels of noise, usually a result of poor Phase Noise or excessive residual FM from the Local Oscillator (LO), the receiver sensitivity tests will always lead to a confusing and inaccurate test result. See Figure 1.0 on signal generator quality analysis.

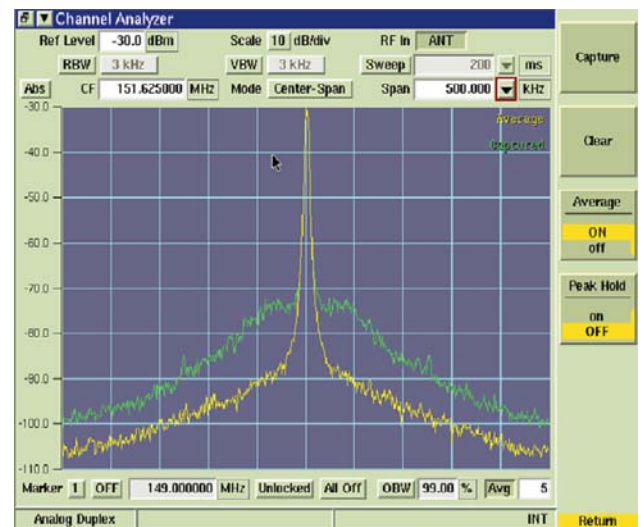


Figure 1.0: Signal Generator Quality Analysis – Green shows high levels of noise

Also, spurious signals need observation. Some low-cost generators emit high levels of spurious signals every 10 MHz as well as LO frequency breakthrough and other RF mixing products. With all those extra signals, the total broadband RF level is much higher than the generator level you have selected! See Figure 2.0 for spurious noise analysis.

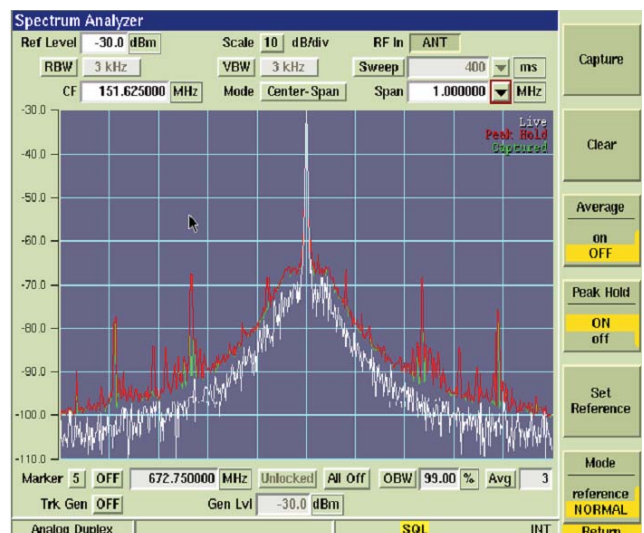


Figure 2.0: Signal Generator Quality Analysis – Red shows high levels of sporadic noise spikes

Low signal quality does not only impact the generator of the RTS; it uses the same LO on the analyzer side. Excessive noise and spurious emissions will cause signals to be displayed on the spectrum analyzer, which physically aren't really there at all. You can waste valuable time tracking a spectral problem in your radio which only exists in the instrument.

In addition to "phantom" signals, the analyzer will display excessive distortion and erroneous deviation measurements as well, as these parameters are "additive" or the sum of all received signals.

Audio measurements, too, can be disputed. If there is no high quality reference signal: measuring Audio distortion, it is impossible when the 1 kHz reference signal is already noisier than you would normally expect from your radio. See Figure 3.0 for audio generator quality analysis.



Figure 3.0: Audio frequency analysis showing 1 kHz tone with artifacts at 2 kHz, 3 kHz, 4 kHz and 5 kHz.

2. Are the Measurement Algorithms Correct?

It takes a lot of math and accurate calculations for a RF instrument to correctly display measurement results such as spectrum or a modulation meter figure. It is obvious that a lot of things can go wrong with all those calculations, if the engineers don't have the right experience. Measurement points and values have to be correlated with display points, if parts of those calculations are wrong; the test results are inaccurate. There are some instruments which did both over and under sample RF parameters, misleading the operator into wrong test results or, at the very least, taking too much time until a full sweep is done.

If you want to use your instrument to tune a radio, both of these issues are unacceptable.

Test the instrument by changing the span and resolution bandwidth (RBW) of the spectrum analyzer display. If there are not enough measurement points in the internal calculation, the measurement will show artifacts: you will see the instrument's filter curve instead of a valid signal. Not very helpful, if you want to assess the quality of a modulated signal.

3. Does Your Instrument Help You Perform Your Job?

Measurement errors and under sampling can be avoided easily if the test set is exercising the right algorithms. An automatic ranging function for your input attenuation is also a must have feature to avoid compression and to keep the instrument within its dynamic range. Some customers could be misled by an instrument which requires manual setting of the input attenuator for all measurements, resulting in totally wrong test results due to the receiver being in compression.

A good RTS should allow automatic and manual ranging of input attenuation and bandwidths (VBW/RBW), but the automatic setting will help you to avoid any wrong test results.

What else does your RTS support? Instruments have been remote controllable for many years, but advanced RTS products also allow running predefined, editable test and alignment scripts for the most popular radio models in the field.

4. Accept Nothing Less But State Of The Art!

Not only are RF parameters worth looking at, if you consider investing in a RTS. It is also important that the choice supports a wide range of conventional and digital standards for PMR. If you are considering investing in a RTS, not only are RF parameters worth looking at, but the new test set support a wide range of conventional and digital standards for PMR. Paging standards like CCIR and ZVEI are a must for your new RTS. Also have a look into the options list. If you can't find future standards like TETRA, APCO 25, dPMR, MOTOTRBO™ (DMR) and NXDN™, then consider purchasing a different instrument.

It is obvious that the ideal instrument is also certified by international standards for EMI, vibration and electric safety. Be aware, that there are brands which do not mark their instruments with certification labels which are legally required, such as UL or CE. It is an illegal offense to run an instrument without those markings, plus you are putting yourself and your employees in danger.

Have a Close Look - Before You Decide!

Investment in RF instrumentation is an important decision for all radio workshops. You are certainly investing a lot of money, and the instrument you are about to purchase needs to be in service for a long time. If you still can't decide your preferred brand, here's probably the simplest indicator that a test set is not worth its money: just perform the same measurement again and again three, four or more times. If there is major variation between results of the different test runs, then you know you have an unreliable test set.

Before you decide on the purchase of a Radio Test Set, just spend a little time, and you will easily be able to find out if the product does what you need it to do.

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