

Recording, analyzing and documenting signals using a single receiver

A new option for the R&S®ESMD wideband monitoring receiver offers a wide range of opportunities for detecting, analyzing and documenting signals – without requiring the functions of a full radiomonitoring system.

The R&S®ESMD as an efficient small system

The R&S®ESMD wideband monitoring receiver (Fig. 1) is used as one of the main components in many large radiomonitoring systems where it functions as a fast search receiver or an I/Q data source. In networked systems, the receiver has a passive role and is controlled by system software. The new R&S®ESMD-RR record and replay option for I/Q data makes it possible to record and replay I/Q data directly in the R&S®ESMD, eliminating the need for a full radiomonitoring system. The R&S®ESMD is transformed into a small signal interception and analysis system with excellent mobility and flexibility.

Fig. 1: The R&S®ESMD wideband monitoring receiver operates in the frequency range from 8 kHz to 26.5 GHz and features a realtime bandwidth of 80 MHz. It is one of the most versatile and powerful instruments currently available on the market. For more information on the receiver, visit the Rohde&Schwarz website (search term: ESMD), where you can also find four videos:

www.rohde-schwarz.com/news211/02

www.rohde-schwarz.com/news211/03

www.rohde-schwarz.com/news211/04

www.rohde-schwarz.com/news211/05.



Bandwidth	Maximum record length
2 MHz	approx. 2.5 min
10 MHz	approx. 42 s
40 MHz	approx. 10 s
80 MHz	approx. 5 s

Fig. 2: Maximum recording capacity of the R&S®ESMD internal memory.

Recording I/Q data in the receiver's memory

In combination with the new R&S®ESMD-RR option, the R&S®ESMD records I/Q data up to the full 80 MHz bandwidth and stores it in the internal memory. The maximum record length with the largest bandwidth is approx. five seconds (Fig. 2).

The memory functions as a ring buffer with a record length that can be defined by the user prior to recording. When the recording is started, the receiver begins to write the I/Q data into the ring buffer. One of three stop conditions must be selected in order to end recording. The receiver continuously overwrites the ring buffer until the chosen condition occurs. The following conditions are available:

- **MANUAL:** The user waits during recording until the relevant event occurs and presses the stop key to end recording and save the event in the memory.
- **BUFFER FULL:** The receiver fills the previously defined ring buffer only a single time. It stops recording as soon as the buffer is full.
- **TRIGGER:** Recording stops when the realtime event capture (REC) defined by the user is triggered.

If the MANUAL condition is selected, the success of the recording depends on the user's alertness. The user must monitor the signals in the spectrum and stop recording at the right moment (Fig. 3). While the TRIGGER condition requires advance knowledge of the signal form or frequency, the user can capture any signal if recording is terminated manually. BUFFER FULL is the ideal choice for recording a section of a continuous signal where the actual time of the recording is not relevant.



Fig. 3: In MANUAL mode, the user monitors the signals in the spectrum and stops recording at the right moment.

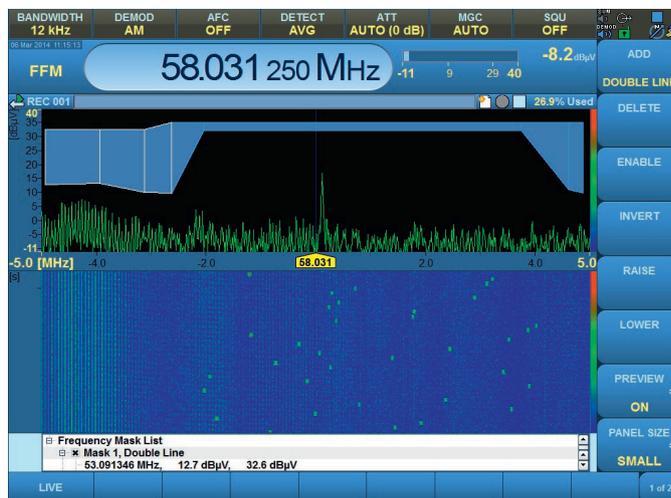


Fig. 4: Mask for triggering realtime event capture (REC) to respond to anomalies in a known signal.

Never miss an event with flexible realtime event capture

Based on the center frequency and signal form in the spectrum, the user decides whether a signal is relevant. The signal's I/Q data is necessary for further analysis. In large radiomonitoring systems, the R&S®ESMD provides the I/Q data of signals of interest for online analysis using signal analysis software. If only one R&S®ESMD is used, the I/Q data can be stored in the internal memory for manual analysis directly on the instrument or exported for subsequent automated analysis using separate software.

Rare, short-time signals are difficult to record. In order to record the I/Q data of these signals, the configurable REC function included in the R&S®ESMD-RR option can be used to stop recording in the ring buffer. Once recording is stopped, the ring buffer contains the events defined as relevant by the user. For this purpose, a mask must be edited in the live spectrum and used as a trigger to stop recording (Fig. 4).

The mask behavior is controlled by three different trigger conditions:

- **Positive edge:** Recording in the ring buffer is stopped if a signal enters the defined mask. This condition is ideal for rare, short-time events.
- **Negative edge:** The receiver stops recording in the ring buffer if a signal leaves the defined mask. This condition can be used to trigger on the disappearance of a signal, e.g. if a signal is hidden behind a pulsed signal. The signal becomes visible in the gaps between the pulses.

■ **Gate:** This condition is recommended for recording I/Q data from voice communications. As long as a signal is in the predefined mask, the memory is filled up to a predefined length. The receiver stops recording when the data volume in the ring buffer reaches a predefined value or the signal leaves the mask. It then starts a new recording. If a signal touches the mask again, the process is repeated. The user specifies the number of individual recordings. This process is repeated until the defined number of recordings is reached or the entire memory is full. It is also possible to specify whether to bridge over speech pauses during voice communications without interrupting recording.

The pre-trigger and post-trigger time can be used to control when recording is stopped relative to the trigger event. If the pre-trigger time is set to 100 % (always specified as a percentage), the receiver immediately stops recording when the trigger event occurs, and all I/Q data captured prior to the occurrence of the event is stored in the internal memory. If the pre-trigger time is set to 50 %, the trigger event is located in the middle of the recording. As a result, recording continues after the trigger event for half of the record length. The user defines which I/Q data is important relative to the trigger event.

In-memory processing of I/Q data

In mobile applications without access to large radiomonitoring systems, the R&S®ESMD can be used to replay stored I/Q data for manual analysis. The I/Q data can also be



Fig. 5: Use of digital downconverters for replaying I/Q data.

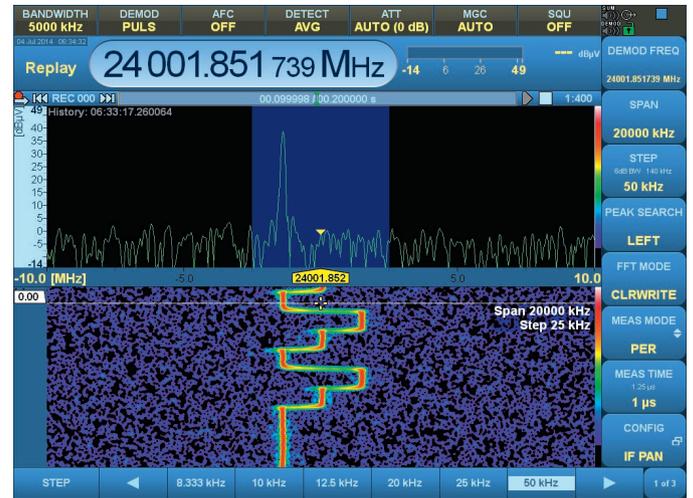


Fig. 6: View of an FSK radar signal with high time resolution.

exported to external storage media for subsequent analysis (e.g. using signal analysis software or another R&S®ESMD).

Realtime replay – signals as received from an antenna

All of the signal information the receiver provides during live operation is saved in the I/Q data, including GPS data, frontend gain and attenuation settings, and a high-accuracy timestamp. As a result, signal scenarios can be reconstructed with the correct level, time and location information.

Recorded I/Q data is forwarded for replay to the R&S®ESMD internal signal processing stage just like live signals present at the antenna input. All receiver functions are available, including demodulation of analog modulated signals and setting of digital downconverters (Fig. 5). The user sets all parameters as if the receiver were in live mode. All changes are immediately adopted without additional calculation time and the updated data is displayed in realtime. I/Q data replay is limited only by the recording bandwidth and time limits.

Detailed display

The advantage of replaying I/Q data from the receiver’s internal memory compared to signal processing in live mode is especially apparent when analyzing digital signals, radar pulses and short-time emissions. When analyzing these signals, users are interested in the time behavior of the signal. The receiver calculates a large number of spectra that must be

combined in live mode prior to display. Combining the spectra in the MAXIMUM FFT mode makes it possible to detect even extremely short pulses but details about the signal time behavior might be lost.

When replaying I/Q data, the time resolution in the waterfall diagram can be increased as far as the nanosecond range per line. The R&S®ESMD is therefore able to display even very short events with high resolution and provide a detailed overview of the spectral signal characteristics not possible in live mode (Fig. 6). Using time and frequency markers, the signal characteristics of known and unknown signals can be analyzed, leaving no details undetected.

Summary

The R&S®ESMD-RR record and replay option for I/Q data makes it easy to search within known signals and detect and analyze unknown signals. Equipped with this option, the R&S®ESMD provides a wide range of opportunities for detecting, analyzing and documenting signals – without requiring the functions of a large radiomonitoring system.

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