Application Note

Interference Analysis

JD7105A Base Station Analyzer / JD7106A RF Analyzer

Introduction

This document presents an overview of signal interference in RF wireless networks as well as a brief demonstration of the interference analysis function of JDSU's wireless field test solutions,

- JD7105A – Base Station Analyzer
- JD7106A – RF Analyzer

JD7105A – Base Station Analyzer

Background

Signal interference in wireless networks negatively affects transmission coverage and mobile capacity, limiting the overall network performance. Unavoidable signal interference is becoming more prevalent in the wireless community with the increasing number of active transmitters on the RF spectrum.

The spectrum is shared among different systems and services such as mobile communications, mobile radios, paging, wireless local area networks, and digital video broadcasting. In addition to the licensed systems, the spectrum is also occupied by unlicensed transmitters, reflections, and fading. The composition of all these signals is making a very complex environment which must be routinely monitored in order to maximize service performance.

Fig 1 – Spectrum Environment

Wireless service providers have traditionally used spectrum analyzers to monitor the performance of their transmission signals as well as the presence of adjacent frequencies in order to identify possible sources of interference. Unfortunately, the use of spectrum analysis has some limitations such as lack of location identification of the interfering sources, as well as the inability to identify intermittent signals.

To solve this, JDSU has introduced the Interference Analysis function in the JD7105A – Base Station Analyzer, and also in the JD7106A – RF Analyzer. This function performs two fundamental measurements for interference analysis:

1. Spectrogram. A measurement that monitors the spectrum in three dimensions, power, frequency, and time.
2. Received Signal Strength Indication. This measurement tracks the power through time of up to six different signals simultaneously.

In addition, the logging capability of JDSU's Analyzers enable users to collect data and perform unattended spectrum monitoring, capturing and storing the spectral data, while performing other tasks.

Demonstration

Equipment

The equipment required for this demonstration includes the following:

- JD7105A – Base Station Analyzer or JD7106A – RF Analyzer.
- Wide-band RF antenna (Omni or directional)

Instrument Setup

The setup diagram for interference analysis with an Omni antenna is as follows:

Fig 2 – Basic interference analysis testing

Interference Measurement

The key measurement parameters of interference analysis are:

- Spectrogram.
- RSSI - Received Signal Strength Indicator.

Once it has been identified the target signal using the instrument's spectrum analysis, it can then be setup the interference analysis function to monitor a frequency span and verifying the potential presence of interfering signals.

The typical steps to locate interference signals using JDSU's instruments are as follows:

1. Select interference analyzer mode.
2. Look at the spectrum display on the bottom of the spectrogram display to locate the suspected interfering signal.
3. Set markers on the different suspect frequencies.
4. Look at the assignments for this frequencies readout of the spectrum display.
5. Set a time interval, which the spectrogram will be saved.
6. Select the RSSI mode to track in more detail the signals identified with the markers, where each signal is being tracked measuring power variation through time.

Typical operating procedure to identify interference signals:

Instruction	Keystrokes
Set the instrument for spectrum measurement:	
i. Tune the center frequency to the carrier's frequency to monitor adjacent interfering signals	[Freq/Chan] {Center Frequency} {Carrier's Frequency} {MHz}
ii. Observe the display to verify the presence of the carrier's signal and if there is any indication of interfering signals.	
iii. Call up the marker menu	[Marker] {M1} {On} {M2} {On}… (up to 6 active markers)
iv. Set marker 1 to the carrier's frequency, and then assign multiple markers (up to 6 in total) to the suspect interfering signals	Rotate the KNOB or Up/Down Arrow Keys to move the active markers
v. Call up the interference analyzer mode, and choose spectrogram	[Mode] {Interference Analyzer} {Spectrogram}
vi. Call up the marker menu to analyzer frequency components (M1 ~ M6)	[Marker] {M1 ~ M6} {On}
NOTE: If you want to see the power variation of interfering signal, set marker to that frequency and move to RSSI mode	
vii. Call up the RSSI mode	[Mode] {Interference analyzer} {RSSI}

Table 1 – Basic Interference Measurements

Note: The key names denoted by [ ] indicate hard keys located on the front panel, while key names denoted by { } indicate soft keys located on the right side of the display.

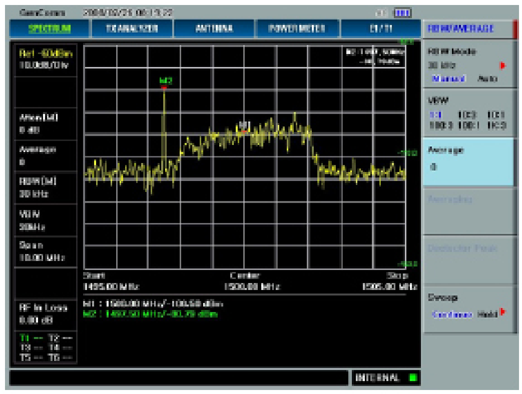

Fig 3 – Spectrum display

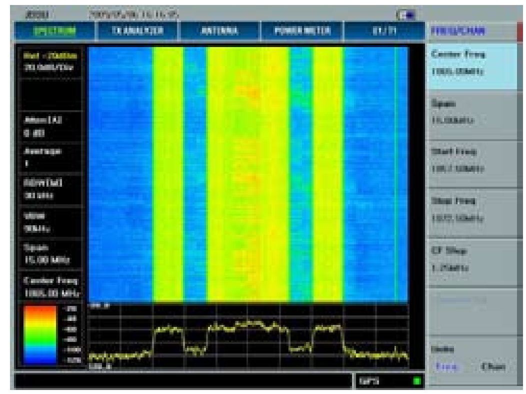

Fig 4 – Spectrogram display

Fig 5 – RSSI display

Identifying Intermittent Interference Signals

Intermittent interference can be difficult to identify. The spectrogram display is ideal for locating intermittent interference since it displays how a signal changes over time, together with its corresponding frequency and power level.

Intermittent signals will show up as discontinuous vertical lines. Signals of varying frequency will appear as a slanted or crooked line through the display.

Once it has been located an intermittent interfering signal, a marker can be set to its frequency and switching to the RSSI mode will provide further analysis of the interfering signals, where it tracks the signal's power variations over time.

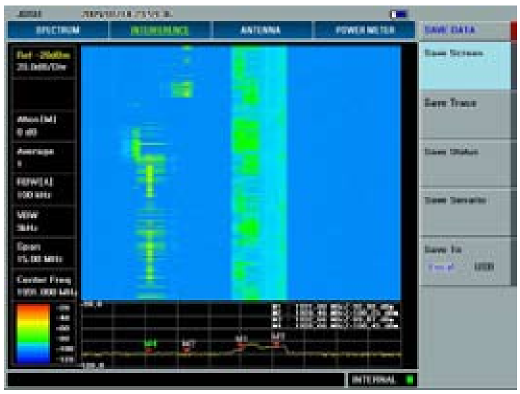

Fig 7 – Intermittent signal activity

Fig 8 – RSSI view for intermittent signals

Spectrogram Analysis

Introduction

A spectrogram is a three dimensional measurement.

7. The horizontal line or X-Axis of the spectrogram is frequency
8. The vertical line or Y-axis is time
9. And the color identification (spectrogram) indicates power level of the tracked signal. As the signal strength increases, the color on the spectrogram will change accordingly.

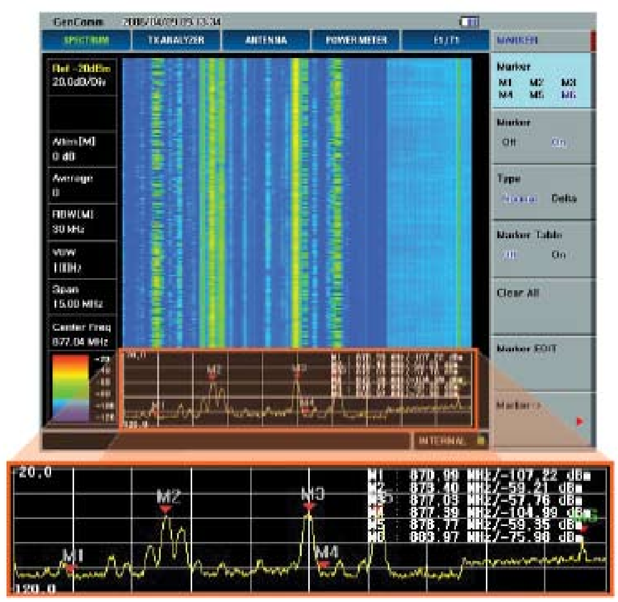

Fig 9 – Spectrogram measurement tracking six signals

The Spectrogram mode is useful for tracking the source of an interfering signal. This measurement is done at a defined frequency range. The power at a frequency (in dBm) is displayed along with a spectrogram. This mode is especially useful when attempting to locate an emitter using a directional (Yagi) antenna.

If a directional antenna is used the strength of the tracked signal will change corresponding to the direction of the antenna, and the interfering source will be located in the direction where the spectrogram indicates the highest signal strength.

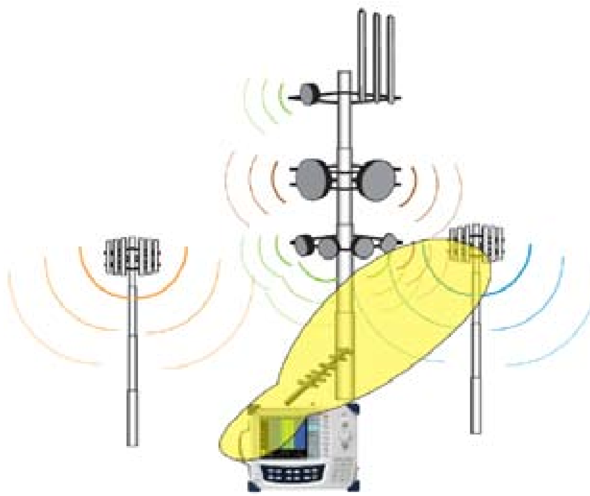

Fig 10 – Interference measurement with a directional antenna

Different methods are used to accurately identify the interfering source; the most commonly used is triangulation, where a directional measurement is taken from three different locations and the source is found where the three measured directions intersect.

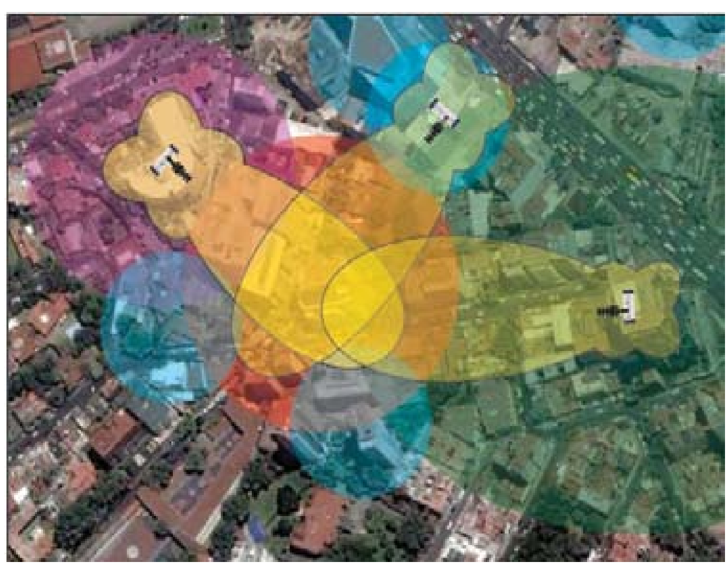

Fig 11 – Interference location through triangulation

Spectrogram Parameters

The spectrogram function of JDSU's analyzers provides great flexibility on different measurement parameters of the spectrogram to better analyze RF interference.

The spectrogram parameters include:

- Reset/Restart Measurement
- Time Interval
- Auto Save On/Off
- Time Cursor

Reset/Restart

Resets or Restarts the spectrogram measurement. When this feature is activated the accumulated spectrogram traces are erased and the measurement is initialized.

Time Interval

The Time interval feature sets the time between two consecutive measurement points. This time can be set from 110ms to 2hrs per measurement point. The spectrogram displays a total of 400 measurements, providing in a single display measurements from 44sec to over 33 days.

Auto Save On/Off

The Auto Save feature stores the spectrogram data automatically, where the data is named Log – followed by the time at which the data was stored. Each screen contains all the 400 data points and is stored as separate display, which can be saved for up to seven days. The unit saves the data in the saved trace directory and it can be recalled by selecting recall trace measurement.

Time Cursor

The Time Cursor is used to view the spectrogram at any measurement point. The Time Cursor indicates a horizontal line cursor which can be vertically moved through the spectrogram with the instrument's knob or arrow keys. The date and time of the measurement is indicated at the cursor's position along with the corresponding waveform shape at the bottom of the display.

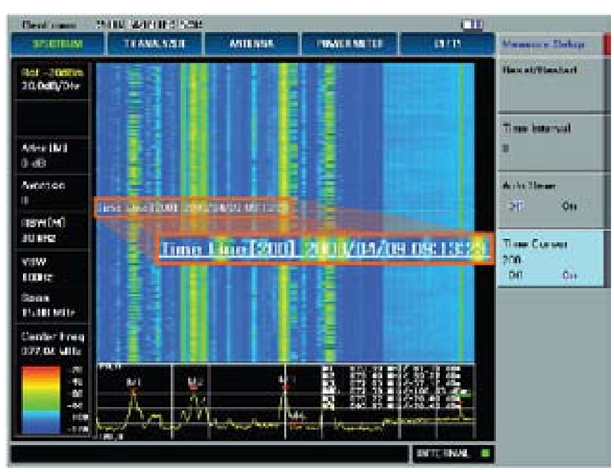

Fig 12 – Spectrogram measurement with Time Line Analysis

RSSI Analysis

Introduction

The RSSI - Received Signal Strength Indicator, is a two dimensional measurement of power variations through time, with the ability to simultaneously monitor up to six different signals capturing the following signal components:

- Frequency
- Maximum Power
- Minimum Power
- Average Power

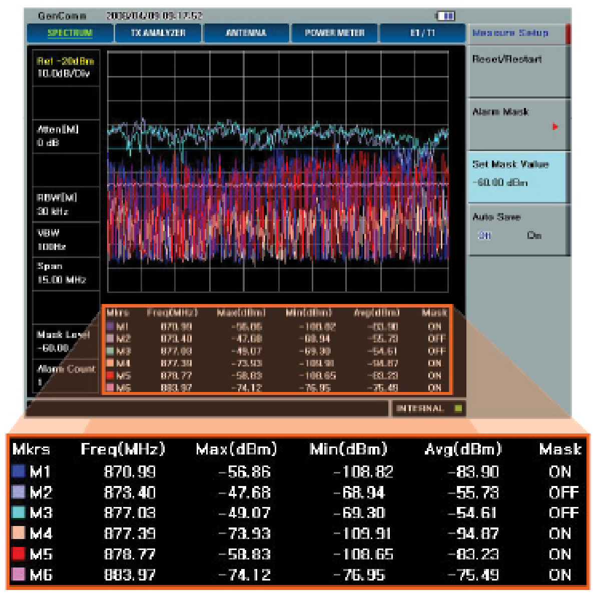

Fig 13 – RSSI measurement tracking six signals

JDSU's RSSI analysis also permits the assignment of a power threshold applicable to any of the monitored signals, where the instrument will alarm when the assigned signal measurement goes beyond the predefined threshold.

RSSI Parameters

The RSSI function of JDSU's analyzers provides great flexibility on different measurement parameters of the RSSI to better analyze RF interference.

The RSSI parameters include:

- Reset/Restart Measurement
- Alarm Mask
- Auto Save On/Off

Reset/Restart

Resets or Restarts the RSSI measurement. When this feature is activated the accumulated RSSI traces are erased and the measurement is initialized.

Alarm Mask

Alarm masks or thresholds are defined to indicate maximum power levels permissible in a specific signal measurement. An alarm mask can be assigned to each signal being traced; if the power level of the monitored signal reaches the alarm mask level, then the instrument will increase the alarm counter and will generate an audible alarm.

Auto Save On/Off

The Auto Save feature stores the RSSI data automatically, where the data is named Log – followed by the time at which the data was stored. Each screen contains 30sec of measurement points and is stored as separate display, which can be saved for up to seven days. The unit saves the data in the saved trace directory and it can be recalled by selecting recall trace measurement.

Conclusions

Interference Analysis is a fundamental testing procedure to monitor the spectrum's environment, which it is heavily used by different sources and organizations. An accurate analysis of the spectrum will ensure service coverage of wireless services and the identification of any interfering signals which may degrade the intended service.

JDSU's field test solutions perform all the necessary measurements that characterize the condition of wireless communications as well as the proper identification of impairments; analyzing the cell site performance including power transmission and power transfer, as well as monitoring the transmission delivery including spectrum and interference analysis. In conjunction, these conditions represent the overall RF performance of the wireless service delivered.

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