

Wireless Tools of the Trade . . .

The Spectrum Analyzer

by Randy Ferras, Encom
Wireless Solutions, Inc.



Spread Spectrum (S/S) radiomodem usage in all aspects of the Traffic Industry is increasing on a daily basis. The major benefit of S/S technology is its' being able to be deployed rapidly, without the challenge of regulatory issues or licensing. An obvious downside to unlicensed technology is the fact that there may be operating frequency conflicts between other users and ourselves within the same geographical area. These radio frequency conflicts, when they affect the integrity of our system, are referred to as interference, and depending on the degree of conflict, may cause the affected systems to perform intermittently, consistently poorly, or in extreme cases, not at all.

Due to the unlicensed nature of the available bands, the concept of unavoidable interference has been synonymous with the concept of S/S. The first offerings in the S/S radiomodem field left a lot to be desired in terms of quality, performance and reliability. Unfortunately, many end-users who tried to apply this early technology in their projects came away frustrated and disenchanted, citing outside interference as a primary point of system instability once the equipment was installed in the field.

This may have been the case in some systems, but likely not all.

At the frequencies and power levels where typical S/S equipment operates, initial RF system engineering, if not performed properly, can result in RF links that are marginal at the best of times. If RF signal levels reaching remote sites are borderline, the sites may operate poorly. Poor construction practices during installation of the antenna system (antenna, lightning suppression, coax cabling, connectors) can also greatly affect S/S system performance. In both these cases the resulting symptoms may be similar to interference symptoms, and outside interference may be unfairly blamed for poor system performance.

The actual application may also affect overall system performance. Most of the S/S radiomodems in use today in the traffic control industry are designed for the transfer of asynchronous serial data. A typical application would be the interconnecting of a local controller to a system master via the equipments respective RS232 serial

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ports. This is not news, of course, but it should be realized that if the local and master application software are not properly configured to compensate for the requirements of the radiomodem (parameters that affect internal application timing, and timing of signals on the devices' RS232 ports, etc.), the system communications quality may suffer, showing symptoms similar to a link being interfered with.

Having said all this, what typically happens when a new S/S system is turned up in the field, say in a major cities' downtown core? If there is no data flowing after system power-up, obvious checks are made for AC power, data cable connections, antenna connections, etc. If the system is communicating, but with poor results, a typical first response is to reconfigure the radiomodems, flipping DIP switches or flipping bits to change center frequencies or hop patterns. Why? The assumption here is that someone else in the immediate area is interfering with our system. In some cases this could be true. In others, we could invest time and energy, and come away frustrated when we fail to find a setting that improves communications quality. Because of a lack of tools, we have no idea if we are sharing spectrum with others, and if so, who they may be or what channels they occupy.

With copper or fiber circuits, you cannot see the data carried with the naked eye, but you can at least see and feel the medium itself. For most people this is comforting. With RF, however, the medium is invisible, and therefore somewhat intimidating. Our medium is an extremely low level, high frequency electrical signal received off-air that may be competing with many others. What is required to efficiently work with this RF is a tool that will provide us a visual image of all the in-band energy that is being picked up by our antenna. With knowledge of what else is out there, we can configure our equipment to avoid obvious congested frequencies, maximizing our chances for first round commissioning success. On the other hand, should system communications quality be poor with no apparent localized RF interference noted, we can immediately move on and investigate other potential causes of poor data integrity, making the best use of our time.

Spectrum Analysis

To display the minute levels of RF being received by our antenna, a device called a Spectrum Analyzer is used. A sensitive receiver in the Analyzer is constantly swept across a selected portion of the RF spectrum, with its' output displayed on a calibrated screen. The resultant visual image is an almost real-time "snapshot" of all the in-band energy being picked up by our antenna and made available to our radio equipment.

As should be expected in any RF system deployment today,

the desired signal (ours) may share prime spectrum space with other users, or may just have to compete in a high ambient noise environment. With the proper RF tools (spectrum analyzers) and techniques (site surveys) we can identify potential problems early on, allowing us to design around, or compensate for them, rather than being taken by surprise during system commissioning. For any RF system being considered in an urban location, doing the homework up-front can significantly stack the odds for success in our favor.

The Spectrum Analyzer screen shots, shown below, provide an amazing amount of information, which is available right off our antennas. Learning to interpret all that this tool is capable of showing us may take time, but for most of our situations the basics are all that is required.

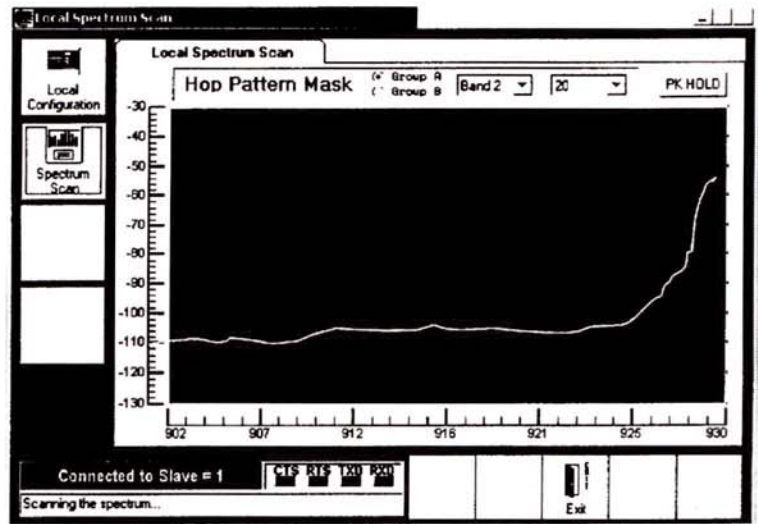


Fig 1. Shown above is a typical urban scan. We are looking at all of the 902 - 928 Mhz. unlicensed band. The noise floor sits at about -105 dBm, which is quiet. No other SS users are obvious. The energy being picked up at the top end of the band is likely from a close digital paging transmitter (operating around 929 Mhz.)

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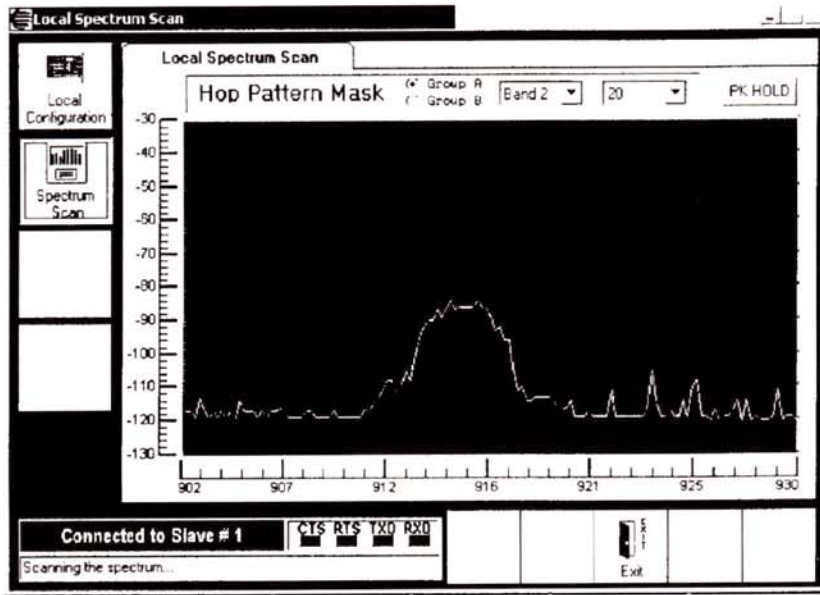


Fig 2. Shown to the left is a typical direct sequence transmitter, located fairly close to our station. Note the center frequency at 915 Mhz, with a measured level of about -86 dBm. Our goal in system configuration is to avoid overlapping any such existing users. Our equipment has not been turned on at this point.

Fig 3. Shown to the right is how a frequency hopping system was configured to avoid the direct sequence station. In today's environment we need the ability to select hopping patterns that exclude whole segments of a band, to completely avoid conflict with wide bandwidth, stationary (direct sequence) users. Spectrum usage information available before (and during) commissioning can take most of the guesswork out of bringing up such a system successfully.

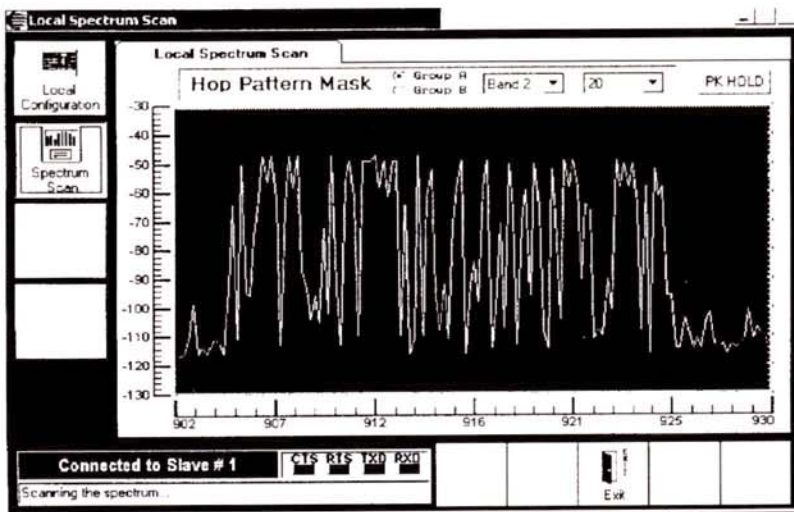
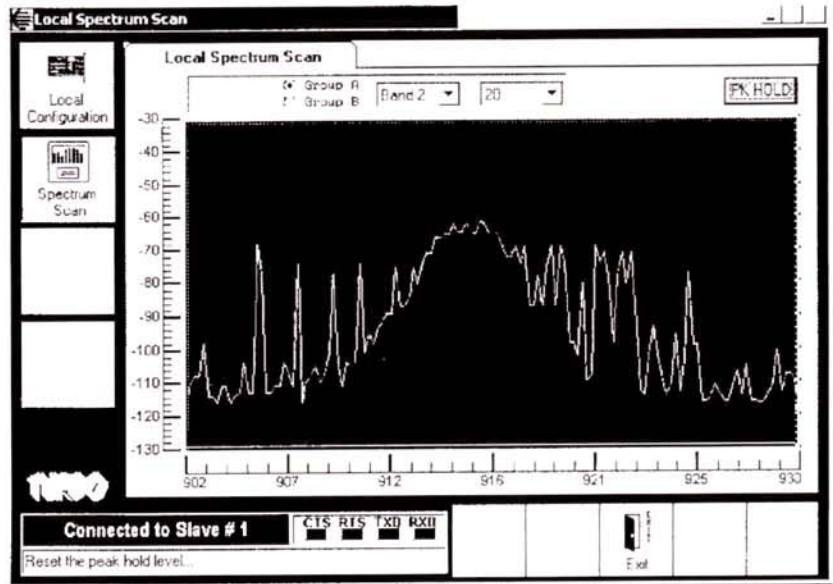


Fig 4. (Shown left) This very congested sweep taken at a remote site looks daunting at first glance. In reality, what we are looking at are poll requests from our own frequency hopping Master station, along with responses from close in remotes. How did we come to this conclusion? We keep monitoring at our remote site, while powering down our Master radiomodem, stopping polling. As the remotes do not speak unless spoken to, all of our RF traffic disappears, providing us a look at the local RF spectrum.

