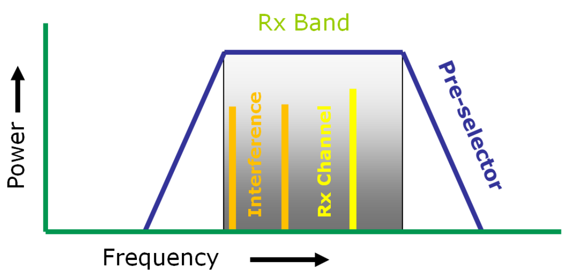
# Interference Troubleshooting Guide – utilizing Anritsu's Handheld BTS Master™, Cell Master™, Site Master S332/62E™, Spectrum Master™ w/ Options 25/27/31 and Master Software Tools

## What is Interference?

Interference is a receiver issue. **Receiver de-sense** occurs when an un-desired signal enters the receivers' front end and causes a reduction in sensitivity. This reduced sensitivity, in turn, lowers the apparent carrier-to-interference ratio (C/I) of the desired signal.




The unwanted, or interfering, signal does not need to be on the receive channel. If strong enough, it only needs to be within the radios' Rx duplexer or pre-selector frequencies.

In extreme cases, **receiver blocking** occurs and the desired signal is lost entirely.

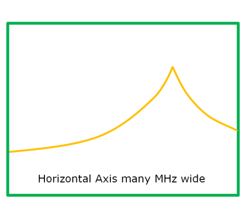
## Types of Interference

**Self Interference** is common within cellular systems. Common sources of self-interference include:

- Coverage issues due to power settings, mast height, or antenna tilt.
- Enhanced RF propagation over water.
- Errors in the PN Offset or Scrambling Code settings for CDMA and W-CDMA systems.
- Aliasing of PN Offset or scrambling codes.
- Multipath, when the number of paths exceed the number of receiver fingers.

**Impulse noise** is a common source of interference. It is mostly a problem at lower frequencies, save for arcing base station RF components, which cause problems centered on the carrier frequency. Impulse noise shows up as an intermittent rise in the spectrum analyzer's noise floor, or if in a wide span, in a shape similar to the illustration. Sources include:

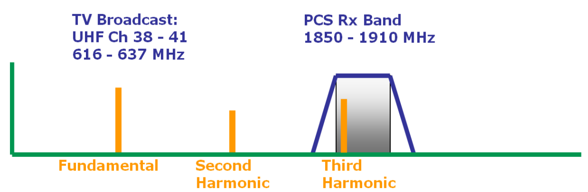
- Lightning arrestors
- Arcing antennas
- Arcing duplexers
- Electric motors
- Bakery ovens
- Welders
- Electric fences




Generic shape of impulse noise
Max-Hold waveform

## Types of Interference

**Harmonics** are signals that occur at multiples of a radios' carrier frequency. Often, the worst harmonic is the third. For example, if a carrier is at 300 MHz, the harmonic at 3 x 300, or 900 MHz, would be the strongest.




Sometimes harmonics become much worse than the legal limit. For instance, a transmitter with a class B output stage may lose a transistor, only amplifying half of the signal. This will produce a "Picket Fence" array of harmonics across the spectrum.

In other cases, legal harmonics may be an issue. For instance, the third harmonics of a United States UHF TV station on channel 38 through 41 will be in the PCS uplink bands. If the UHF station is physically close to the PCS band cellular receiver, the cellular receiver may be de-sensed or blocked by this legal signal.

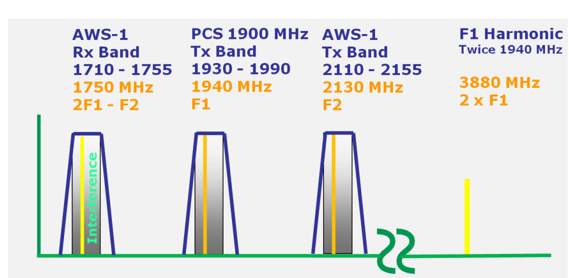
**Intermodulation Distortion (IM)** is caused by two or more strong signals and a non linear device such as a transistor, diode, or an environmental diode created by rust or corrosion. The two or more strong signals need to be stronger than +7 dBm, or so, to make the non-linear device switch. IM is often called the "Rusty Bolt" effect. More accurately, it is called Passive Intermodulation (PIM). The formula for the most common IM products are:

- 2f1 – f2
- 2f2 – f1

Where f1 and f2 represent the frequency of strong suspect source signals.

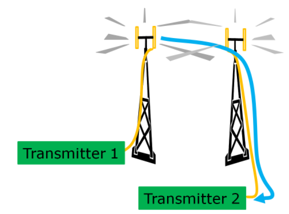
Here's an example of potential IM between a PCS 1900 MHz band transmitter and a cell site on the new AWS-1 2110 MHz band:

2F1 - F2
(2 x 1940) - 2130 = 1750




## Types of Interference

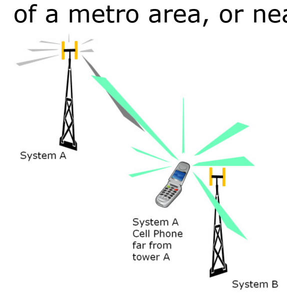
**Transmitter back feed** can create IM, as shown below. If the antenna and filter frequency response allow, and if the antenna isolation is poor, one transmitter's signal can reach the transistors in another transmitter's output stage, creating IM.




**Shared antennas** can create IM if the antenna or antenna cable run is corroded.

**Environmental diodes** also can create IM. Rusty roofs, rusty fences, corroded cables, and corroded connectors all can provide the rust needed for intermodulation.

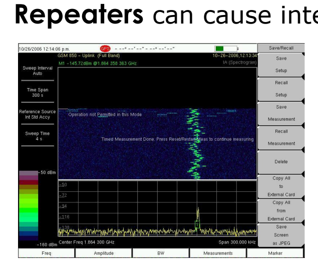
**Near Far** problems may occur near the edge of a metro area, or near microcells, where one network operator has better coverage than another. If a cell phone is a long ways from its tower, it will be transmitting at high power. If, at the same time, it is near another operator's tower, one it cannot hand off to, it may be transmitting within the other base station's pre-selector and cause de-sense. Near Far problems can be reduced by co-location.




**Unintentional interference** occurs when radio operators are unaware they are transmitting in another's band. This is usually easily corrected.

**Intentional interference** does occur, often with the best of intentions. Employers want to keep their employees off the phone; drivers want other drivers to keep their eyes on the road, and so on. A web search will spot many different types of cell phone jammers.

**Repeaters** can cause interference in two ways. The spectrogram shows a small office repeater, illegally installed, that had insufficient isolation between the two antennas which created an oscillation.

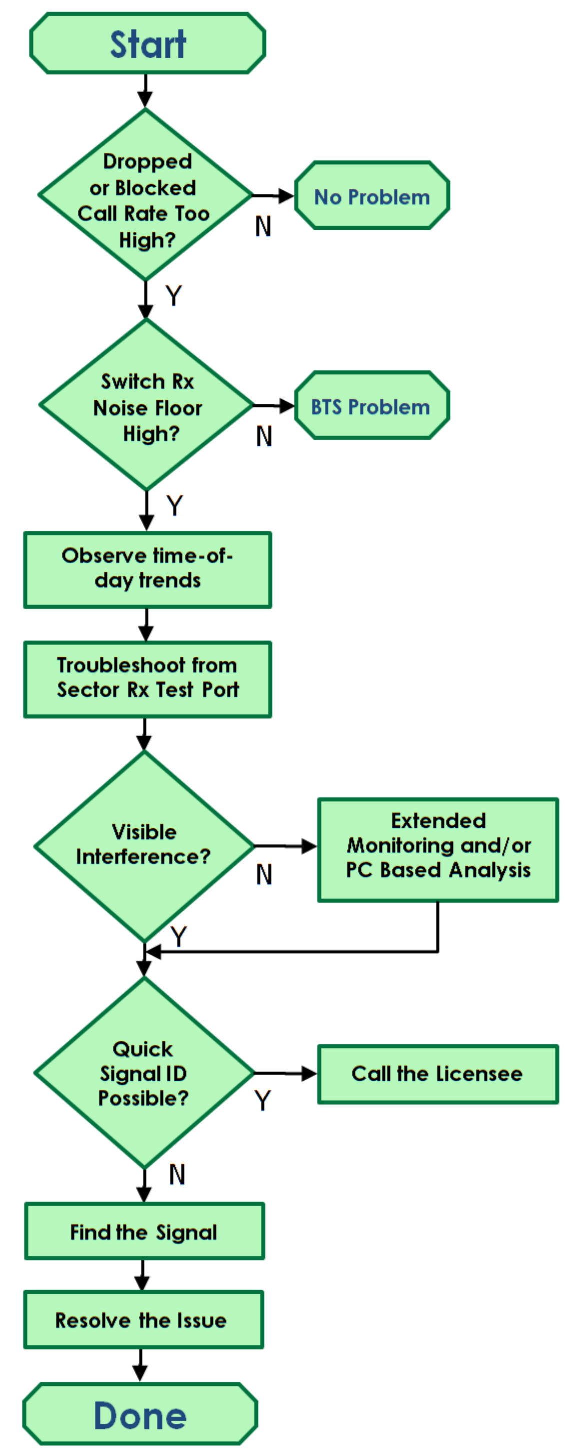


A different repeater issue comes up when a network operator installs a large area repeater that unintentionally amplifies other operator's signals. This can lead to unexpected excess coverage problems and frequency re-use issues.

## When to Hunt Uplink Interference

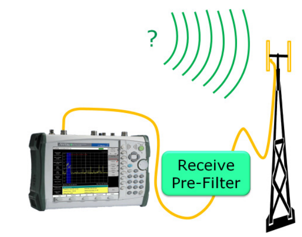
One of the most important things to know about interference hunting is when, and where, to start looking for the signal. As the flow chart shows, there are a number of diagnostic clues that indicate interference.

The most critical step in this decision tree is the Rx noise floor. If it is possible to monitor this from the switch, this becomes a powerful monitoring tool. If the Rx noise floor is high, it is time to start looking for the interference that makes it high.

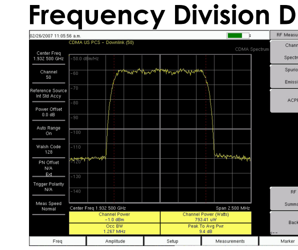



## Do I have Uplink Interference?

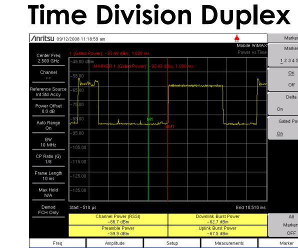
**Rx Noise Floor** tests can be done by hooking up to a Rx test port, or the Rx antenna, for the affected sector and make measurements when calls are not up. It is best if the receive pre-filter is between the spectrum analyzer and the Rx antenna, since that will allow the spectrum analyzer to see the same signal the receiver does.



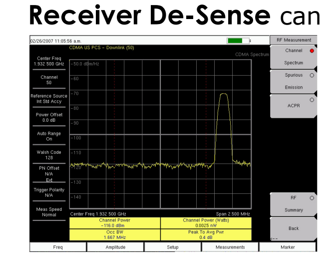

**Frequency Division Duplex** (FDD) base stations, such as GSM, CDMA, and W-CDMA, can use the spectrum analyzer's channel power measurement, but use it at the receive frequency. This approximates the switch's Rx noise floor measurement. The measurement must be made during a quiet time when no calls are up. The same screen also normally has occupied bandwidth, to aid in signal identification.



**Time Division Duplex** (TDD) systems, such as TD-SCDMA and WiMAX can use the gated power measurement on the Power vs. Time screen to approximate the switch Rx noise floor measurement. Again, the Rx noise floor measurement must be made during a quiet time, when no calls are up.



**Receiver De-Sense** can be caused by strong signals outside the channel, but within the pre-filter. The illustration shows a signal just outside a W-CDMA Rx channel (indicated by the vertical dotted lines) which is lowering the cell's receive coverage. Once interference is seen at the Rx antenna, it is time to find it again at ground level and locate the source.



## Downlink Interference

Downlink interference is also a receiver issue. In this case, the interference hunt needs to start from the area identified as faulty by customer complaints.

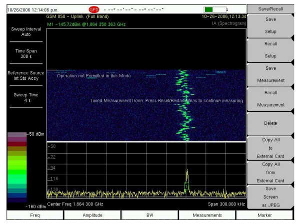
Anritsu

# Interference Troubleshooting Guide – utilizing Anritsu's Handheld BTS Master™, Cell Master™, Site Master S332/62E™, Spectrum Master™ w/ Options 25/27/31 and Master Software Tools

## Interference Monitoring

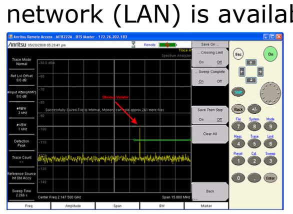
If the interfering signal is not present when you are at the base station, interference monitoring can help. The goal of monitoring is to find out when the interference happens, what it looks like on the spectrum analyzer, how it behaves in the frequency domain, and where it is visible.

The **spectrogram** is quite useful when looking for intermittent or hopping signals.



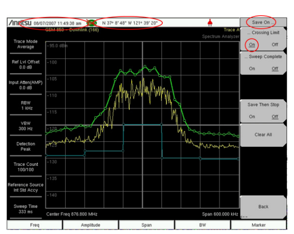
First, its colors allow spotting signal patterns that might otherwise go unnoticed. By adjusting the top and bottom colors, these differences can be highlighted. Second, when paused, it is possible to scroll through the data, viewing intermittent signals of interest in both the spectrogram mode and the conventional Power versus Frequency mode.

**Remote Monitoring** is useful if a local area network (LAN) is available at the monitoring



sight. In this case, it can be very helpful to hook the BTS Master up and operate the instrument remotely. This makes it possible to monitor the site from the office, modifying the instrument setup when the interference appears to get a better view of the issue. This is a good way to characterize an intermittent interfering signal without multiple trips to the site.

**Save-on-Event** masks are a helpful way to

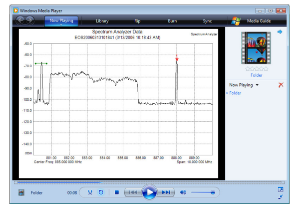


simplify stand-alone signal monitoring. It is very useful when a LAN is not available. The best way to create a Save-on-Even mask is to first collect a max-hold waveform of the normal spectrum. The mask (limit lines) can then be created with a one button click. It can then be set to capture traces only when unusual events, such as interference, occur. This extends monitoring time and expedites analysis. On the lower side of the signal, a minimum mask can be created, which will save traces only when signals that should be present are not. This would show if a carrier went missing for some reason.

## Master Software Tools

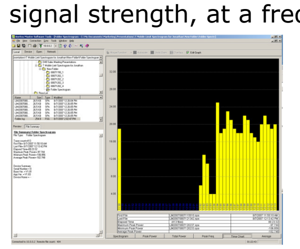
Once data is captured, it can be moved to a PC or laptop for off-line analysis.

**Movie capability** allows replay of significant parts of the power versus



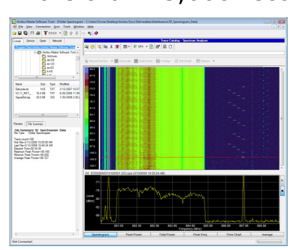
frequency captured traces in real-time. This allows viewing the trace as if you were there during the interfering event. By seeing the signal in this manner, it is sometimes possible to recognize the interference immediately.

The **histogram** allows correlating captured signal strength, at a frequency, to time.



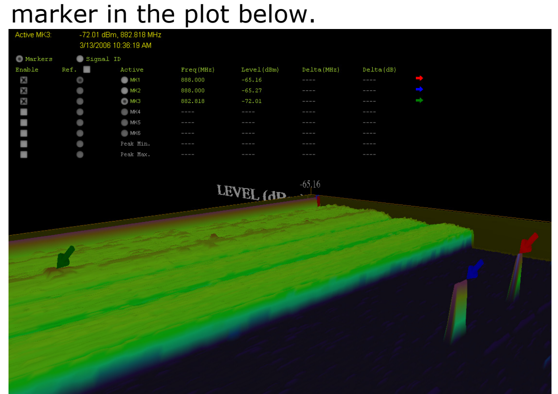
This helps characterize how the interfering signal behaves over time. If it shows, for instance, that the interference consistently shows up between 3:00 PM and 3:05 PM on weekday afternoons, that's a good time to run the interference hunt.

The **Folder Spectrogram** allows views of more than 15,000 recorded traces at once.



Like the spectrum analyzer based spectrogram, it is a great help when looking for weak signals, drifting carriers, or hopping signals. When loaded with the results of a Save-on-Event signal monitoring session, the time mark on each trace can be particularly useful.

The **3D-Spectrogram** can make recorded signals near, or on, other signals really stand out. As an example, take a look at the small interference signal near the green marker in the plot below.

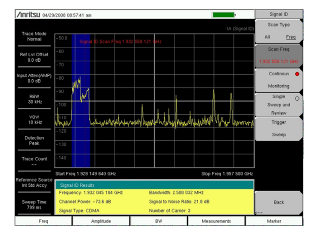


## Identifying Interference

**Visual Recognition** by signal shape requires experience, but is a quick way to identify common signals.

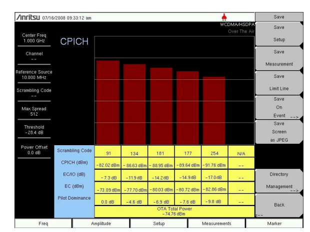
**Call signs** are a quick way to identify traditional radio signals. Even paging signals broadcast a Morse code identifier. These call signs can be found in regulatory data bases, such as the US FCC's data base at http://wireless2.fcc.gov/UlsApp/UlsSearch/searchLicense.jsp. Regulatory data bases gives information on licensed transmitters, including location, frequency, signal type, and contact phone numbers.

**Signal identification** software can identify digital signals. Many digital signals, cellular signals among them, do not transmit a easily



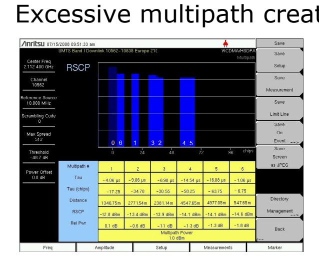
decoded call sign. The Master series of spectrum analyzers has a Signal ID option which takes much of the mystery out of the spectrum.

**Scrambling Code or Pilot Scanners** can be used to troubleshoot interference problems caused by the network operator's own signals. These powerful tools

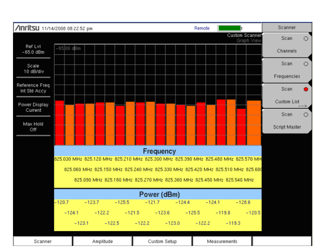


give information to identify self interference sources including signal quality, pilot dominance, scrambling codes, PN Offsets, and Sector IDs.

**Multipath Scanners** analyze specific digital signals to look for excessive reflections. Excessive multipath creates interference from



fading, particularly affecting CDMA and W-CDMA cell phone reception. These scanners show the various time delays, in distance, chips, and micro-seconds a specific digital signal experiences.



**Channel Scanners** work on any signal and are useful when looking for IM or harmonics. They can help spot signals widely separated in frequency that turn on and off together. This action indicates a cause-and-effect relationship between the two signals.

## Locating Interference

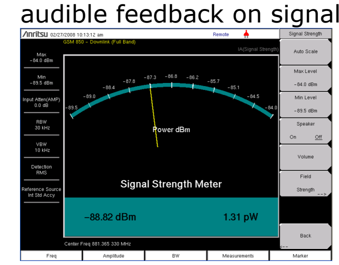
**Spectrum Analyzer** sensitivity is important when searching for an interference source. The better the sensitivity, the larger the area over which a signal can be detected. Modern hand-held spectrum analyzers, when optimized for interference hunting, are capable of displaying a noise floor under -160 dBm.

**De-sense** can be an issue for spectrum analyzers

as well as radio receivers. When a spectrum analyzer is used to hunt signals in the physical vicinity of a strong transmitter, the front end may be de-sensed. There are a number of small receive filters available for spectrum analyzers that eliminate this issue.

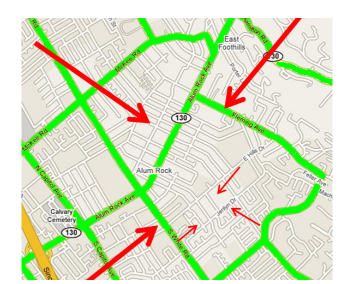
**Fixed Markers** are one of the simplest ways to look for changes in a signal as you move around. A marker can be placed on the interfering signal and frozen, or become fixed, in amplitude. A second marker is used to show the difference between the fixed marker and the current trace.

**Signal Strength Meters** offer both visual and audible feedback on signal strength. It's a quick



way to hear the signal strength change as you move around or swing a directional antenna. When close to an interference source, this can be a fast way to find the source. The RSSI display can be used in a similar manner.

**Direction Finding (DF)** work is best done with a

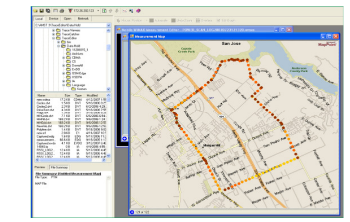


directional antenna, such as a Yagi, tuned to the band of interest. The DF process involves taking a series of directional readings, or bearings, of the suspect signal and recording those readings on a map. By taking readings closer and closer to the source, the signal can be found, even if reflections are present.

Some signals are difficult to spot from ground level. It can be helpful to take bearings from building rooftops if possible. If not, bearings can be taken at ground level at an intersection, followed by travel in the direction of the strongest signal. Repeat as needed to find the source.

## Locating Interference

**Plotting interference** signal strength is a powerful way to locate elusive signals. Since



the Master series instruments have a GPS option, it's possible to hunt down interference by recording an interference signal's power readings by location which can then be placed on a PC based map. There, the readings can be collected and compared to readings from other signal hunting sessions. This can be very useful when dealing with an intermittent signal. This technique can also be used for frequency clearing and checking coverage.

## Resolving Interference

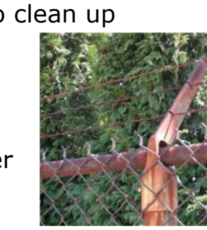
Once interference is located, the issue needs to be resolved. If the signal is illegal or the result of equipment problems, the solution is

Filter picture courtesy of Telewave www.telewave.com

often to turn the offending transmitter off. In some cases personal safety may be at stake. In this case, please get assistance from regulatory or police agencies.

In other cases, a transmitter or receiver will need filtering. There is a wide array of band pass, band reject, and notch filters available and more can be custom made. Sometimes, due to legal rights and contracts, the only solution is to choose another location for one of the radios.

If the issue is IM, it is time to clean up environmental diodes. This can involve relocating transmitter antennas to ensure adequate isolation, swapping out old multi-carrier antennas, and dealing with rusty or corroded junctions.



Corrosion can be dealt with by cleaning the affected joint, insulating the junction so electrical contact is no longer made, or by making a solid electrical connection between the offending parts. Some fences or galvanized structures may need to be removed or replaced.

Old lightning arrestors are prone to arcing, as are corroded or fractured antennas. Generally, the only way to deal with this is to replace the part.

Anritsu



Document No. 11410-00472, Rev C Printed in the United States 2010-01