

# Hunting for Sources of Interference in Mobile Networks



## ▶ Recognizing Clues and Gathering Evidence with Measurement Tools

There are many possible offenders capable of creating signals that interfere with the wireless RF signals and plague cellular communications systems.

This application note will help you better recognize those interference sources and gather “evidence” to prove your findings to others.<sup>1</sup>

Part 1 describes new measurement tools and techniques that will help you identify and locate many types of interfering signals. Part 2 is an illustrated reference with examples of measurement results from typical interference sources.

### Part 1 – Test Tools and Techniques

#### Selecting, Connecting and Using Test Tools

Today’s technician is responsible for maintaining many more base stations than ever before. When a BTS is plagued with interference, you need a tool that helps you identify and find the source of the offending signal quickly. The Tektronix NetTek YBT250 field transmitter and interference tester, as shown in Figure 1, includes automated measurements specifically designed to speed the process of identifying the causes while greatly reducing the complexity of testing on site. Among the automated measurements are spectrum display, signal modulation identification, spectrogram displays, signal

strength indication, and unattended signal logging. The NetTek YBT250 also features high sensitivity (with a built-in pre-amplifier), battery operation, accessory antennas and results storage – all in a compact, rugged, weather resistant package.

#### Measurements at the Base Station Receiver

The best way to hunt for interference in the base station receiver is to disable traffic on the channel to be measured. This will assure that no calls are assigned to it and the only signals that you will see are the interfering ones. This is a routine matter when the interference is so severe that the channel or the entire face (sector) has already been completely shut down.

If you need to leave the channel active, you should disconnect one of the two diversity receivers. While you are looking at the signals from one receive antenna, the remaining receiver will handle legitimate call traffic. In this case, you must wait for a quiet time between active calls to get valid measurements of the interference. This procedure is more difficult and time-consuming, and should only be used if absolutely necessary.

<sup>1</sup> For additional information, see *Fundamentals of Interference in Mobile Networks*, a companion application note from Tektronix.

# Interference Testing Field Guide

► Application Note

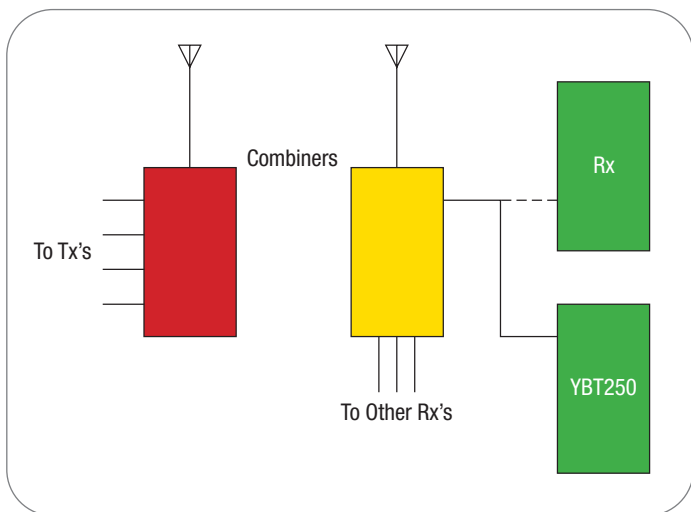


► **Figure 1.** YBT250.

## Connecting the Test Equipment

Start your search at the receiver that has the problem. Disconnect the cable from the receiver input, and connect it to the YBT250; you should be looking at just what the receiver would see.

Figure 2 shows the connection being made after the receiver multicoupler (and TMA, if used). If you prefer to connect in front of the multicoupler, stay on the receiver side of any power insertion unit. The TMA may not be equipped with relays to pass signals without power being applied to a mast-mounted preamplifier.



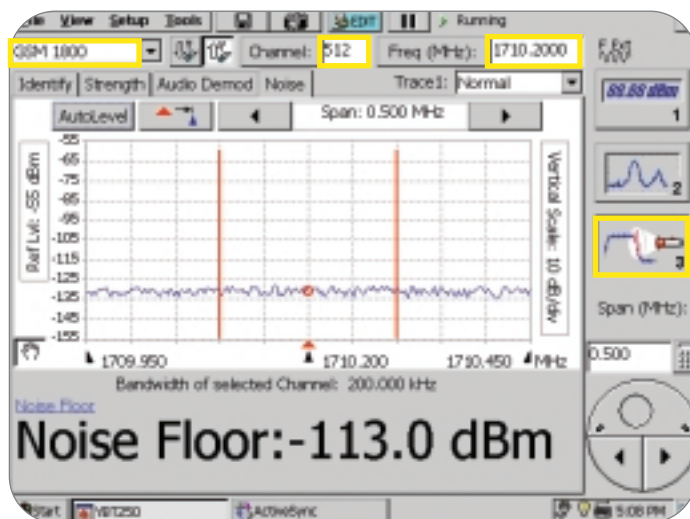
► **Figure 2.** Connect the YBT250.

## Measuring the Noise Floor

Begin by examining the incoming signal, with and without interference (if possible). The YBT250 lets you measure the total RF power arriving at a receiver, including noise, undesired signals of all types and any desired signals that happen to be present at the time of measurement.

Select the signal standard on the YBT250 that matches the BTS being tested (GSM, CDMA, AMPS, etc.) and enter the measurement frequency (or channel number) of the channel that is experiencing the interference. Tap the *Noise* tab within the *Interference Main Button* (3) to make the Noise Floor Measurement and record the total power found in the receiver channel.

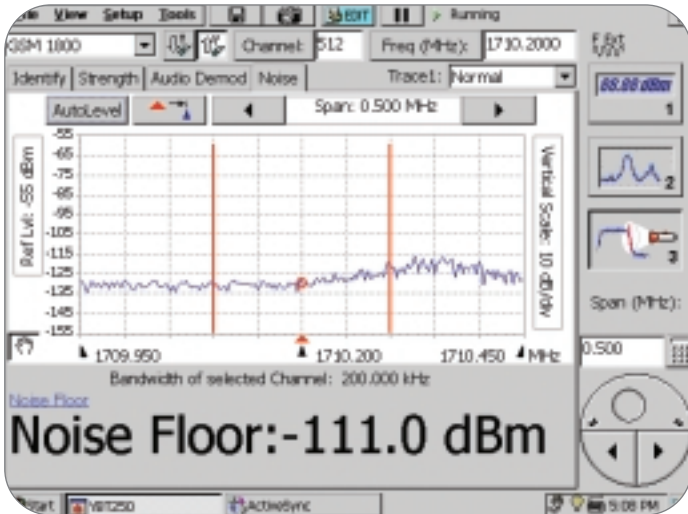
Figure 3a shows the result of a noise floor measurement on a channel with no interference. The number displayed is the total power of all signals found in this channel (between the red cursors.). Since there is no interference at this time, the noise floor readout is the sensitivity of the YBT250 itself.



► **Figure 3a.** YBT250 noise floor.

This same channel is shown in Figure 3b with an interfering signal adjacent to it. The interfering signal is affecting the channel of interest. Note that the total noise floor is now 2 dB higher than before.

This example shows a fairly mild case of interference. Interference that is 6 dB higher than a clear channel would reduce by a factor of 2 the maximum distance that this site could reach – shrinking the coverage to one fourth of its specified area.



▶ **Figure 3b.** Higher noise floor due to interference.

**Automatically Identifying Communication Signal Sources**

The YBT250 memory contains tables of characteristics for common communications signals. When you tap the *Measure* button, a series of tests are automatically performed to capture the characteristics of the interference. In many cases, the *Identify* function will automatically suggest the type(s) of signal that might be causing the interference. This can save you considerable time in your hunt.

Figure 4 illustrates the results of an automatic identification process for interference in an IS136 PCS channel. The left column at the bottom of the screen shows a list of the signals that might be authorized for this frequency. The right column lists suggestions of what is actually present – in this case, a CDMA signal.



▶ **Figure 4.** Interference identity screen.

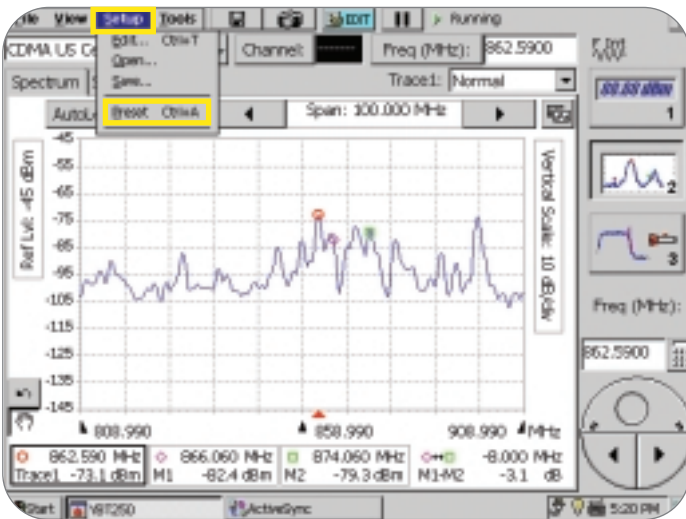
# Interference Testing Field Guide

► Application Note

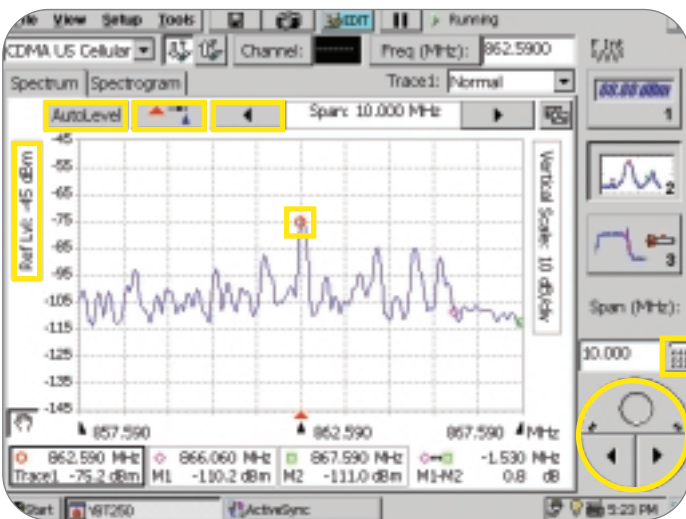
## Using Automatic Spectrum Analysis to Learn More About the Signal

Many of the normally complex settings of a spectrum analyzer can be automatically set for you by the YBT250. There is no need to adjust controls such as resolution bandwidth or video bandwidth, they are automatically set internally.

To quickly view an entire wireless frequency band, you first select from the list the standard that matches the network you are testing. Next tap the “Setup” menu, and then “Preset,” as shown in Figure 5a. After you confirm the preset operation, the measurement frequency and the frequency span will be set to automatically display the entire assigned range (including transmit and receive bands) plus a little extra on



► Figure 5a. Preset for the cellular band.



► Figure 5b. Automatic spectrum features.

each end. Now tap “AutoLevel,” as shown in Figure 5b, and the YBT250 will set its sensitivity (reference level) to maximize the viewing window of the signals being tested. *AutoLevel* also protects against distortions caused by an excessively large signal that is present outside of the viewing area.

If the signals are constantly changing amplitude (as with GSM, for example), you may not catch the signals at their maximum when you press *AutoLevel*. If the levels increase beyond range, a warning banner on the screen will ask you to decrease the reference level. Tap the “Ref Lvl” button and the “increase” arrow, or enter a reference level 10 or 20 dB higher using the numeric keypad. This will allow more headroom for those highly variable signals.

Tap on the trace of the suspect signal in the display to place the Measurement Marker (round red icon) on the trace. Tapping the button next to “AutoLevel” moves the measurement frequency to the center of the screen, and the “Decrease Span” button allows you to focus the screen on the suspect signal.

## Getting Clues from the Spectrum Width

The *Spectrum* display of the YBT250 can give you valuable clues to the source of an interfering signal. The spectrum width of the signal is one of the most useful. Table 1 lists the spectrum widths for some common interference signals.

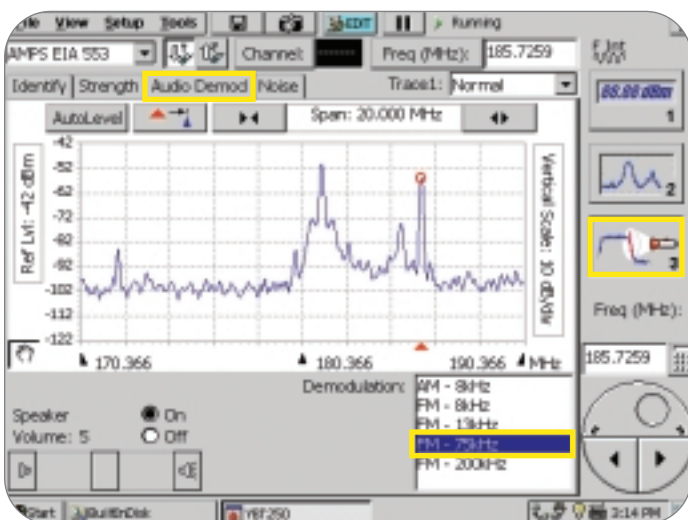
**Table 1. Spectrum Width Characteristics**

| Signal Class   | Signal Type          | Width        |
|----------------|----------------------|--------------|
| Wide Digital   | CDMA (IS-95)         | 1.23 MHz     |
|                | W-CDMA               | ~4 MHz       |
|                | TV Digital Broadcast | 5 to 7 MHz   |
| FM             | TV Digital STL       | 7 MHz        |
|                | 2-Way FM             | 15 kHz       |
|                | Analog Cellular      | 7 – 30 kHz   |
| Narrow Digital | Paging FM            | 15 kHz       |
|                | FM Broadcast         | 250 kHz      |
|                | TV Sound             | 70 kHz       |
|                | Broadcast Audio STL  | 250 kHz      |
|                | Broadcast Video STL  | 15 or 30 MHz |
| Other          | Paging FSK           | 10 kHz       |
|                | US-TDMA              | 30 kHz       |
|                | GSM                  | 200 kHz      |
| Other          | SMR                  | 20 kHz       |
|                | AM Voice             | 6 kHz        |
|                | SSB Voice            | 3 kHz        |

**Demodulating and Listening to the Interference**

There are many interference sources besides communications signals. Power-line related sources, or other unique sounding signals may be easier to identify when they are demodulated and can be heard through the speaker or headphones.

Tap the “Audio Demod” button to have the YBT250 demodulate the signal. You can also select from both AM and FM demodulation to monitor analog communication and broadcast signals for station identification. The demodulation operation is limited to short time periods to conserve battery power.



▶ **Figure 6.** Demodulating an incoming signal and listening to it.

**Tracking Interference over Periods of Time Using the Spectrogram**

Sometimes the interference is not present when you are looking for it. Some forms of interference only appear for short periods of time during long periods of inactivity. The spectrogram is a valuable tool for the detection and tracking of time-variant interference.

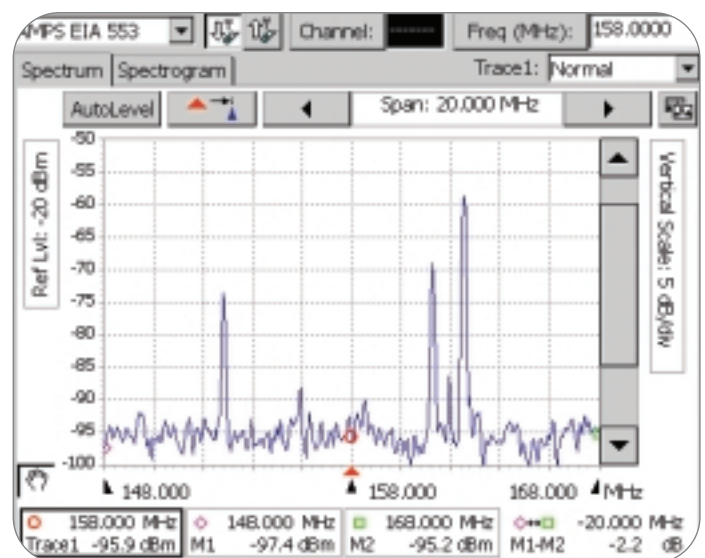
Start with a spectrum measurement and adjust the display to the area where the interference is occurring. Select the “Spectrogram” button. The spectrum display acquires a third dimension – time. The signal amplitude (which was displayed as the vertical axis of the spectrum view) is now displayed as color, the horizontal axis is still frequency and the vertical axis is time.

Note that the amplitude scale can be set for less than 10 dB per division. This stretches the signals over the entire axis to make best use of all of the available colors in the spectrogram and makes it easy to see each of the different signal strengths.

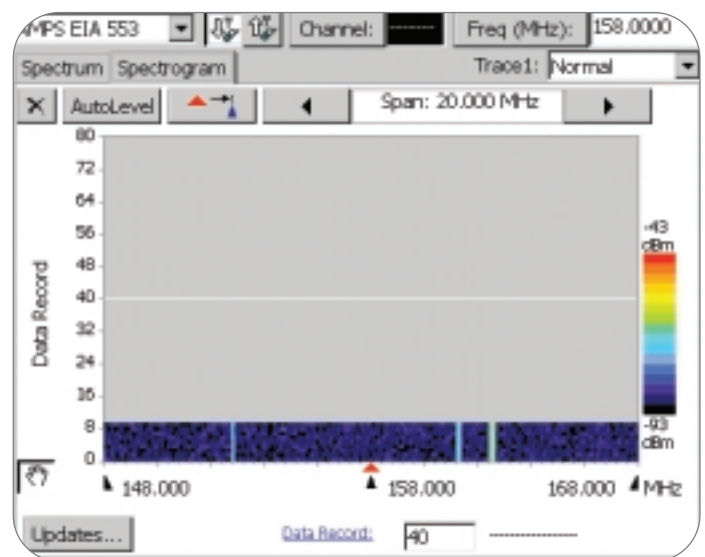
The history builds up with earlier time shown at the top of the display. As each new acquisition is processed into a frequency spectrum, its

trace is placed on the bottom of the spectrogram, pushing the older spectrum traces up. This creates a display where a continuous signal produces a solid vertical line (no change in frequency over time), while intermittent signals appear as broken lines at each of their separate frequencies. Colors indicate signal strength at each frequency and time.

Figure 8 shows the beginning of a spectrogram with the first ten spectrum traces at the bottom of the display. The lines at approximately 153, 161 and 162.5 MHz correspond to the signals seen in the spectrum display of Figure 7.



▶ **Figure 7.** A snapshot of some communication signals.

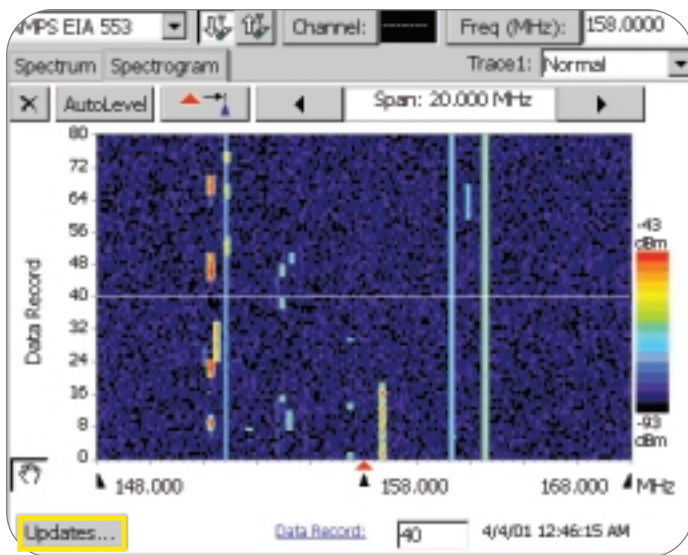


▶ **Figure 8.** The beginning of a spectrogram.

## Interference Testing Field Guide

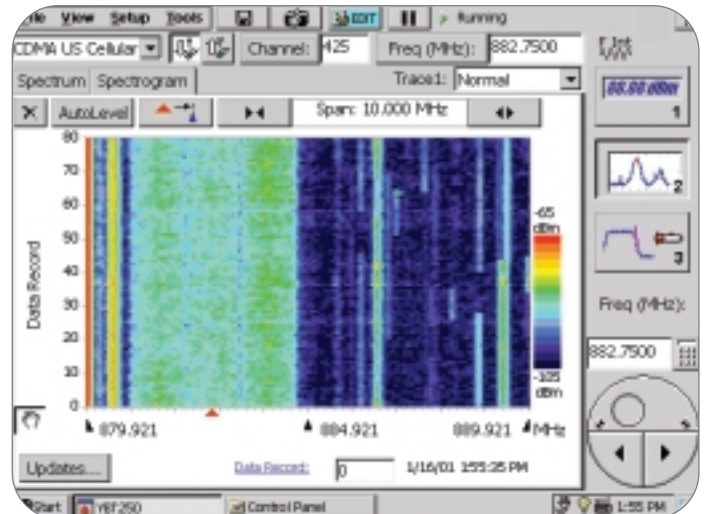
### ► Application Note

A little over a minute later the full spectrogram is completed, as shown in Figure 9. You can see that at least nine other signals have come and gone during the time span of the spectrogram.



► **Figure 9.** Completed spectrogram.

The spectrogram gives you a wealth of information in a single, compact easy to read format. Figure 10 is the spectrogram of measurements taken at a location in between several cellular sites. The left half of the display shows three CDMA channels next to each other. They have slightly changing amplitude as the number of users changes from time to time. The right half of the screen shows a dozen or so narrow-band cellular signals (both AMPS and IS-136). You can easily see how these traffic channels turn on and off as phone calls start and end.



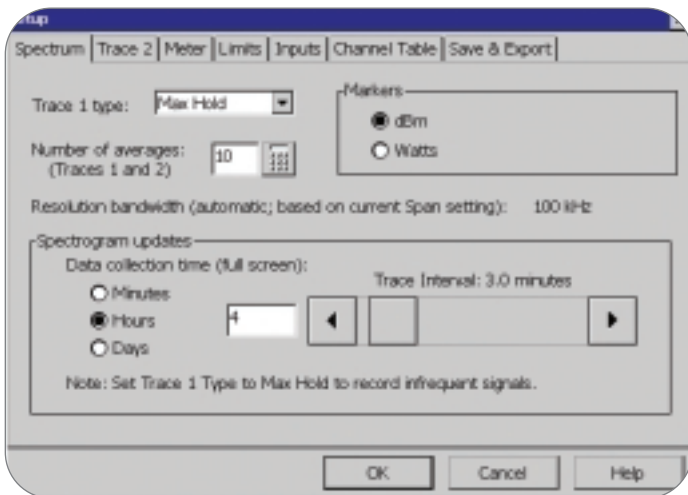
► **Figure 10.** Spectrogram of live cellular signals.

### Catching Sporadic Signals with Unattended Timed Spectrogram

In some cases the interference may appear only occasionally over long periods of time. The YBT250 can be left on site (using external power) to provide unattended monitoring of interference problems. You can get records of dropped calls from the mobile switching center and compare them to the timed spectrogram to see if an intruding RF signal is a likely cause.

The spectrogram can be programmed to update a new line only at timed intervals. In this mode, any arbitrary time span can be observed, and the YBT250 can be set so that the highest peak value of the signals seen during measurement time period is displayed on its own line. Any interference will leave its footprints in the spectrogram. The marker can be used to read out the time of the intrusion.

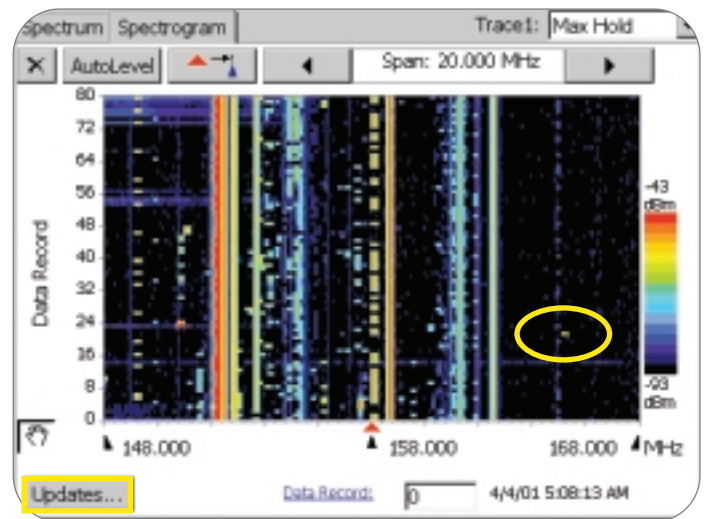
To set up a timed spectrogram, tap the “Updates” button in the lower left of the spectrogram screen, as shown in Figure 12a. You can select the time span of a spectrogram in minutes, hours, or days and set how many of those time units will be shown on a full spectrogram screen. The resulting time for each update will be displayed above the sliding entry bar. For the example in Figure 11, each update will take three minutes, and the full screen will show the signal activities over a four-hour period. When updates are scheduled for a delayed time, you will want to select the *Trace 1 type* to be “Max Hold.” This will record the maximum of any of the signals that show up during the three-minute delay time (instead of just saving those that were present at the end of delay time.) When you have finished selecting the setup, tap the “OK” button to return to the spectrogram mode.



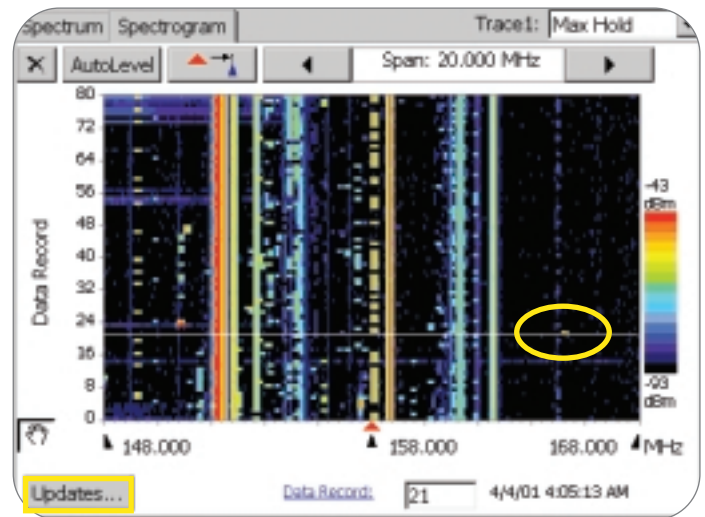
► **Figure 11.** The spectrogram Setup screen.

Figure 12a shows the result of a timed spectrogram measurement. The spectrogram contains a four hour span of capture time, and you can see many signals that were only present for a short time. In particular, there is a signal that was only present during one update time during the entire four-hour period.

In Figure 12b, the cursor has been placed on the signal that was present during only one update time, and displays the number of the data record and its date and time.



► **Figure 12a.** Timed spectrogram (four hours).



► **Figure 12b.** Timed spectrogram with cursor.