R&S®PR100
Radio Interference Detection and Analysis
Application brochure

Short-range detection in mobile radio networks

Applicable products from Rohde & Schwarz:
- R&S®PR100 portable receiver
- R&S®HE300 active directional antenna

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Table of Contents

Introduction

This application brochure serves as a guideline and manual for mobile radio network field technicians and radio engineers tasked with detecting radio interference. Rohde & Schwarz offers a comprehensive product portfolio for the analysis of various mobile radio network systems including 2G, 3G and next-generation wireless-communications technologies.

Radio frequency interference (RFI) is defined as an unwanted signal that originates from an internal or an external source. Internal RFI may stem from faulty channel or code planning (e.g. incorrect TCH reuse factor) or double scrambling code provisioning. To detect this type of interference, Rohde & Schwarz offers coverage measurement tools and network scanners that can scan GSM, UMTS and CDMA2000® frequencies in parallel. Rohde & Schwarz has additional application sheets that describe this product family.

Another internal source of interference is the base station subsystem. Faulty components such as antennas, RF cables, connectors, filters, duplexers, power amplifiers and guy wires can produce intermodulation, harmonics, passive fractional spectral emissions and other types of interference. In some cases, even working components can cause radio interference together with plates, wires and metal boxes. Rohde & Schwarz offers the R&S®FSH4 and R&S®FSH8 handheld spectrum analyzers, including a two-port vector network analyzer with VSWR bridge, for identifying faulty components. An additional application sheet is available on this topic.

This application brochure is based on the R&S®PR100 portable receiver and the R&S®HE300 active directional antenna for the detection of external RFI sources, which can originate from licensed or non-licensed radio services. Direct or up- and downconverted carriers from various sources can interfere with the uplink and downlink channels in the mobile radio network bands.

RFI and the user channel

Today's wireless telecommunications systems use digital modulation for upconversion in the transmitters and digital demodulation for downconversion in the receivers. In-phase/quadrature-phase modulation/demodulation technology is used in all latest-model mobile phones and base stations (e.g. GMSK, BPSK, 8PSK, QPSK, 16QAM). A distinction is made between (super) heterodyne and homodyne receiver technology. Both types generate a symbol rate at the end and subsequently a bit rate containing the different physical channels, which in turn represent a group of dedicated users and a control channel.

When discussing RFI, the focus is on non-government authority signals that appear as "normal" GSM, CDMA or WCDMA signals.

Interfering signals generate additional noise inside the receiver in the user channel. This noise decreases the S/N ratio, leading to diminished radio coverage. To detect the symbol rates, each modulation scheme requires a specific S/N ratio. Higher modulation schemes such as 8PSK or QAM need a higher ratio than simple FM systems because they require higher bandwidth. If the noise increases due to an interferer, the ability of the demodulator to distinguish between different symbol rates is reduced. This leads to a bit error rate (BER) that may not impact voice channels, but can affect the control and data payload channels. The worst case is a dropped call, cell handover failure or a reduced data rate for the customer application. If the noise increases by 6 dB, the maximum usable distance will be reduced by half compared to a normal noise floor. This example illustrates the importance of detecting and analyzing interference.

Terminology

The following is a list of common terms associated with the detection of interference in mobile radio network systems:

- RFI indicators, impact of RFI on mobile radio networks
- Downlink RFI (forward base frequency band), mobile interference
- Uplink RFI (reverse base frequency band), base station interference
- Co-channel interferer
- Adjacent channel interferer
- Narrowband RFI in relation to user channel bandwidth
- Broadband RFI in relation to user channel bandwidth
- Fade-out signal (FOSiG) method, disruption of the base station transmit signal
- R&S®PR100 modes: frequency, memory and panorama scan
- R&S®PR100: spectrum and spectrogram, waterfall diagram
- R&S®HE300 active directional antenna: direction finding, triangulation, localization
- R&S®PRView software: documentation and editing
- R&S®GX430 software: radio system classifier application

2.1 RFI indicators

RFI can cause mobile-originated or mobile-terminated calls to be interrupted or dropped. Handover scenarios will not work properly and data rates for schemes such as HSDPA, HSUPA, GPRS, EDGE and EV-DO can be decreased due to demodulation errors in the uplink or downlink receiver components. RFI signals can also be intermittent, such as when a private WiFi router is switched on and off in the morning or evening. The faulty transmit filter interferes with the WCDMA downlink channel. Blocked cells and low voice quality can be an indication of RFI. Radio access network (RAN) counters in operation and maintenance (O&M) systems are used to collect data related to problems in the radio access network caused by SGSN or GGSN network elements. When voice quality, signal quality or latency thresholds are exceeded, a specific counter is incremented. Although there are many types of counters, only one or two are required to detect the presence of RFI.

2.2 Downlink RFI

Cellular networks use a lower frequency band for the uplink (reverse baseband) from the mobile phone to the base station and a higher frequency band for the downlink (forward baseband). The bands are separated using duplex spacing. There are some exceptions such as cdmaOne, where the uplink and downlink channels may overlap within a specific channel range.

Downlink RFI occurs in the receiver band of the mobile phone, e.g. if the interference originates from a high transmit location such as the roof of a building or a hill. If the interference is short-range, such as from a wireless video transmitter in a store, it will affect only a small number of mobile phones.

2.3 Uplink RFI

Uplink RFI affects the base station receiver band and ultimately all mobile phones since they have to increase transmit power depending on the strength of the RFI signal. The impact on CDMA-based systems is increased PN noise, lower data rates and a decrease in voice quality due to unscrambling problems in the rake receiver. Cellular networks use sector antennas with an angle between 30° and 180°. In some cases omnidirectional antennas are utilized. The base antenna direction can be used to locate the interferer.

Direct transmitted, mixed signals and PIM:
RFI can be a direct transmitted signal (or harmonics of it) or a mixed signal from up- or downconversion systems such as active conversion or passive intermodulation signals (PIM).
If no direct service is related to the frequency band, the RFI could be a harmonic of any order or a converted signal due to an oscillating amplifier or passive intermodulation caused by faulty cable connectors or partially broken antennas, for instance.

2.4 Co-channel interferer

Example: GSM, 200 kHz channel spacing, up to 600 kHz bandwidth due to GSMK modulation. If channel TCH 21 is used for sector A, TCH 22 and TCH 23 cannot be used for sectors B and C. If a signal is transmitted in TCH 21, this is referred to as co-channel RFI.

2.5 Adjacent channel interferer

Following the example from 2.4, an interfering signal is referred to as an adjacent channel interferer if it is located in TCH 22 or 23. In other words, it is located either one channel higher or lower than the user channel (21).

2.6 Narrowband RFI

Different cellular standards use different types of modulation such as cdmaOne 1.23 MHz, WCDMA 5 MHz and GSM 200 kHz. Depending on the RFI bandwidth in relation to the interfered user channel, the term "narrowband" applies if the ratio is less than 20%. An AM audio transmitter with 15 kHz bandwidth in the WCDMA downlink band is considered a narrowband interferer, which could drive the mobile receiver into compression depending on the signal strength. On the other hand, a 15 kHz interferer bandwidth transmitted in a paging network with 30 kHz channel bandwidth is no longer considered narrowband RFI.

2.7 Broadband RFI

Broadband RFI occurs if the interferer bandwidth is more than 20% of the user channel bandwidth. For example, a WiFi transmitter with 2 MHz bandwidth and a faulty transmitter filter could impact the CDMA2000® band, reducing the signal level by 40 dB.

2.8 FOSiG method

The best way to detect, locate and analyze RFI signals is to switch off the wanted signal in the observed channel or band. The downside is interruption of service to all customers in the affected sector. The upside is a channel with a normal noise floor and isolation of the RFI signal. This is the preferred method depending on the extent of the service interruption (e.g. total service disruption).

2.9 Non-FOSiG

RFI sometimes appears only for a few seconds or a fraction of a second. The affected channels are typically located in high-use, high-turnover areas such as inner cities and financial districts. This eliminates the option of switching off the base station signal for an extended period of time during the day. The alternative is to switch off the signal in the middle of the night during low-activity periods or to perform an analysis during the day. The R&S®PR100 portable receiver provides an overview of the signal power for the specific channel or band.

2.10 Scan modes

The R&S®PR100 offers three scan modes:

- Frequency scan mode:
  used for scanning a specific frequency range with user-defined parameters; step size between 1 Hz and 1 GHz
- Memory scan mode:
  for scanning channels stored in a specific memory range of the device. The user can set parameters such as frequency, demodulation type, bandwidth and squelch for each line in a memory table. This could be a channel table for any type of interferer such as a 35 MHz standard for RC model airplanes
- Panorama scan mode:
  used as a "quasi spectrum analyzer" for a wide scanning range without scanning. Step size, start/stop frequency and sampling analog RF panorama scan resolution can be set. Decreasing the resolution increases the measurement time depending on the RFI signal. For optimal results, start with the highest resolution and reduce it according to the RFI signal

2.11 Spectrum and spectrogram, waterfall diagram

In fixed frequency mode (FFM) or RX mode, the R&S®PR100 provides two displays, allowing the user to set the following parameters for two different signals: frequency, IF bandwidth, demodulation bandwidth, demodulation type and markers. The display will show the IF spectrum for a specific center frequency with a maximum IF bandwidth of 10 MHz. For direct demodulation, different types are available (AM, FM, LSB, USB, ISB, CW, I/Q, PULSE). The IF bandwidth ranges from 1 kHz to 10 MHz. The demodulation bandwidth can be set between 150 Hz and 500 kHz.

To search for short-time RFI signals, the RFI amplitude variation must be shown as a function of time. This is referred to as the spectrogram or waterfall view. The most recent measurements are displayed on the top line of the waterfall view.

Compared to the single spectrum IF view, the signals are now easier to detect. For instance, a radio-controlled garage door opener, which operates close to some cellular bands at 866 MHz, will not appear in the spectrum view when used only for a second. Instead, it will show up as a narrowband vertical line in the waterfall view. Stopping the recording makes it easier to analyze the signal.

2.12 R&S®HE300 active directional antenna: direction finding, triangulation, localization

RFI detection should initially be carried out with an omnidirectional antenna in order to gain an overview of the disturbed band or channel. As a second step for uplink interference detection, a diversity base antenna should be used, followed by the R&S®HE300 active directional antenna for the range between 500 MHz and 7.5 GHz. When an RFI signal has been detected in any scan mode or in the fixed frequency mode, select the RX only or RX + SPECTRUM mode from the DISPLAY MODE menu. RFI signal strength, measured in dBµV or dBm, is displayed numerically and graphically with a horizontal bar.

An audio tone that can be heard via loudspeaker or headphones also provides an indication of RFI signal strength. By moving the R&S®HE300 in a continuous circle, the direction of maximum signal strength is found as soon as the audio tone reaches its maximum pitch. However, the influence of the environment has to be taken into account. In urban areas, for example, reflections from coated windows on office buildings can cause measurement errors.

It is therefore advisable to perform measurements from several positions. GPS position and compass angle should be noted on a map for RFI transmitter position triangulation. This procedure requires experience and knowledge of wave propagation and wavelengths, particularly inside buildings.

2.13 R&S®PRView software: documentation and editing

The R&S®PR100 can be connected to the R&S®PRView software via a LAN or USB interface. The R&S®PRView software can be used for tasks such as screenshots or editing memory scan lists, antenna lists, and k-factor lists.

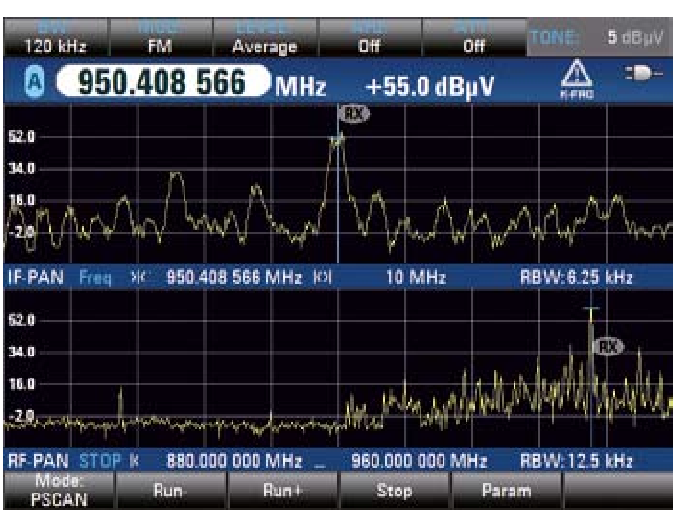
Optimum RFI detection settings for the R&S®PR100

3.1 General tips for locating RFI

- Start with a wideband panorama scan with coarse resolution (PSCAN, RBW, e.g. 100 kHz) for maximum scan speed
- Set the measurement time to the minimum value of 500 µs, for maximum scan speed
- After identifying a frequency range of interest, restrict the start and stop frequency of the panorama scan to this band and decrease the PSCAN RBW in order to increase resolution and sensitivity
- Switch to DUAL SPECTRUM mode and select the frequency of interest with the RX marker while running the panorama scan
- Stop the panorama scan; the receiver will automatically switch to fixed frequency realtime operation with a maximum IF bandwidth of 10 MHz
- The signal can be analyzed in detail by zooming in or out, performing demodulation tasks, etc.
- The fixed frequency mode (FFM) takes full advantage of the sophisticated signal processing capabilities of the R&S®PR100 such as maximum monitoring speed and performance

3.2 Settings for interference detection with the R&S®HE300 active directional antenna

- Tune the R&S®PR100 to the center frequency of the target interference signal
- The demodulation bandwidth must be equal to or greater than the bandwidth of the interfering signal to achieve maximum sensitivity
- If the demodulation bandwidth is too narrow, the R&S®PR100 will measure only part of the RF level, thus reducing system sensitivity
- The demodulation type is not critical since it does not influence the measurement
- Switch off automatic frequency control (AFC) and switch off manual gain control (MGC) to avoid automated tuning effects inside the receiver that cannot be controlled and which can affect the measurement results
- Switch off the SQUELCH function
- Switch on the AVG detector for the level measurement path for a stable level reading
- Increase the measurement time to 200 ms for additional stability
- Switch on the TONE function to listen to the audio tone; this helps locate a signal without constantly looking at the dBµV level reading on the display
- Adjust the audio tone (for most comfort) to a medium power level by using the center knob on top of the receiver
- If the signal of interest is too strong, switch on the attenuator (ATT) to prevent receiver overload



Dual spectrum mode for fast transition between broadband PSCAN and narrowband IF analysis.

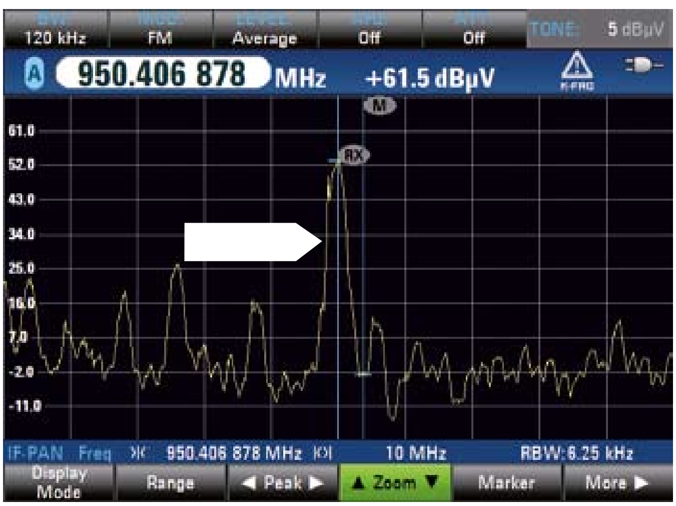
Level measurement of signal at center frequency and its acoustical representation by means of the Tone function.

3.3 Interfering signal adjacent to a wanted signal

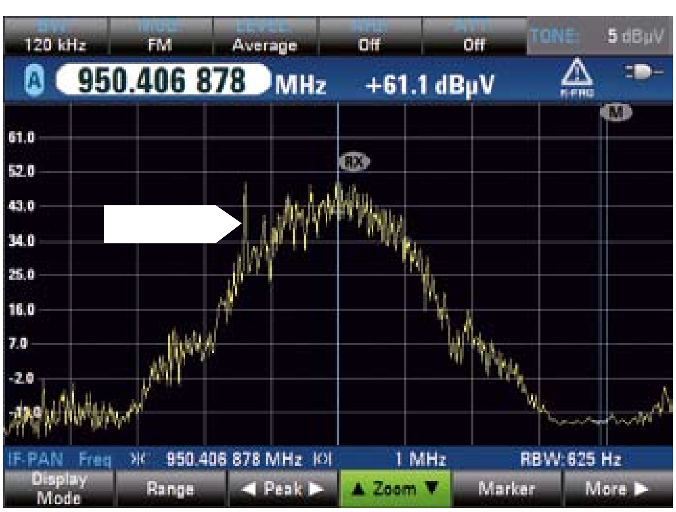
- Set the receiver to the center frequency of the wanted signal and use the 10 MHz IF bandwidth
- The wideband view shows only the wanted signal (white arrow in 10 MHz spectrum)
- Use the ZOOM function (center frequency remains the same) to locate the additional peak in the spectrum, which may be the interfering signal (white arrow in 1 MHz spectrum)
- For a smooth curve, select the AVERAGE function on the display
- Increase the measurement time to 100 ms or more

3.4 RFI on the same frequency, but shortly after the wanted signal

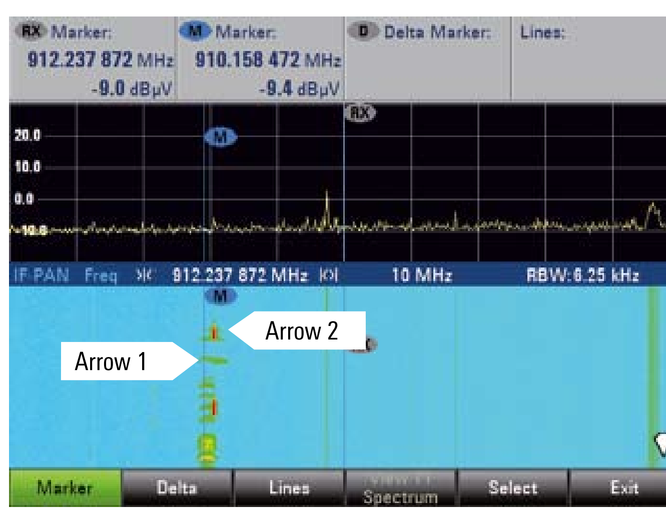
- Set the receiver to a center frequency near the wanted signal and use the 10 MHz IF bandwidth
- Select the SPECTRUM + WATERFALL combination display
- Set the IF spectrum to MAX HOLD and use a measurement time of 100 ms, for example
- The wanted signal at 'Arrow 1' (a GSM mobile phone) is followed by an interfering signal with unstable timing at 'Arrow 2'
- Both signals disappear from the spectrum view at the time of the screenshot, but they can easily be monitored in the waterfall diagram



RFI close to a wanted carrier is hard to find if IF spectrum setting is too wide.



By zooming in, the RFI signal can be clearly identified.

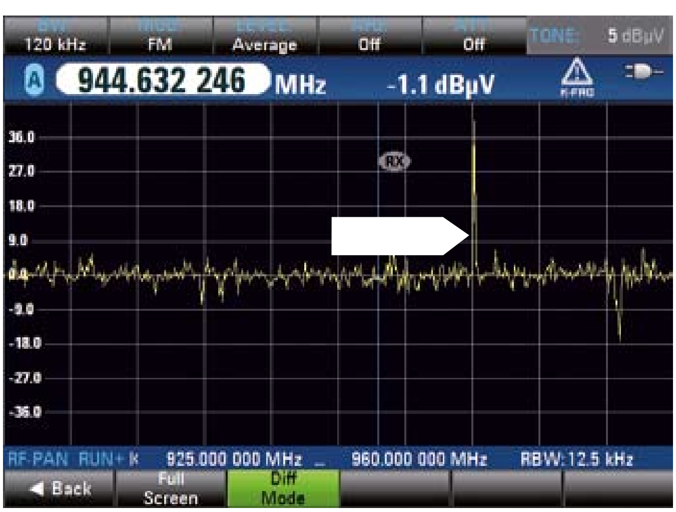


RFI shortly after the wanted signal is clearly visible in the waterfall diagram.

3.5 Short-time RFI hidden in stable wanted signals

- Use the panorama scan to display the spectrum of the GSM downlink from 925 MHz to 960 MHz
- Short-time RFI signals are difficult to identify among the many signals that are displayed
- By activating the differential measurement mode, the receiver stores a reference spectrum received when DIFF MODE is pressed
- Each newly calculated spectrum is subtracted from the stored reference spectrum
- As a result, stable signals that are present in both spectra are suppressed
- New signals not present when DIFF MODE was pressed are then made visible
- This significantly reduces the number of peaks in the spectrum that must be analyzed

The large number of signals makes it difficult to identify time-variant signals.



The differential mode enables the operator to easily identify a signal that was not present at the time when the reference spectrum was stored.

Detecting RFI in the uplink band

4.1 Preparation, preliminary checks, tips

Make sure there are no base station hardware alarms related to power amplifiers (VSWR problems), TMA, duplexers, combiners and microwave, fiber-optic or DSL links. Check the GPS module if the base station has one (clocking reference). An unstable clock reference can lead to an incorrect base station transmit or receive center frequency.

From the RAN management system, retrieve a list of interfered channels that have been identified with counters for events such as dropped calls, blocked calls and dropped handovers.

4.1.1 FOSiG method

- The FOSiG method in the uplink band means that no mobile TX signal is available, which isolates the interfering signal for detection
- This is accomplished by blocking the specific channel via an O&M command for the controlling unit (no adjacent channels)
- If the entire channel is blocked by RFI, switch off the base station downlink signal so that no broadcast information is available for mobile phones (no uplink traffic)

4.1.2 Non-FOSiG method

The non-FOSiG method does not permit the suppression of user signals. A composite user and interferer signal is provided instead.

If the base station cannot be switched off due to high traffic levels, delay this procedure until the early morning hours when traffic is lower (2:00 to 4:00 a.m., for example) or wait until there is no activity (provided the RFI is present!).

If the uplink channel is not taken out of service, the noise level will increase, especially in CDMA systems. Depending on the distance between the mobile phone and the base station, the uplink signal may be clear in urban areas.

4.2 RFI detection method

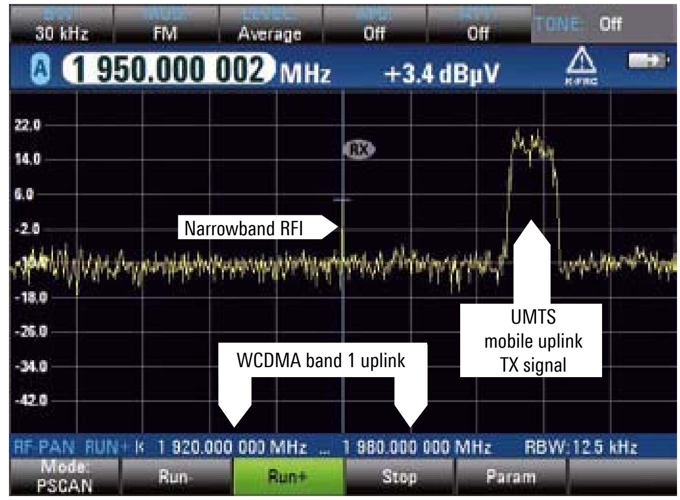
4.2.1 Scanning overview

Strong signals close to transmitter locations can cause intermodulation in the frontend of the R&S®PR100. External band filters are recommended in this case.

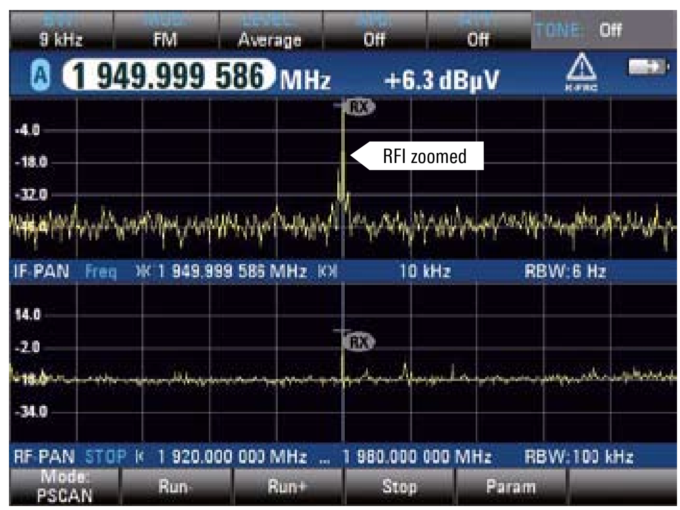
Connect an omnidirectional antenna matched to the frequency range of interest, set the uplink band start and stop frequency in the panorama scan mode and use an RBW of 100 kHz.

The following examples are based on WCDMA band 1, 200 kHz channel spacing, 3.84 MHz channel bandwidth, 1.92 GHz to 1.98 GHz uplink band, 2.11 GHz to 2.17 GHz downlink band:

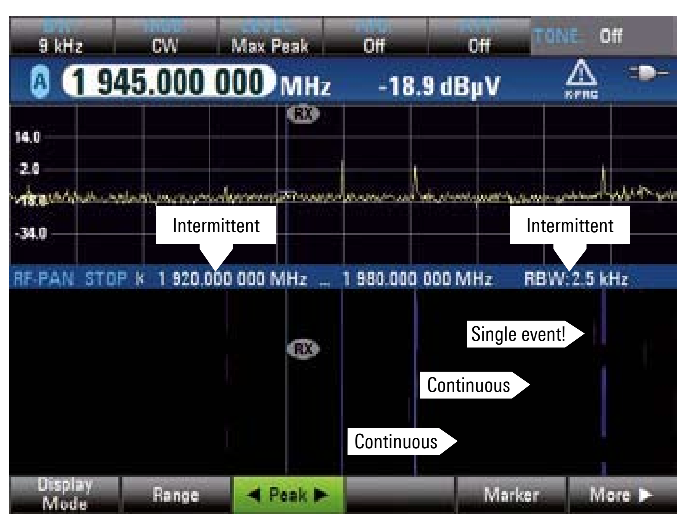
- For a more detailed analysis of the RFI, switch the display mode to DUAL SPECTRUM
- Stop the PSCAN; the IF-PAN will immediately display the RFI signal
- Press DISPLAY, press the ZOOM softkey and decrease the IF bandwidth ▷ the RFI signal is spread further
- Press the RANGE softkey to improve the resolution of the RFI power level
- RFI may be a continuous or non-continuous signal
- The RFI bandwidth may be constant or it may vary
- A spectrogram or 2D waterfall analysis is available to display the frequency and time domain on a single screen
- If the RFI cannot be detected with the normal spectrum or dual spectrum display, select the SPECTRUM + WATERFALL DISPLAY mode
- Start again with 100 kHz RBW and stepwise reduce the RBW to increase the sensitivity and resolution – which will also increase the scan time, however
- Press the MARKER softkey on the display menu and select LINES to measure the start and stop time of non-continuous signals
- Select DELTA MARKER to measure the frequency offset



The screenshot above displays the band 1 uplink PSCAN sweep. A UMTS phone transmits on channel 10 and occupies 3.84 MHz bandwidth. The center line shows a continuous narrowband RFI signal close to 1950 MHz ▷ RX marker.



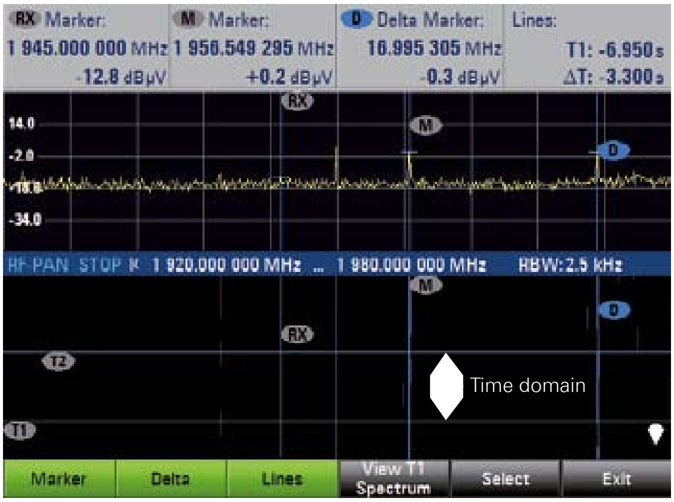
Dual spectrum display after PSCAN stop. The interferer signal can be better identified in the upper IF-PAN screen.



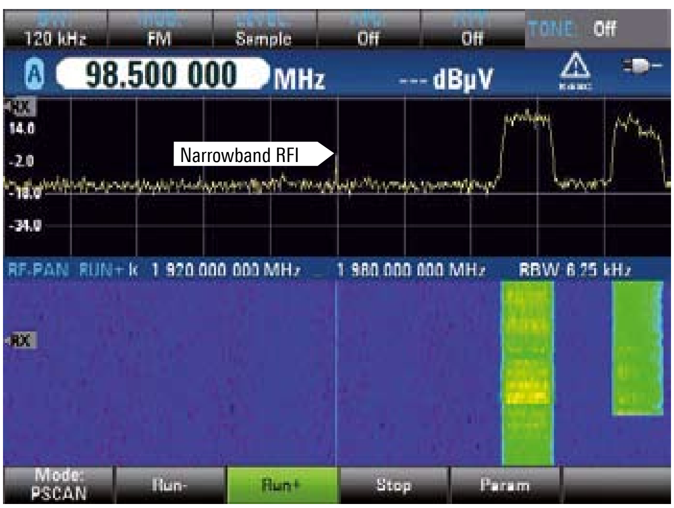
WCDMA band 1 dual screen with spectrum and waterfall screen. Several RFI signals are present; two are continuous and two are intermittent. Two individual RFI events are indicated.

4.2.2 Locating the direction of strongest signal strength

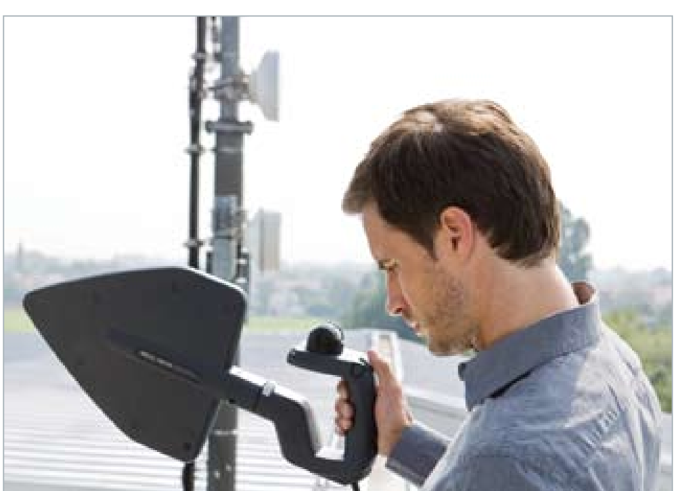
- Connect a directional antenna such as the R&S®HE200 or R&S®HE300 to the R&S®PR100
- Switch to RX or RX + SPECTRUM display mode
- Switch off the AFC and squelch function
- Select the appropriate frequency, making sure the RBW of the demodulation path is higher than the RFI bandwidth to achieve best sensitivity
- Select the appropriate antenna model from the configuration menu
- Zoom the signal, press the PEAK softkey, select the target interferer signal with the left and right arrows
- Turn on the audio tone function and set the volume level to mid-range
- Move the directional antenna clockwise or counterclockwise while listening to the audio tone
- The higher the pitch of the audio tone, the stronger the signal
- The direction of the signal source is located when the audio tone reaches its peak
- Note the position and direction and move to another position
- Perform the same procedure and note the position and direction
- The point at which the two signals cross represents the geographic position of the RFI source
- Take into account that reflecting walls, windows and metal plates in urban areas may cause measurement errors
- Note: The detected RFI position may be a point of reflection
- If the signal is analog-demodulated (FM, AM, USB or LSB voice), listen to it by selecting the corresponding demodulation setting. Press the MOD+ or MOD- keys and select enough bandwidth for clear demodulation
- Additional classification methods are available through the R&S®GX430 PC software, which can classify and decode various modulation types and coding schemes



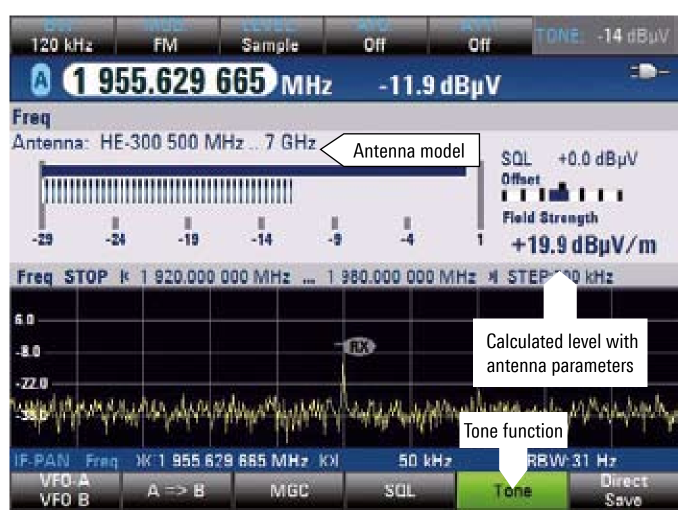
The lines can be positioned to meet user requirements.



Spectrum and waterfall screen: two mobile phones transmitting in the WCDMA uplink band.



R&S®HE300 handle with 500 MHz to 3.5 GHz log-periodic module.



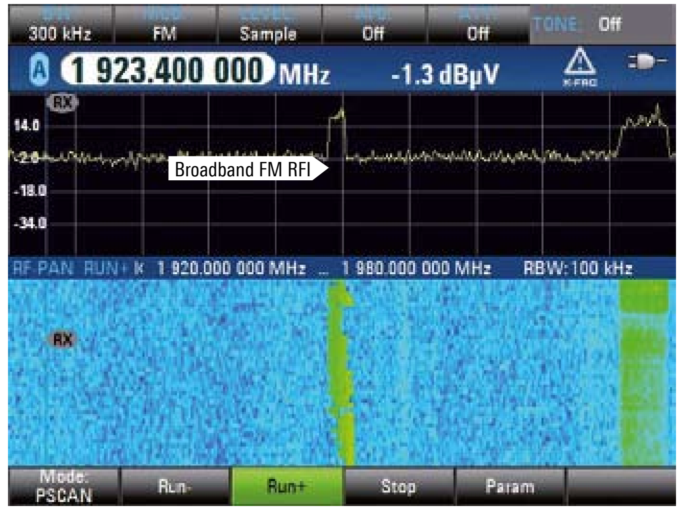
Level measurement of signal at center frequency and its acoustical representation by means of the Tone function.

4.2.3 Uplink scanning via base station diversity antenna connection

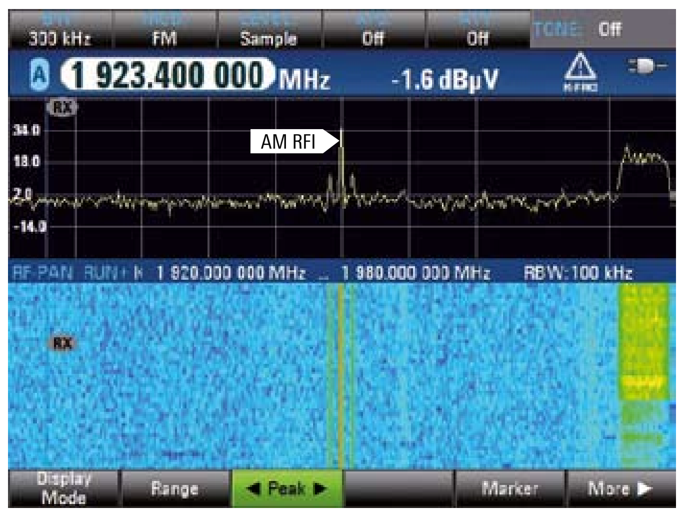
Some OAM alarms and messages rely on values measured in the base station. This includes increased noise in the uplink band when there is no call activity, increasing numbers of dropped calls, inferior voice quality and handover problems.

One unconventional method of detecting and locating RFI involves connecting the R&S®PR100 directly to the receive antenna. This enables the uplink band to be monitored directly at the antenna instead of through the base station.

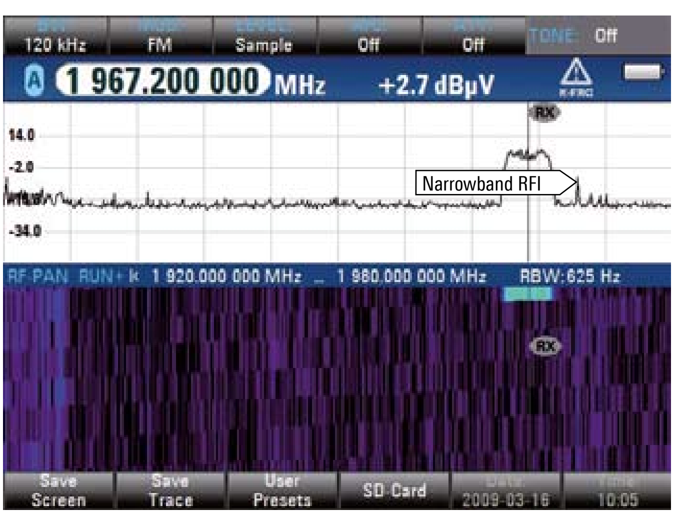
- Parameters such as the antenna pattern, gain, directivity and band sensitivity can be monitored
- If the base station is in service, placing bandpass filters in front of the R&S®PR100 is highly recommended (the use of external DC blocks is also required in case DC voltage is present on the RF cable)
- Some base station systems use an internal LNA, which can be connected to a monitor port in front of or behind an LNA stage or directly to the antenna feeder cable
- Disconnect the diversity receive antenna from the BTS and connect it to the R&S®PR100. This ensures reception of the desired uplink band without interference from TX signals
- Use the PSCAN mode, select a frequency range that is 10 % wider than the uplink band of the cellular network being monitored
- Perform the measurements as outlined in 4.2.1
- The Ethernet interface can be used for remote viewing with the R&S®PRView software, remote control with the R&S®RAMON software and service classification using the R&S®GX430 software. Initiate a waterfall screenshot if an alarm from an RAN system indicates the presence of RFI



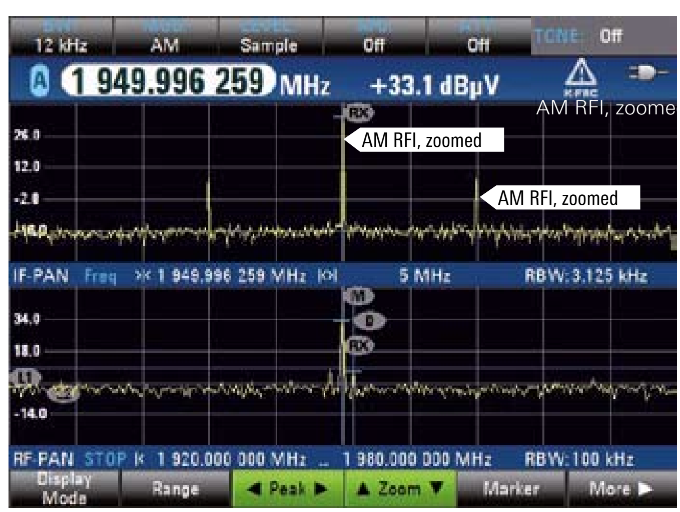
Indication of potential harmonics or mixed signals, continuous or intermittent.



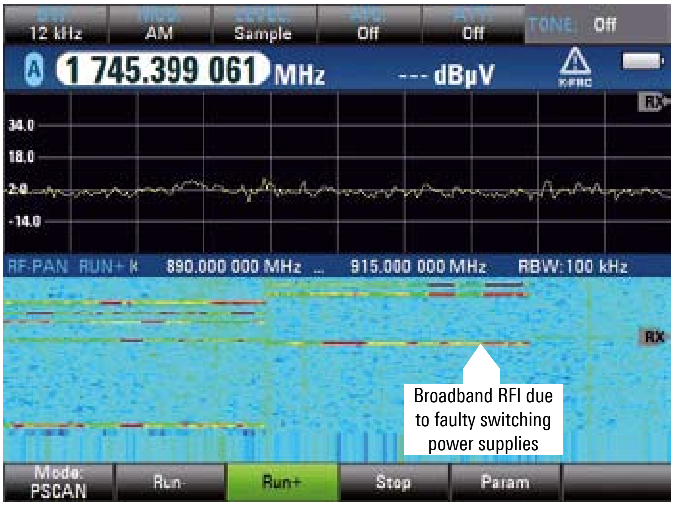
AM-modulated RFI with sideband signals.



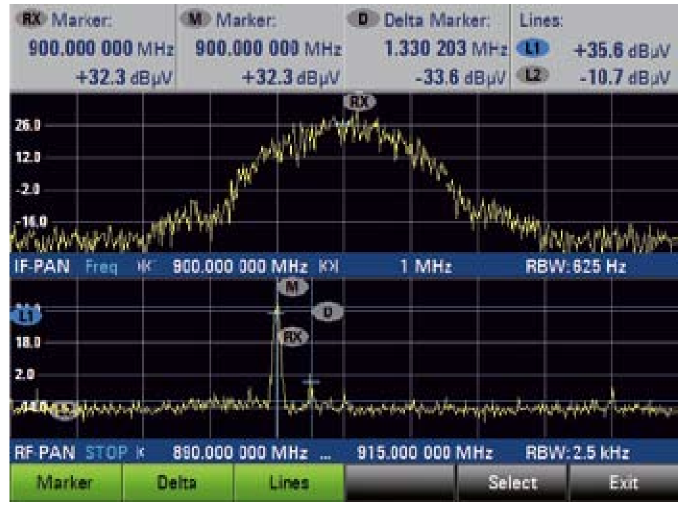
Multiple narrowband interferer signals inside WCDMA band 1, channel 10.



Dual screen display mode, higher AM signal resolution.

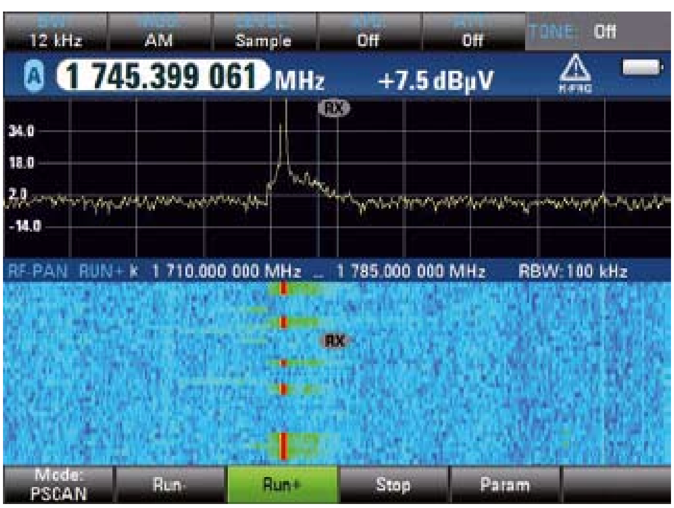


GSM 900 MHz uplink band with broadband RFI due to faulty switching power supplies in LC plasma displays used for advertisements.

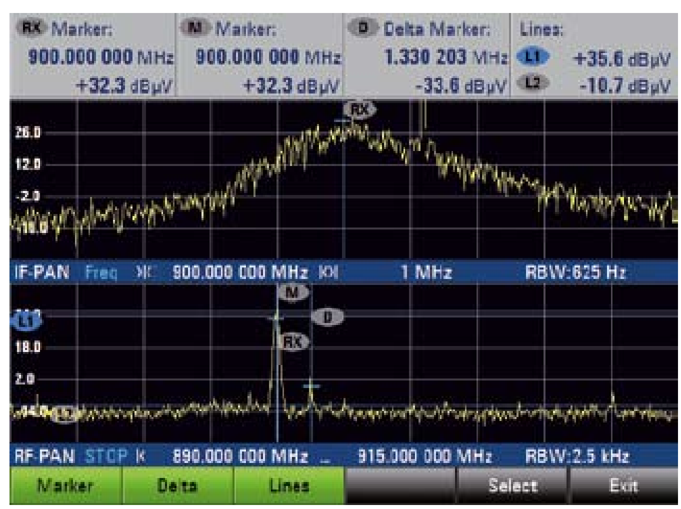


Occupied spectrum for GSM900 mobile phone in normal mode, dual screen display. Lower RF-PAN displays the full GSM900 uplink band and the upper part displays a single zoomed mobile TCH uplink channel with GMSK spectrum.

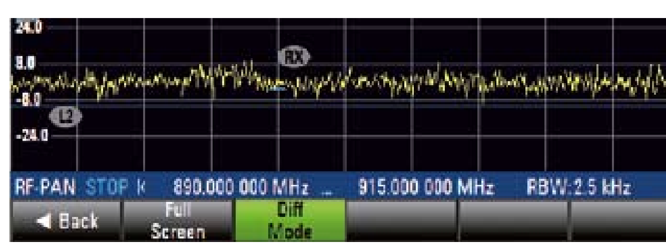
- Different marker, delta and line settings
- For a more detailed analysis, the RMS detector of the demodulation path should be used



Defective TX filter in a GSM mobile phone, GSM 1800 MHz band. The occupied spectrum exceeds the specified spectrum mask ▷ adjacent channels are blocked.

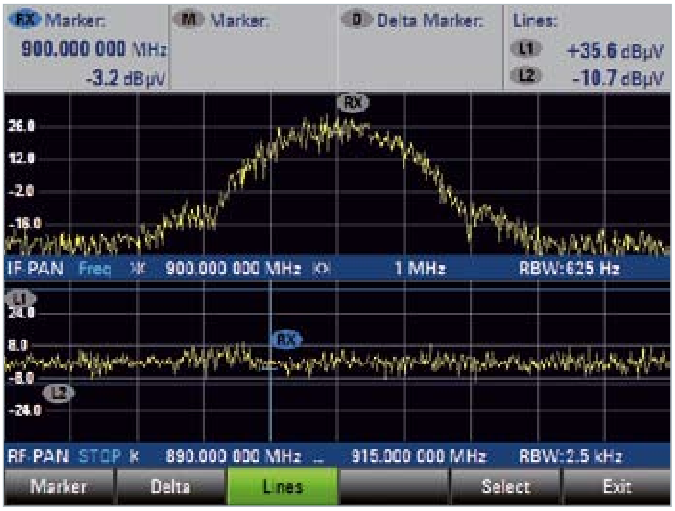


Interference from a broadband digital signal on the same GSM 900 MHz channel.

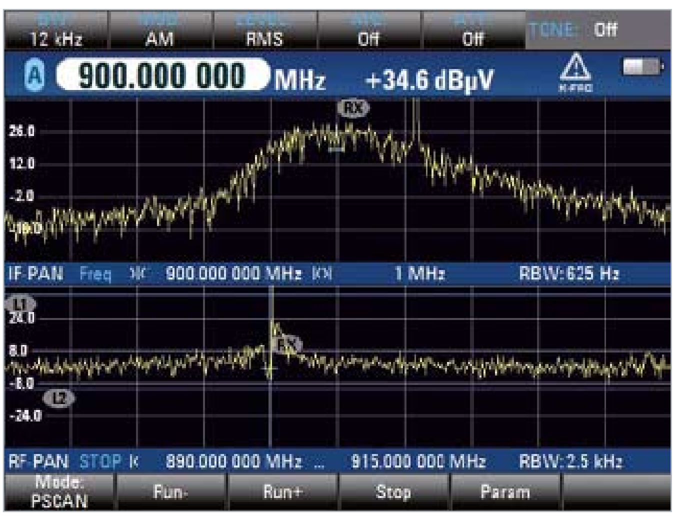


Use the DIFF mode in the PSCAN display mode to suppress the user signal, leaving only the short-time RFI signal.

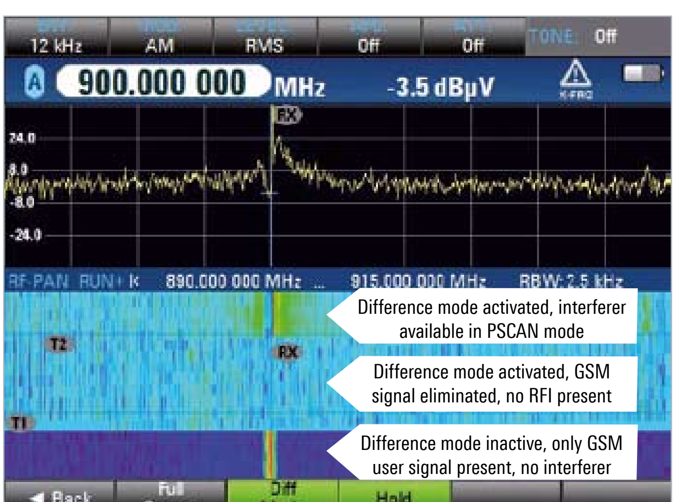
4.2.4 Uplink RFI screenshots



Lower curve: DIFF mode activated to display a wanted signal ▷ waiting for interferer signal to appear.



Upper curve: DIFF mode activated, GSM uplink mobile TX signal and interferer signal. Lower curve: DIFF mode activated, short-time interferer signal is displayed in PSCAN mode.



DIFF mode with spectrum and waterfall screen.

Detecting RFI in the downlink band

5.1 Preparation, preliminary checks, tips

Make sure there are no base station hardware alarms related to power amplifiers (VSWR problems), TMA, duplexers, combiners and microwave, fiber-optic or DSL links. Check the GPS module if the base station has one (clocking reference). An unstable clock reference can lead to an incorrect base station transmit or receive center frequency.

From the RAN management system, retrieve a list of interfered channels that have been identified with counters for events such as dropped calls, blocked calls and dropped handovers

5.1.1 FOSiG method

The FOSiG method in the downlink band means that no mobile TX signal is available, which isolates the interfering signal for detection.

This is accomplished by blocking the specific channel via an O&M command for the controlling unit (no adjacent channels)

- If the entire channel is blocked by RFI, switch off the base station downlink signal so that no broadcast information is available for mobile phones (no uplink traffic)

5.1.2 Non-FOSiG method

The non-FOSiG method does not permit the suppression of base station signals. A composite base station and interferer signal is provided instead.

- If the base station cannot be switched off due to high traffic levels, reduce the TX power
- If the downlink signal remains in service, the noise level will increase, especially in CDMA systems. Depending on the distance between the mobile phone and the base station, the uplink signal may be clear in urban areas
- Determine what a normal downlink signal looks like in the spectrum and waterfall
- Technologies such as GSM and TETRA are TDMA-based systems in contrast to C2K, UMTS, TD-SCDMA, which are code-domain-accessed systems that work on the same frequency with different codes

5.1.3 General tips for detecting RFI in the downlink band

RFI in the downlink band reduces the mobile phone receiver's ability to demodulate and decode the physical channels, which leads to lower voice quality and decreased data rates for packet-switched services. Key performance indicators (KPIs) such as call setup times, latency times and handover times will be impacted.

- Error correction in the baseband component of the receiver is effective up to a certain BER, beyond which calls can drop or handovers can fail
- An RFI signal with –80 dBm/10 kHz bandwidth is a relative power value. The impact of the RFI depends on the signal strength of the base station downlink. Mobile phones in close proximity to the base station or at the outer edge of the cell range calculate different C/I values because the signal strength of the base station varies
- Locating the cause of service reduction (RFI) could also be accomplished with coverage and QoS measurement systems such as R&S®ROMES. These systems can perform a full uplink and downlink analysis, including all KPI measurements and GPS data logging, which together provide the optimal tools for detecting RFI in the affected area

5.1.4 RFI sources in the downlink band

The base station can also be a source of RFI, e.g. when faulty TX filters create spectrum interference in adjacent channels. QPSK modulation for WCDMA is characterized by steep filter slopes, eliminating the need for complete user channel separation. The UARFCN of the adjacent operator is 200 kHz outside of the 5 MHz bandwidth of the other operator ▷ analyze BTS with the R&S®FSH4.

- Antenna blades, wires and soldered components can cause PIM due to faulty connections or metal corrosion ▷ analyze the cabling and antenna components with the R&S®FSH4 handheld spectrum analyzer
- Incorrect channel or scrambling code planning, crosstalk from other network operators ▷ use the R&S®ROMES software plus the R&S®TSMx to scan the network
- The most challenging sources of RFI are not related to commercial operator base station systems as mentioned previously. Other sources that should be considered include:
  - Nonharmonic RF within switching power supplies close to shopping windows, railway stations, street lamps, flat lighting, LCD or plasma flat screens, computers, kitchen appliances

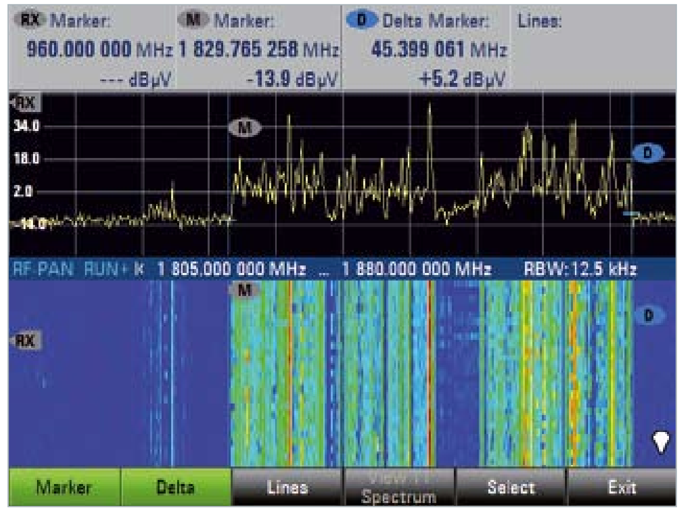
- Audio and video transmitters using AM, FM FSK and AFSK modulation in various ISM or professional bands typically found in schools, universities, concert halls and sports arenas. They are sometimes used to monitor building and garage entrances as an example. Even when outside of the desired band, they can produce harmonics caused by defective TX filters or intermodulate with other signals
- Illegal (non-licensed) GSM, UMTS, CDMA2000®, TETRA and WiMAX™ repeaters used to extend coverage in hotels, ports and on private property
- Short-range wireless communications: Bluetooth®, RF USB, ZigBee, WLAN, RFID, DECT
- Hobby RC electronics: 35 MHz, 40 MHz, 72 MHz, 433 MHz, 2.4 GHz
- Amateur radio signals, which can intermodulate with commercial services
- Various wireless consumer electronics products from other countries that use different frequencies (e.g. USA versus Europe)
- Computer cables, power line communications that have powerful spike spectra
- RFI fading caused by multipath propagation ▷ perform fading analysis with R&S®TSMx scanners

RFI in the downlink channel is a common cause of mobile phone service reduction. Relying on the R&S®PR100 together with network quality analysis tools is therefore highly recommended. A decrease in service quality can be detected immediately by using the R&S®ROMES software and a mobile phone.

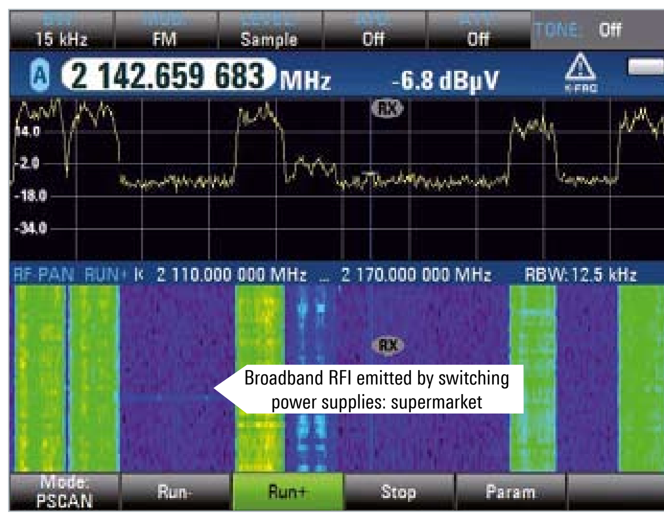
The two figures show a mobile phone operating at 1858.2 MHz with RFI from a direct adjacent channel at 1858.4 MHz. With normal 400 kHz channel spacing, the next usable channel should be at 1858.8 MHz.

5.2 R&S®PR100 base station downlink spectral analysis

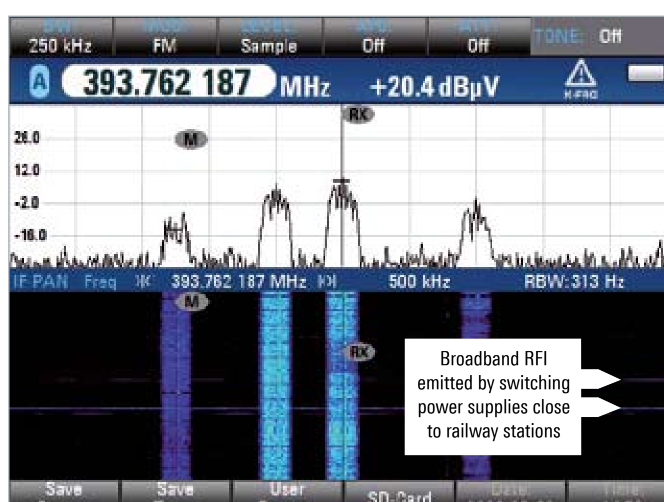
- Connect an omnidirectional antenna and set the frequency range of interest. Choose PSCAN mode with RBW of 100 kHz, set the downlink band with start and stop frequency or select a stored user preset with GSM, CDMA2000®, WCDMA, TETRA band values
- Spectrum and waterfall display is the first choice
- If needed, run the marker menu with marker, delta marker and lines on the screen
- For GSM systems, a frequency reuse factor is used to separate channels due to the special envelope of a GMSK-modulated carrier, which occupies much more than 200 kHz of bandwidth
- Rohde & Schwarz FFT technology in the R&S®PR100 permits the detection of leakage transmit power



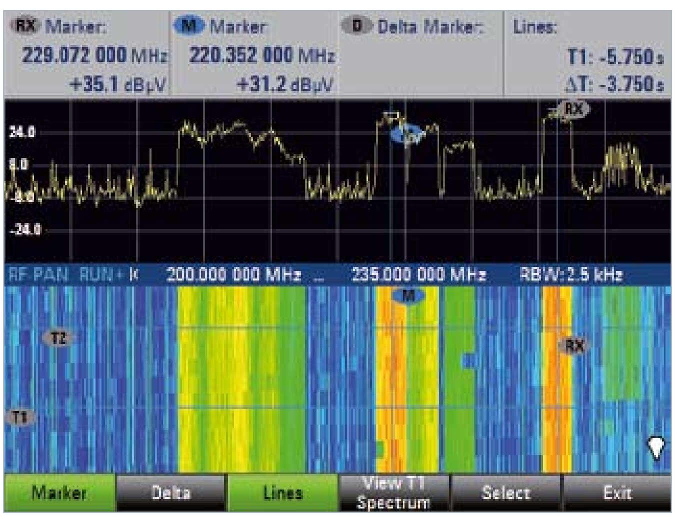
GSM1800 downlink band, markers active.



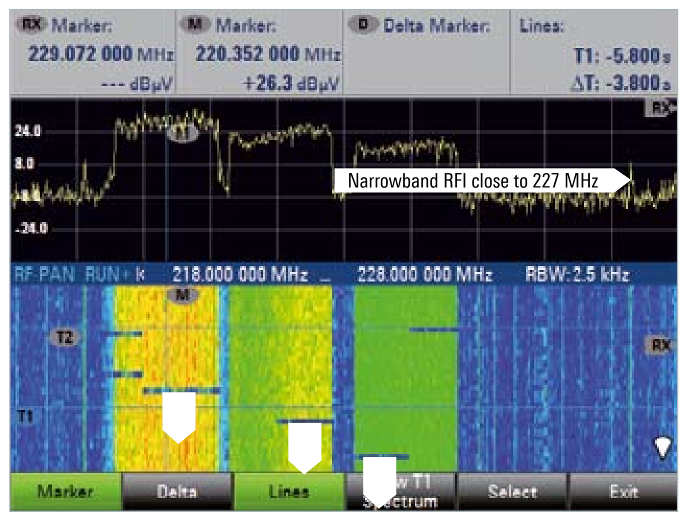
WCDMA band 1 downlink spectrum and waterfall analysis, six channels on air.



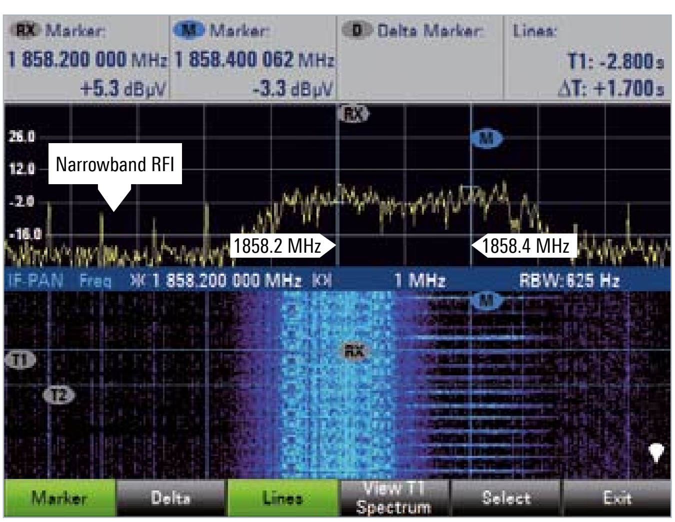
TETRA downlink band 4, four channels on air.



DAB channels between 200 MHz and 235 MHz.

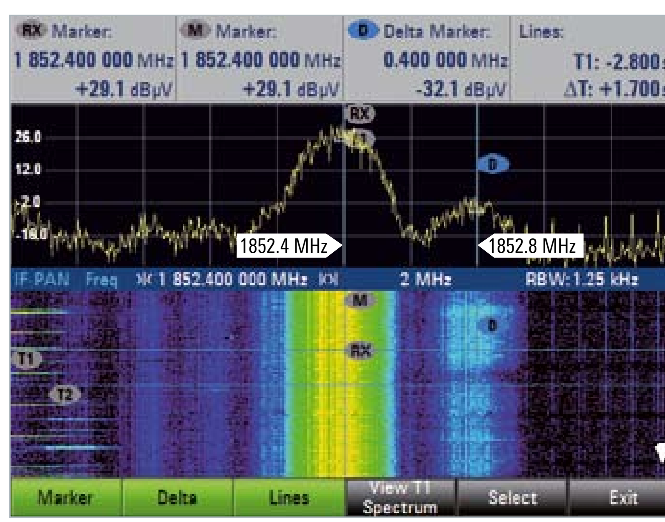


All three DAB channels have problems related to the spectral envelope ▷ may be caused by a defective filter or amplifier.



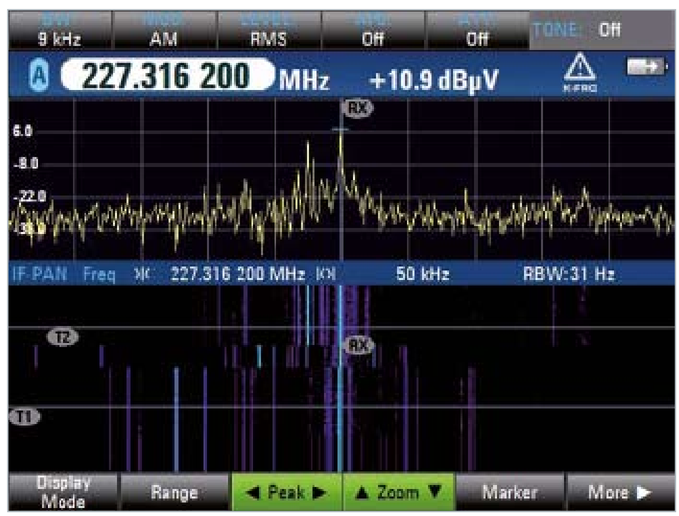
Adjacent channel interference

A continuously transmitting BCCH is detected at 1858.2 MHz while the adjacent channel at 1858.4 MHz is in burst mode ▷ the GMSK envelopes of both channels interfere with one another ▷ frequency reuse rule.

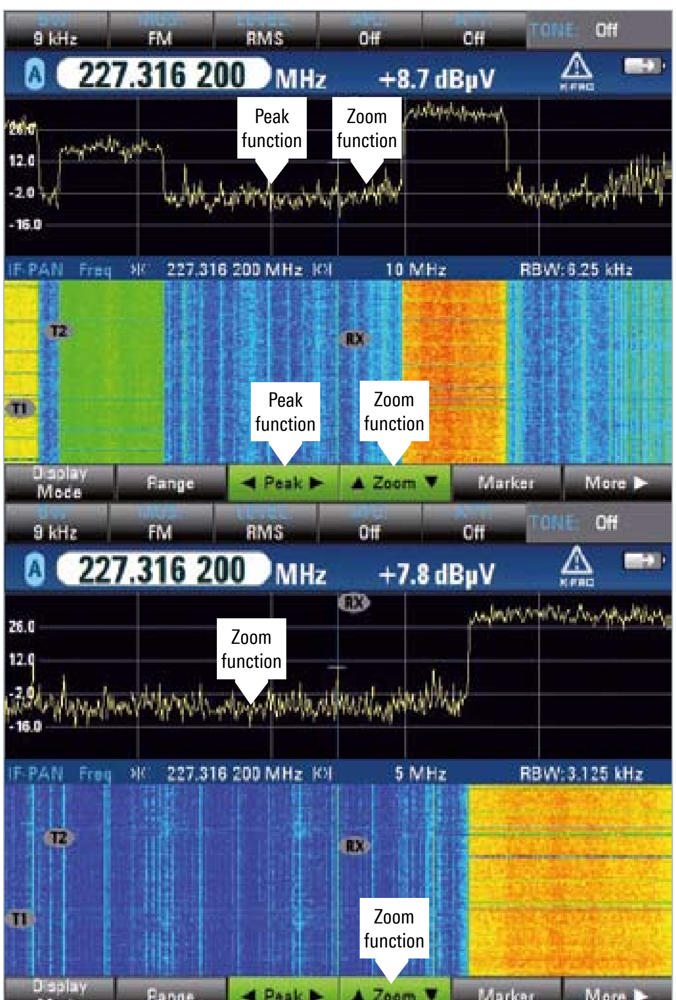


Right GSM downlink channel setting, one in between channel is not in use. A continuously transmitting BCCH is detected at 1852.4 MHz while the adjacent channel at 1852.6 MHz is not used; the next used channel is at 1852.8 MHz.

Zoom to 2 MHz.



Zoom to 50 kHz.

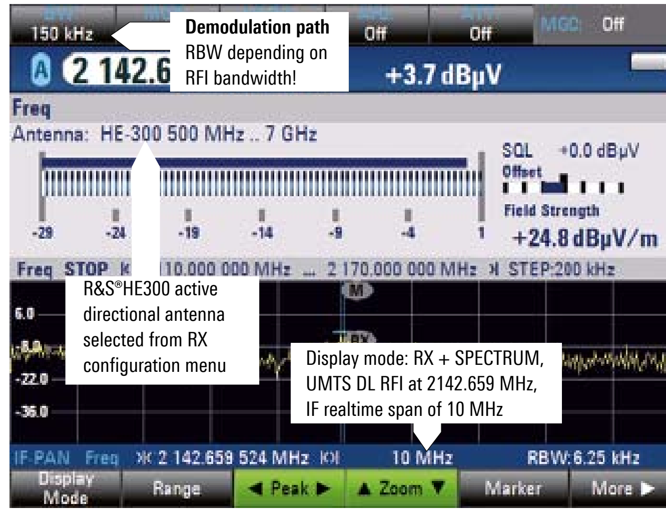


The zoom function expands the IF display for a more detailed analysis of the RFI.

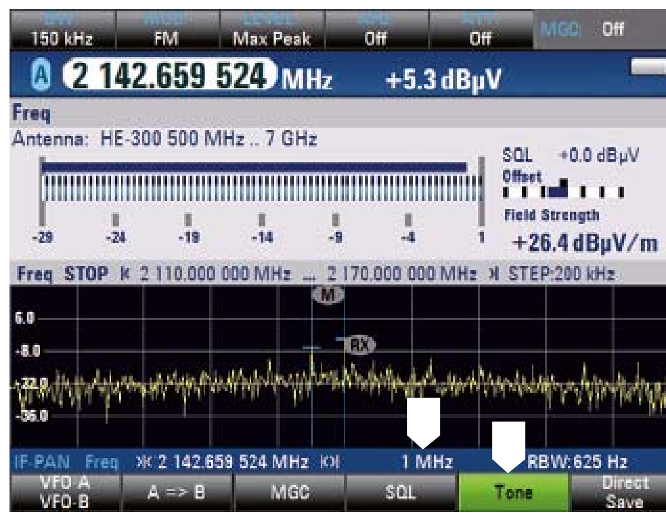
Zoom to 10 kHz.

5.2.1 Locating the direction of highest signal strength

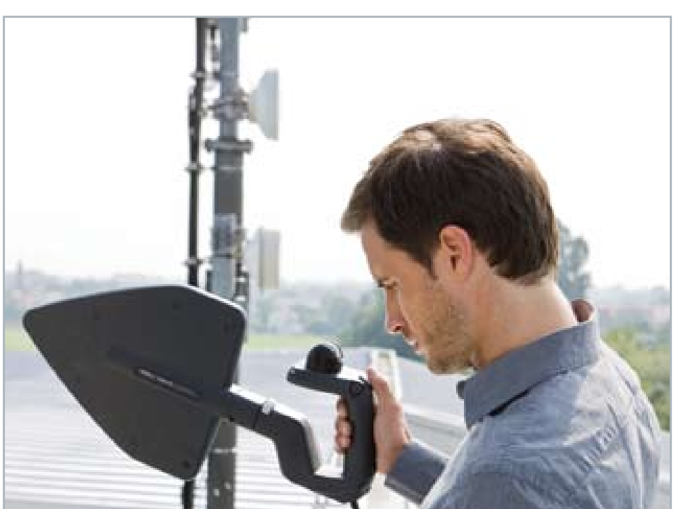
- Connect a directional antenna such as the R&S®HE200 or R&S®HE300 to the R&S®PR100
- Switch to RX or RX + SPECTRUM display mode
- Switch off the AFC and squelch function
- Select the appropriate frequency; RBW should be higher than the RFI bandwidth to achieve best sensitivity
- Select the appropriate antenna model from the configuration menu
- Zoom the signal, press the PEAK softkey, select the zoomed interferer signal with the left and right arrows
- Turn on the audio tone function and select a mid-range volume
- Move the directional antenna clockwise or counterclockwise while listening to the audio tone
- The higher the pitch of the audio tone, the stronger the signal
- The direction of the signal source is located when the audio tone reaches its peak
- Note the position and direction and move to another position
- Perform the same procedure and note the position and direction
- The point at which the two signals cross represents the geographic position of the RFI source
- Take into account that reflecting walls, windows and metal plates in urban areas may cause measurement errors
- Note: The detected RFI position may be a point of reflection
- If the signal is analog-modulated (FM, AM, USB or LSB voice), listen to it by selecting the corresponding demodulation setting. Press the MOD+ or MOD- keys and select enough bandwidth for clear demodulation
- Additional classification methods are available through the R&S®GX430 PC software, which can classify and decode various modulation types and coding schemes



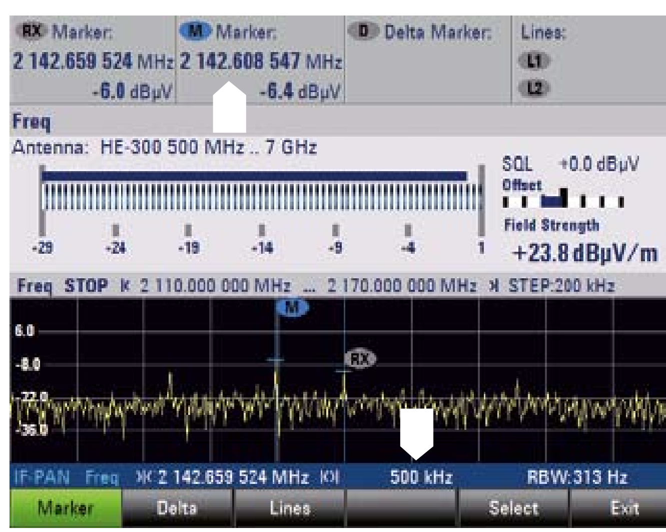
The bandwidth for the IF spectrum and for the level measurement path can be set independently from each other.



IF realtime span of 1 MHz, tone function activated: Listen to the tone while rotating the R&S®HE300 active directional antenna.

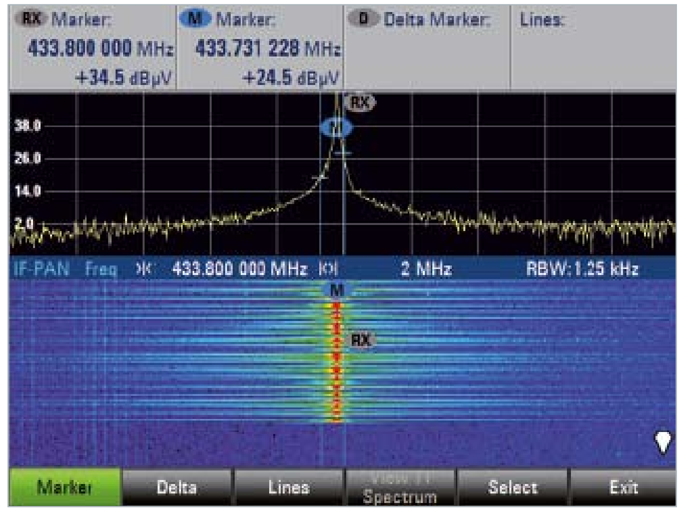


R&S®HE300 handle with 500 MHz to 3.5 GHz log-periodic module.

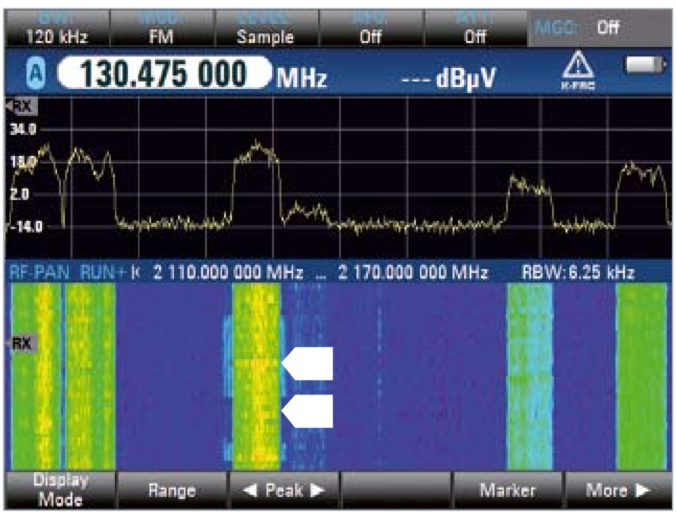


Marker menu selected: 2nd RFI signal IF realtime span of 500 kHz.

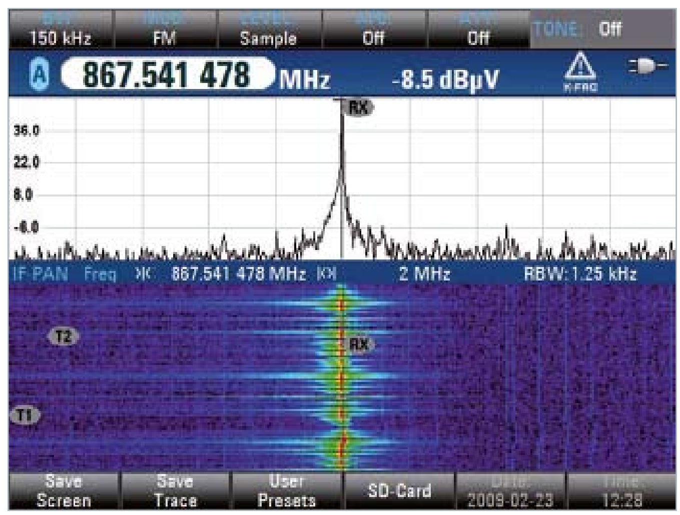
Additional RFI screenshots



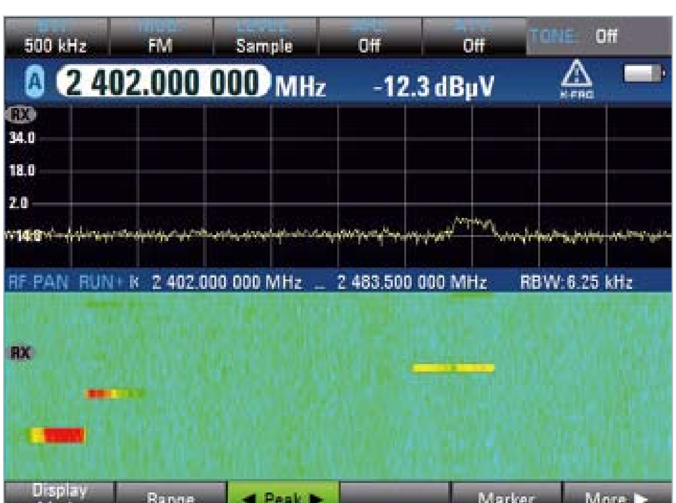
433 MHz ISM non-licensed band TX signal: garage door opener; occupied bandwidth nearly 2 MHz! Low-cost device without TX filter.



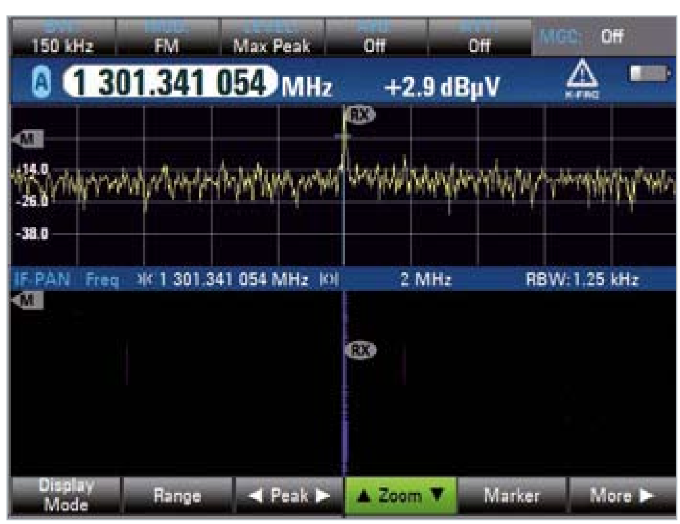
WCDMA TX bandwidth problem in WCDMA downlink band: defective amplifier and/or faulty duplex filter and/or intermodulating antenna system.



433 MHz ISM non-licensed band TX signal: garage door opener; 1st harmonic, occupied bandwidth nearly 500 kHz! Low-cost device without TX filter.



Bluetooth® hopping signals:
Europe + US band: 2.402 MHz to 2483.5 MHz.



433 MHz ISM non-licensed band TX signal: garage door opener; 2nd harmonics.

Cellular bands, paging bands, non-licensed services, broadcast

The following list is an overview of available commercial and professional cellular mobile networks. Although this is a partial list, it is still useful for calculating harmonics and upmixed or downmixed RFI emissions. The websites of the various networks and agencies (e.g. FCC, ANSI, ITU, 3GPP, ETSI, TETRA Forum, WiMAX Forum) contain detailed information.

Service name	Downlink	Uplink	Signal bandwidth	CH # start	CH # stop
cdmaOne US Cellular	870 MHz	825 MHz	1.23 MHz	1	799
cdmaOne US Cellular	870 MHz	825 MHz	1.23 MHz	990	1023
cdmaOne US PCS	1930 MHz	1850 MHz	1.23 MHz	1	1199
cdmaOne Korea PCS	1840 MHz	1750 MHz	1.23 MHz	0	599
cdmaOne Japan	860 MHz	915 MHz	1.23 MHz	1	799
cdmaOne Japan	843 MHz	898 MHz	1.23 MHz	801	1039
cdmaOne Japan	832 MHz	887 MHz	1.23 MHz	1041	1199
cdmaOne China-1	934.9875 MHz	889.9875 MHz	1.23 MHz	0	1000
cdmaOne China-1	917.0125 MHz	872.0125 MHz	1.23 MHz	1329	2047
cdmaOne China-2	934.9875 MHz	889.9875 MHz	1.23 MHz	0	1000
cdmaOne China-2	917.0125 MHz	872.0125 MHz	1.23 MHz	1329	2047
cdma2k_0 N.A. Cellular	870 MHz	825 MHz	1.23 MHz	1	799
cdma2k_0 N.A. Cellular	870 MHz	825 MHz	1.23 MHz	990	1023
cdma2k_0 Korea	870 MHz	825 MHz	1.23 MHz	1	799
cdma2k_0 Korea	870 MHz	825 MHz	1.23 MHz	990	1023
cdma2k_1 N.A. PCS	1930 MHz	1850 MHz	1.23 MHz	0	1199
cdma2k_2 TACS Band	934.9875 MHz	889.9875 MHz	1.23 MHz	0	1000
cdma2k_2 TACS Band	916.9875 MHz	871.9875 MHz	1.23 MHz	1329	2047
cdma2k_3 JTACS Band	860 MHz	915 MHz	1.23 MHz	1	799
cdma2k_3 JTACS Band	843 MHz	898 MHz	1.23 MHz	801	1039
cdma2k_3 JTACS Band	832 MHz	887 MHz	1.23 MHz	1041	1199
cdma2k_3 JTACS Band	838 MHz	893 MHz	1.23 MHz	1201	1600
cdma2k_4 Korea PCS	1840 MHz	1750 MHz	1.23 MHz	0	599
cdma2k_5 NMT-25k-450	460 MHz	450 MHz	1.23 MHz	1	300
cdma2k_5 NMT-25k-450	421 MHz	411 MHz	1.23 MHz	539	871
cdma2k_5 NMT-20k-450	461.01 MHz	451.01 MHz	1.23 MHz	1039	1473
cdma2k_5 NMT-20k-450	489 MHz	479 MHz	1.23 MHz	1792	2016
cdma2k_6 IMT-2000	2110 MHz	1920 MHz	1.23 MHz	0	1199
cdma2k_7 N.A. 700 MHz Cell	746 MHz	776 MHz	1.23 MHz	0	359
cdma2k_8 GSM Band	1805 MHz	1710 MHz	1.23 MHz	0	1499
cdma2k_9 GSM Band	925 MHz	880 MHz	1.23 MHz	0	699
cdma2k-10 SMR 800 Band	851 MHz	806 MHz	1.23 MHz	0	719
cdma2k-10 SMR 800 Band	935 MHz	896 MHz	1.23 MHz	720	919
cdma2k-11 400 PAMR Band	460 MHz	450 MHz	1.23 MHz	1	400
cdma2k-11 400 PAMR Band	420 MHz	410 MHz	1.23 MHz	472	871
cdma2k-11 400 PAMR Band	489 MHz	479 MHz	1.23 MHz	1536	1715

Service name	Downlink	Uplink	Signal bandwidth	CH # start	CH # stop
WCDMA_1 2100 (Band 1)	0	1922.4 MHz	5 MHz	9612	9888
WCDMA_1 2100 (Band 1)	2112.4 MHz	0	5 MHz	10562	10838
WCDMA_2 1900 (NA PCS)	0	1852.4 MHz	5 MHz	9262	9538
WCDMA_2 1900 (NA PCS)	1932.4 MHz	0	5 MHz	9662	9938
WCDMA_2 1900 Addl (NA PCS)	0	1852.5 MHz	5 MHz	12	287
WCDMA_2 1900 Addl (NA PCS)	1932.5 MHz	0	5 MHz	412	687
WCDMA_3 1800 (DCS)	0	1712.4 MHz	5 MHz	8562	8913
WCDMA_3 1800 (DCS)	1807.4 MHz	0	5 MHz	9037	9388
WCDMA_4 2100 (Band 4)	0	1712.4 MHz	5 MHz	8562	8763
WCDMA_4 2100 (Band 4)	2112.4 MHz	0	5 MHz	10562	10763
WCDMA_4 2100 Addl (Band 4)	0	1712.5 MHz	5 MHz	1162	1362
WCDMA_4 2100 Addl (Band 4)	2112.5 MHz	0	5 MHz	1462	1662
WCDMA_5 850 (US Cell)	0	826.4 MHz	5 MHz	4132	4233
WCDMA_5 850 (US Cell)	871.4 MHz	0	5 MHz	4357	4458
WCDMA_5 850 Addl (US Cell)	0	826.5 MHz	5 MHz	782	862
WCDMA_5 850 Addl (US Cell)	871.5 MHz	0	5 MHz	1007	1087
NADC IS136 Cellular	870 MHz	825 MHz	30 kHz	1	799
NADC IS136 Cellular	870 MHz	825 MHz	30 kHz	990	1023
NADC IS136 PCS	1930.02 MHz	1849.98 MHz	30 kHz	1	1999
SMR 800 Hz to 25 kHz	850.9875 MHz	805.9875 MHz	25 kHz	1	600
SMR 800 Hz to 12.5 kHz	851 MHz	806 MHz	25 kHz	1	1199
SMR 1500	1501 MHz	1453 MHz	25 kHz	1	479
GSM/EDGE 450	460.6 MHz	450.6 MHz	200 kHz	259	293
GSM/EDGE 480	489 MHz	479 MHz	200 kHz	306	340
GSM/EDGE 750	777 MHz	747 MHz	200 kHz	438	511
GSM/EDGE 850	869200 kHz	824200 kHz	200 kHz	128	251
GSM-E/EDGE 900	935 MHz	890 MHz	200 kHz	0	124
GSM-E/EDGE 900	935 MHz	890 MHz	200 kHz	975	1023
GSM-P/EDGE 900	935 MHz	890 MHz	200 kHz	1	124
GSM-R/EDGE 900	935 MHz	890 MHz	200 kHz	0	124
GSM-R/EDGE 900	935 MHz	890 MHz	200 kHz	955	1023
GSM/EDGE 1800	1805.2 MHz	1710.2 MHz	200 kHz	512	885
GSM/EDGE 1900	1930.2 MHz	1850.2 MHz	200 kHz	512	810
PDC1500 (JDC)	1477 MHz	1525 MHz	30 kHz	0	960
PHS	1895.15 MHz	1895.15 MHz	200 kHz	1	77
AMPS EIA 553	870 MHz	825 MHz	30 kHz	1	799
AMPS EIA 553	870 MHz	825 MHz	30 kHz	990	1023
N-AMPS IS-88 M	870 MHz	825 MHz	10 kHz	1	799
N-AMPS IS-88 M	870 MHz	825 MHz	10 kHz	990	1023
N-AMPS IS-88 L	869.99 MHz	824.99 MHz	10 kHz	1	799
N-AMPS IS-88 L	869.99 MHz	824.99 MHz	10 kHz	990	1023
N-AMPS IS-88 U	870.01 MHz	825.01 MHz	10 kHz	1	799
N-AMPS IS-88 U	870.01 MHz	825.01 MHz	10 kHz	990	1023
TACS	934.9875 MHz	889.9875 MHz	25 kHz	1	1000
ETACS	934.9875 MHz	889.9875 MHz	25 kHz	0	1000
ETACS	934.9875 MHz	889.9875 MHz	25 kHz	1329	2047
NTACS	860 MHz	915 MHz	12.5 kHz	1	799
NTACS	843 MHz	898 MHz	12.5 kHz	800	1039
NTACS	832 MHz	887 MHz	12.5 kHz	1040	1199
JTACS	860 MHz	915 MHz	20 kHz	0	798
JTACS	843 MHz	898 MHz	20 kHz	800	1038
JTACS	832 MHz	887 MHz	20 kHz	1040	1198
PDC 800 Analog	843 MHz	898 MHz	25 kHz	0	1680

Service name	Downlink	Uplink	Signal bandwidth	CH # start	CH # stop
NMT-411 25 kHz	421 MHz	411 MHz	25 kHz	539	871
NMT-450 25 kHz	460 MHz	450 MHz	25 kHz	1	300
NMT-450 20 kHz	461 MHz	451.01 MHz	20 kHz	1039	1473
NMT-470 20 kHz	489 MHz	479 MHz	20 kHz	1792	2016
NMT-900	934.9875 MHz	889.9875 MHz	25 kHz	1	1000
NMT-900 (offset)	935.025 MHz	890.025 MHz	25 kHz	1025	2023
MATS-E	934.9875 MHz	889.9875 MHz	25 kHz	1	1000
C-450 (SA)	454.98 MHz	464.98 MHz	20 kHz	1	247
C-450 (P)	463.0375 MHz	453.0375 MHz	20 kHz	1	887
1xEVDO_0 N.A. Cellular	870 MHz	825 MHz	1.23 MHz	1	799
1xEVDO_0 N.A. Cellular	870 MHz	825 MHz	1.23 MHz	990	1023
1xEVDO_0 Korea	870 MHz	825 MHz	1.23 MHz	1	799
1xEVDO_0 Korea	870 MHz	825 MHz	1.23 MHz	990	1023
1xEVDO_1 N.A. PCS	1930 MHz	1850 MHz	1.23 MHz	0	1199
1xEVDO_2 TACS Band	934.9875 MHz	889.9875 MHz	1.23 MHz	0	1000
1xEVDO_2 TACS Band	916.9875 MHz	871.9875 MHz	1.23 MHz	1329	2047
1xEVDO_3 JTACS Band	860 MHz	915 MHz	1.23 MHz	1	799
1xEVDO_3 JTACS Band	843 MHz	898 MHz	1.23 MHz	801	1039
1xEVDO_3 JTACS Band	832 MHz	887 MHz	1.23 MHz	1041	1199
1xEVDO_3 JTACS Band	838 MHz	893 MHz	1.23 MHz	1201	1600
1xEVDO_4 Korea PCS	1840 MHz	1750 MHz	1.23 MHz	0	599
1xEVDO_5 NMT-25k-450	460 MHz	450 MHz	1.23 MHz	1	300
1xEVDO_5 NMT-25k-450	421 MHz	411 MHz	1.23 MHz	539	871
1xEVDO_5 NMT-20k-450	461.01 MHz	451.01 MHz	1.23 MHz	1039	1473
1xEVDO_5 NMT-20k-450	489 MHz	479 MHz	1.23 MHz	1792	2016
1xEVDO_6 IMT-2000	2110 MHz	1920 MHz	1.23 MHz	0	1199
1xEVDO_7 N.A. 700 MHz Cell	746 MHz	776 MHz	1.23 MHz	0	359
1xEVDO_8 GSM Band	1805 MHz	1710 MHz	1.23 MHz	0	1499
1xEVDO_9 GSM Band	925 MHz	880 MHz	1.23 MHz	0	699
1xEVDO-10 SMR 800 Band	851 MHz	806 MHz	1.23 MHz	0	719
1xEVDO-10 SMR 800 Band	935 MHz	896 MHz	1.23 MHz	720	919
1xEVDO-11 400 PAMR Band	460 MHz	450 MHz	1.23 MHz	1	400
1xEVDO-11 400 PAMR Band	420 MHz	410 MHz	1.23 MHz	472	871
1xEVDO-11 400 PAMR Band	489 MHz	479 MHz	1.23 MHz	1536	1715
TD-SCDMA (A Band)	1900.8 MHz	1900.8 MHz	1.6 MHz	9504	9596
TD-SCDMA (A Band)	2010.8 MHz	2010.8 MHz	1.6 MHz	10054	10121
TD-SCDMA (B Band)	1850.8 MHz	1850.8 MHz	1.6 MHz	9254	9546
TD-SCDMA (B Band)	1930.8 MHz	1930.8 MHz	1.6 MHz	9654	9946
TD-SCDMA (C Band)	1910.8 MHz	1910.8 MHz	1.6 MHz	9554	9646
TD-SCDMA (D Band)	2570.8 MHz	2570.8 MHz	1.6 MHz	12854	13096
TD-SCDMA (E Band)	2300.8 MHz	2300.8 MHz	1.6 MHz	11504	11996
iDEN_1 800 MHz (Standard)	851 MHz	806 MHz	25 kHz	1	1199
iDEN_2 800 MHz (Extended)	851 MHz	806 MHz	25 kHz	1	1519
iDEN_4 900 MHz	935.00625 MHz	896.00625 MHz	25 kHz	1	398
iDEN_5 1.5 GHz	1501 MHz	1453 MHz	25 kHz	1	479
LTE Band-1	2110 MHz	1920 MHz	1.4 MHz to 20 MHz	0	599
LTE Band-2	1930 MHz	1850 MHz	1.4 MHz to 20 MHz	600	1199
LTE Band-3	1805 MHz	1710 MHz	1.4 MHz to 20 MHz	1200	1949
LTE Band-4	2110 MHz	1710 MHz	1.4 MHz to 20 MHz	1950	2399
LTE Band-5	869 MHz	824 MHz	1.4 MHz to 20 MHz	2400	2649
LTE Band-6	875 MHz	830 MHz	1.4 MHz to 20 MHz	2650	2749
LTE Band-7	2620 MHz	2500 MHz	1.4 MHz to 20 MHz	2750	3449
LTE Band-8	925 MHz	880 MHz	1.4 MHz to 20 MHz	3450	3799
LTE Band-9	1844.9 MHz	1749.9 MHz	1.4 MHz to 20 MHz	3800	4149
LTE Band-10	2110 MHz	1710 MHz	1.4 MHz to 20 MHz	4150	4749
LTE Band-11	1475.9 MHz	1427.9 MHz	1.4 MHz to 20 MHz	4750	4999

Service name	Downlink	Uplink	Signal bandwidth	CH # start	CH # stop
LTE Band-12	728 MHz	698 MHz	1.4 MHz to 20 MHz	5000	5179
LTE Band-13	746 MHz	777 MHz	1.4 MHz to 20 MHz	5180	5279
LTE Band-14	758 MHz	788 MHz	1.4 MHz to 20 MHz	5280	5379
LTE Band-17	734 MHz	704 MHz	1.4 MHz to 20 MHz	5730	5849
LTE Band-33	1900 MHz	1900 MHz	1.4 MHz to 20 MHz	36000	36199
LTE Band-34	2010 MHz	2010 MHz	1.4 MHz to 20 MHz	36200	36349
LTE Band-35	1850 MHz	1850 MHz	1.4 MHz to 20 MHz	36350	36949
LTE Band-36	1930 MHz	1930 MHz	1.4 MHz to 20 MHz	36950	37549
LTE Band-37	1910 MHz	1910 MHz	1.4 MHz to 20 MHz	37550	37749
LTE Band-38	2570 MHz	2570 MHz	1.4 MHz to 20 MHz	37750	38249
LTE Band-39	1880 MHz	1880 MHz	1.4 MHz to 20 MHz	38250	38649
LTE Band-40	2300 MHz	2300 MHz	1.4 MHz to 20 MHz	38650	39649
WiMAX-1	2300 MHz	2300 MHz	5/8.75/10 MHz		
WiMAX-2	2305 MHz	2305 MHz	3.5/5/10 MHz		
WiMAX-2	2345 MHz	2345 MHz	3.5/5/10 MHz		
WiMAX-3	2496 MHz	2496 MHz	5/10 MHz		
WiMAX-4	3300 MHz	3300 MHz	5/7/10 MHz		
WiMAX-5	3400 MHz	3400 MHz	5/7/10 MHz		
WiMAX-5	3600 MHz	3800 MHz	5/7/10 MHz		
TETRA-1	336 MHz	300 MHz	25 kHz		
TETRA-2	360 MHz	350 MHz	25 kHz		
TETRA-3	390 MHz	380 MHz	25 kHz		
TETRA-4	395 MHz	385 MHz	25 kHz		
TETRA-5	420 MHz	410 MHz	25 kHz		
TETRA-6	425 MHz	415 MHz	25 kHz		
TETRA-7	460 MHz	450 MHz	25 kHz		
TETRA-8	465 MHz	455 MHz	25 kHz		
TETRA-9	851 MHz	806 MHz	25 kHz		
TETRA-10	915 MHz	870 MHz	25 kHz		

7.1 ITU ISM bands

Frequency range	Center frequency	Availability
6.765 MHz to 6.795 MHz	6.780 MHz	subject to local acceptance
13.553 MHz to 13.567 MHz	13.560 MHz	
26.957 MHz to 27.283 MHz	27.120 MHz	
40.66 MHz to 40.70 MHz	40.68 MHz	
433.05 MHz to 434.79 MHz	433.92 MHz	
902 MHz to 928 MHz	915 MHz	region 2 only
2.400 GHz to 2.500 GHz	2.450 GHz	
5.725 GHz to 5.875 GHz	5.800 GHz	
24 GHz to 24.25 GHz	24.125 GHz	
61 GHz to 61.5 GHz	61.25 GHz	subject to local acceptance
122 GHz to 123 GHz	122.5 GHz	subject to local acceptance
244 GHz to 246 GHz	245 GHz	subject to local acceptance

7.2 Bluetooth® bands

Country	Frequency range	RF channels	
Europe, USA	2400 MHz to 2483.5 MHz	f = 2402 + k MHz	k = 0,...,78
Japan	2471 MHz to 2497 MHz	f = 2473 + k MHz	k = 0,...,22
Spain	2445 MHz to 2475 MHz	f = 2449 + k MHz	k = 0,...,22
France	2446.5 MHz to 2483.5 MHz	f = 2454 + k MHz	k = 0,...,22

7.3 WLAN channels, 2.4 GHz band

Channel	Frequency	FCC	Canada	ETSI	Spain	France	Japan
1	2412 MHz	●	●	●			●
2	2417 MHz	●	●	●			●
3	2422 MHz	●	●	●			●
4	2427 MHz	●	●	●			●
5	2432 MHz	●	●	●			●
6	2437 MHz	●	●	●			●
7	2442 MHz	●	●	●			●
8	2447 MHz	●	●	●			●
9	2452 MHz	●	●	●			●
10	2457 MHz	●	●	●	●	●	●
11	2462 MHz	●	●	●	●	●	●
12	2467 MHz			●		●	●
13	2472 MHz	●		●		●	●
14	2484 MHz						●

R&S®FSHx, R&S®TSMx, R&S®ROMES

RFI internal signals are often generated due to faulty base station system components such as defective non-linear amplifiers as well as cable faults and antenna problems.

Rohde & Schwarz offers the R&S®FSH4 or R&S®FSH8 handheld spectrum analyzers with full two-port scalar/vector network analysis capability. Featuring built-in DTF, power measurements and 3G code domain analyses, they are the ideal solution for fast and accurate measurements. These handheld spectrum analyzers can be remotely controlled via a USB or Ethernet interface.

The operating time on a single battery is approximately four hours. Features such as SD card storage, display snapshot function and user profile GUI provide flexible control of the instrument.

Ready for base station installation and maintenance; up to 8 GHz spectrum analysis and vector network analysis.

The R&S®FSHView software allows the remote, long-term monitoring of RFI.

Ask your local sales representative for a demo.

Rohde & Schwarz offers sophisticated coverage and drive test systems for scanning 2G, 3G, WiMAX™ and LTE networks (e.g. the R&S®TSMx scanners and the R&S®ROMES drive test software).

A scanner is used together with a test mobile phone to perform network quality and KPI analyses, including full layer-3 reports for voice, data and video.

The results are displayed on a city map or listed together with the route track information to enable the user to determine coverage gaps, poor handover areas and faulty cell planning, for instance.

A light version, running on a Symbian OS-based phone, measures all necessary air interface parameters.

- Autonomous 3GPP walk test system for indoor and outdoor applications
- With external (Bluetooth®) or built-in GPS (N95 only)
- Low investment costs (CAPEX); additional control software for standard test mobile phones
- Easy operation (measurement ON, measurement OFF)
- Flexible handling of task files (GSM, GPRS, EDGE, WCDMA, HSDPA)
- Storage of measurement data on the test mobile phone as well as data transmission to an FTP server or via USB cable
- User-definable input frequency range from 30 MHz to 6 GHz
- Two independent RF and signal processing paths, each with a bandwidth of 20 MHz
- Integrated preselection for high intermodulation suppression while dynamic range is high
- Support of WiMAX™ IEEE 802.16e measurements together with the R&S®ROMES drive test software (R&S®TSMW-K28)
- I/Q baseband measurement with Gigabit interface (R&S®TSMW-K1)
- Future-ready software-defined architecture
- Integrated GPS

Fully configurable via the R&S®FSHView software, remote control via Ethernet.

Ordering information

Designation	Type	Order No.
Base unit		
Portable Receiver	R&S®PR100	4071.9006.02
Software options		
Panorama Scan	R&S®PR100-PS	4071.9306.02
Internal Recording	R&S®PR100-IR	4071.9358.02
Remote Control	R&S®PR100-Control	4071.9406.02
Field Strength Measurement	R&S®PR100-FS	4071.9506.02
Accessories		
Battery Pack	R&S®PR100-BP	4071.9206.02
Suitcase Kit	R&S®PR100-SC	4071.9258.02
Carrying Holster	R&S®HA-Z222	1309.6198.00
Soft Carrying Bag	R&S®HA-Z220	1309.6175.00
12 V Car Adapter	R&S®HA-Z202	1309.6117.00
Recommended extras		
Active Directional Antenna	R&S®HE300	4067.5900.02
HF Option for Portable Directional Antenna	R&S®HE300HF	4067.6806.02

For additional information about antennas, receivers, spectrum analyzers and field strength measurement equipment, visit Rohde & Schwarz on the Internet at www.rohde-schwarz.com.

Rohde & Schwarz offers complete solutions for field strength and power measurements for a variety of applications.

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