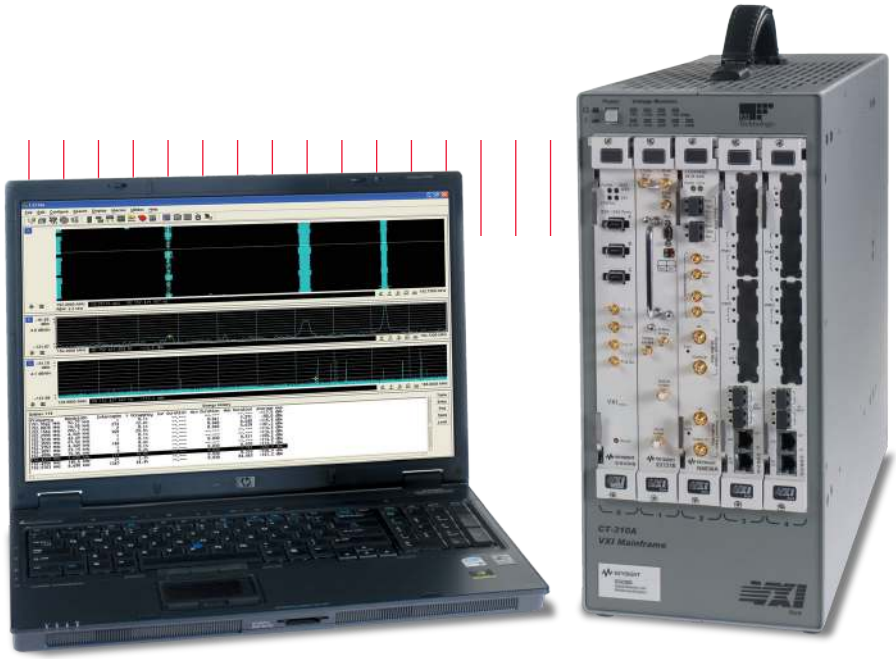
Keysight Technologies
Modulation Recognition

Option MR1 for E3238S Signal Detection and Monitoring Systems

Technical Overview



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Key Features

- Analyze signals with manual assignments, using alarms or from capture files
- Modulation recognition user interface is integrated with the E3238S software interface to maximize operator efficiency
- Signals of interest are compared for all modulation types, and the most likely modulation schemes are displayed graphically with additional information
- Histogram shows relative probability of the various modulation types
- Modulation type information can be linked to the spectrum trace marker location and be displayed in the marker display
- Modulation type can be saved in the signal log

Spectrum monitoring systems with the modulation recognition capability increase productivity by expanding the quick identification of signals of interest. Understanding the modulation information on signals of interest gives you insights on the RF environment. The MR1 Standard Modulation Recognition option provides excellent signal recognition accuracy even in degraded signal environments. It recognizes over 25 modulation types and extracts the modulation attributes of the signal. With information on the signals and RF environment, signal-monitoring solutions can be optimized for more specific processing or other tasks.

The MR1 option adds operator-controlled, manual modulation recognition to an E3238S signal detection and monitoring system. The modulation recognition function uses the E3238S search hardware to capture time snapshots between spectrum sweeps. An algorithm in the host computer analyzes this time data for modulation recognition up to the full bandwidth of the Analog-to-Digital Converter (ADC).

The modulation recognition results are displayed with a real-time histogram and a signal log. Also, the modulation recognition function can be set up as an alarm task. Or, the E3238S capture files can be post-processed using MR1. Tight integration of the MR1 option with the E3238S signal detection and monitoring software enables operators to quickly and efficiently analyze modulation types for a given signal.

Modulation Types Recognized

- FSK
- FM MSK
- 3 level FSK
- 4 level FSK
- 8 level FSK
- Analog FM (including other multi-level FSK, not in above list)
- MSK (includes GMSK and
- offset or staggered QPSK)
- BPSK
- QPSK (includes DQPSK)
- Pi/4 QPSK (including
- Pi/4 DQPSK)
- 8 PSK
- 16 PSK
- 16 QAM
- 32 QAM
- 64 QAM
- 128 QAM
- 256 QAM
- AM
- AM DSBSC
- SSB LSB
- SSB USB
- OOK (aka ASK)
- 4 PAM (aka 4-level
- Manual Morse
- Machine Morse
- Unknown Digital
- Unknown
- Pure carrier
- Noise
- V29 Modem (9600 standardized for to point 4-wire leasted telephone type circuits

Modulation Attributes Displayed

- Frequency
- Bandwidth
- Signal to noise ratio
- Symbol rate
- Frequency deviation
- Confidence
- D/B ratio (frequency deviation divided symbol rate)

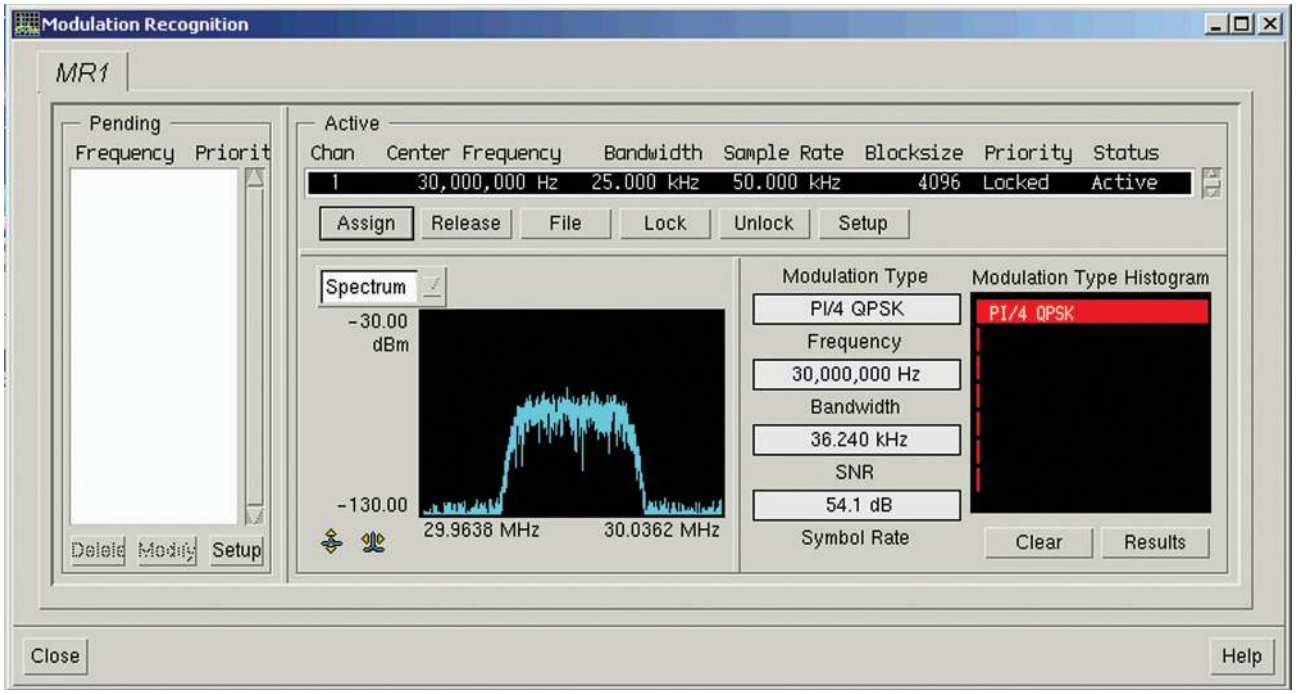

Figure 1. For the assigned signal, the MR1 option shows modulation attributes of frequency, bandwidth, SNR, and most likely modulation type. A histogram of the various modulation types is displayed, with the most likely shown at the top. The display also provides the operator with the signal's spectrum which gives the operator additional information to determine if the signal was captured with sufficient bandwidth to make a correct assessment of its modulation type.

Increase Efficiency Surveying New Environments

When surveying a signal environment, operator efficiency is critical. The E3238S's fast spectrum and spectrogram displays provide visual information on signals to the user. Many of today's communication signals do not have distinctive spectral shapes, so option MR1 adds an analytical tool to determine the modulation type of signals selected by the user. The modulation recognition option of the E3238S software lets an operator handoff signal data to determine the modulation type. With the E3238S alarm tasks, users can combine energy detection, signal capture, and modulation recognition scenarios. Users can also analyze the capture files of the E3238S system.

Operator Efficiency Using Markers

Frequency markers are an efficient manual method for passing signal frequency data to various E3238S features. They are a critical part of the E3238S user interface, providing access to display, modulation recognition and signal recording. Tying all these capabilities to markers decreases the time it takes an operator to catalog the modulation types in a spectral environment. By linking markers to the modulation recognition algorithms, the modulation type is displayed along with the other marker information typical in spectrum analyzers. As the marker is moved from one energy peak to another, the modulation type of each signal is displayed.

Finally, markers can pass signals to audio receivers, including the option AU1 AM/FM software-based handoff receiver, or record snapshots of narrowband time data for later analysis.

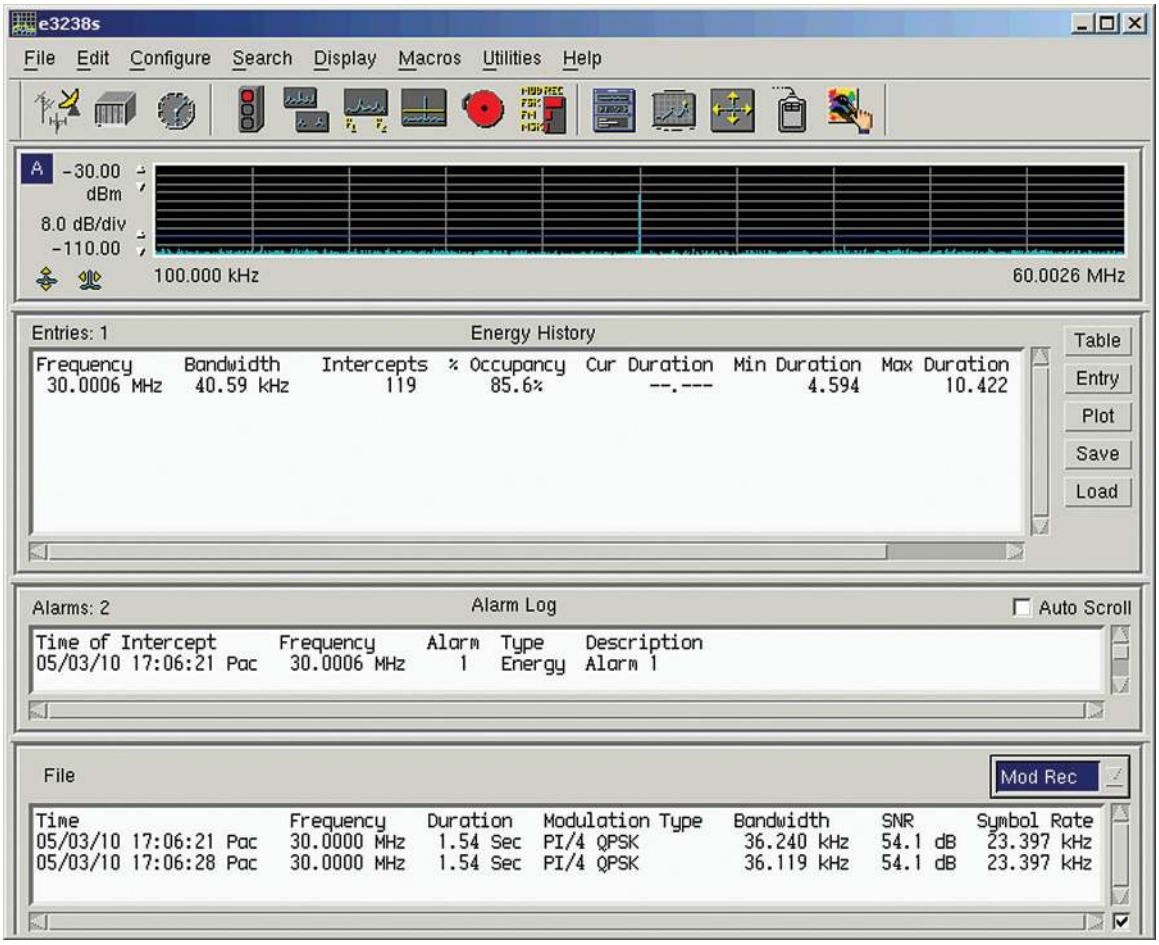

Figure 2. The modulation recognition signal database stores results of the option MR1 analysis. Besides using alarms to hand-off signals to the modulation recognition algorithm, markers can easily be used by the operator from this display. As the marker is moved, new energy is analyzed.

Modulation Recognition with Alarm Tasks

An alarm task from the E3238S software can initiate a modulation recognition task when the alarm conditions are met. Alarms are logical equations that are evaluated during every spectrum sweep. The alarms function can identify energy of interest in the energy history database and take action. Multiple signal events and alarm criteria can be combined into a single alarm. If modulation recognition is integrated into the alarm process, each time the search system detects energy a new entry is placed in the modulation recognition pending queue.

As soon as a measurement channel is available, the modulation recognition function analyzes the energy and reports the modulation type and other parameters. The results and output of the modulation recognition function can also be conditions for other alarms.

Post-processing Capture Files

Besides using the markers and alarms, the option MR1 can be used to analyze time snapshot files. Time snapshots of signals of interest can be recorded as .cap files from the E3238S system. Then, option MR1 can be assigned to analyze this time file data for modulation recognition. For more powerful analysis of complex or emerging-format wideband digital signals, the Keysight Technologies, Inc. 89601A vector signal analysis software is compatible with the E3238S capture files.

High-Recognition Quality Optimizes Signal Capture

Modulation recognition is difficult because of the complexity of today's RF environment. Since signals are detected off the air, the actual signal levels may be of low quality and have low signal-to-noise ratios. Interfering signals can cause errors, and channel distortion changes the signal, complicating the analysis. To increase the probability of a correct determination of the modulation type, the E3238S allows the operator to quickly optimize the signal capture. Using marker functions, operators pass the center frequency and bandwidth to the modulation analysis function. Additionally, the operator can adjust the bandwidth to eliminate adjacent signals. Block size and over-sampling rate can also be changed if the recognition algorithm is unable to determine the modulation type.

Gain Insight on RF Environments

The results of the analysis, including the signal's modulation type and other signal related information, are recorded in a signal database. Documenting signal information provides insights about the communication patterns and frequencies, so you can more efficiently capture signals of interest in the future.

Ordering Information and Configuration

- 35688E-MR1 Standard modulation recognition
- N6820E-MR1 Standard modulation recognition

Since the modulation recognition option is software installed on the PC, adding modulation recognition capability to an E3238S signal detection and monitoring system requires no additional hardware.

Related Literature

- E3238S/35688E Product Overview 5989-1505EN
- E3238S/N6820E Product Overview 5989-2836EN
- E3238S/35688E Configuration and Performance Reference Guide 5989-1795EN
- E3238S/N6820E Configuration and Performance Reference Guide 5989-2837EN

Web Resource

For additional information about the Keysight N6820E-MRI, go to: **www.keysight.com/find/n6820e**

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