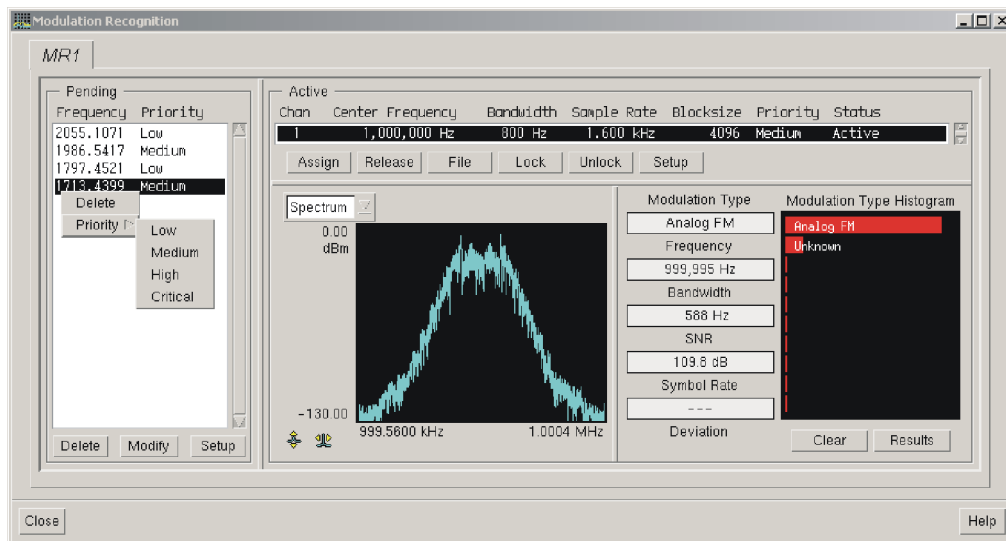


N6820ES Option MR1

Modulation Recognition User Guide



Agilent Technologies

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N6820ES – Modulation Recognition (MR1)

Introduction

This document describes the installation, configuration, and operation of option MR1 (modulation recognition) for the N6820ES Signal Surveyor 4D software. This document only pertains to the use of MR1 without the USD (Universal Signal Detection) option. For information on the use of MR1 in conjunction with USD, please refer to the USD Manual.

The MR1 version of Modulation Recognition uses the N6841A search hardware between sweeps to capture time snapshots. An algorithm that runs on the host computer analyzes these time snapshots. This concurrent operation allows Modulation Recognition to be done at up to the full bandwidth (or frequency span) of the ADC.

- Key Features**
- Identifies a variety of modulation types including analog and digital modulation types. See [page 26](#).
 - Displays results using a real-time histogram display and a log of results.

- System Requirements**
- Agilent N6841A system hardware.
 - N6820ES software version 1.0 running Windows 7 or XP.
 - Modulation Recognition software (options MR1).
 - License file that activates MR1.

Installation and Configuration

To install the MR1 Modulation Recognition software, use the following steps:

1. Install or update the N6820ES revision E2.2 software. The components of MR1 are installed with the N6820ES application. To verify this, check for the presence of the MR1 directory in the N6820ES application home directory (usually C:\E3238s)
2. Verify that the software operates with the hardware.
3. If you have purchased MR1 by itself and are adding it to the N6820ES application, you should have received a software license for it. The procedure for installing and activating the software license is listed under "License Installation" in the *Installation and Configuration Reference*.¹
4. After installation, configure the N6820ES software to load ModRec by editing C:\E3238s\N684x_RF_Sensor\n6841.32bitOS.cfg and n6841.64bitOS.cfg,, and adding the following lines:

```
modRecl.enabled:      True
modRecl.hostLib:      c:/e3238s/MR1/MR1.dll
modRecl.args:
modRecl.alias:
```

In the C:\E3238s\e3238s.cfg file, you may want to insert "!" to comment out the lines that normally disable clearing of the logs:

```
! disableAccess: Clear All
```

In the C:\E3238s\e3238s.cfg file, you may also want to uncomment out the noiseMarker.dll line to enable the Noise Marker display pane.

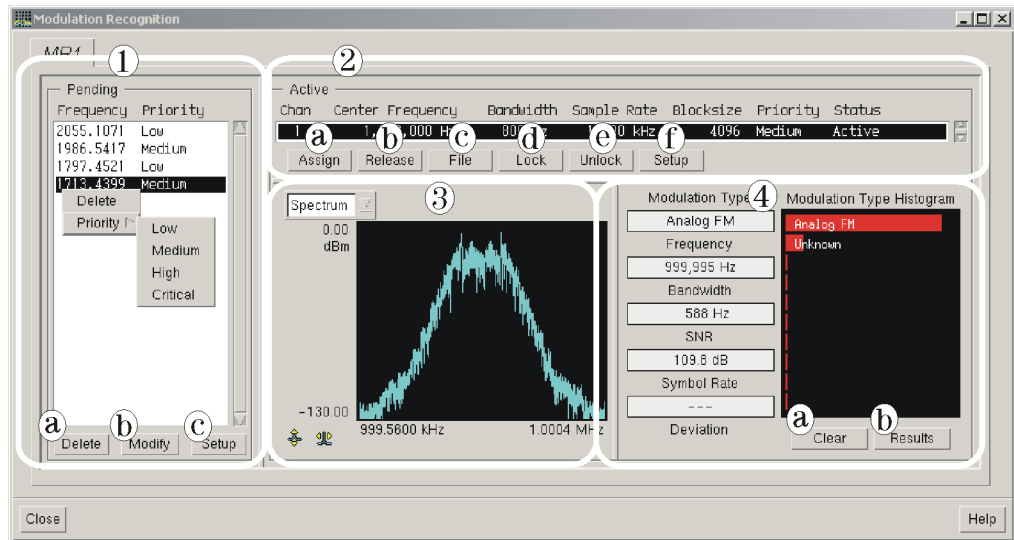
```
userPane: C:\e3238s\lib\noiseMarker.dll
```

5. Update license file if needed. Modulation Recognition requires a license for the MR1 option. These options are listed in your license file, typically in the C:\E3238s\licenses directory.
6. Start the N6820ES application and verify that it runs.
7. Verify that Modulation Recognition is loaded correctly by checking for "Modulation Recognition..." in the Search menu. Also, the Modulation Recognition icon should appear in the tool bar.

¹See \E3238s\manuals\install_ref.pdf

Modulation Recognition Dialog Box

This window displays the processing associated with modulation recognition activity.



Note

This dialog box is specific to the MR1 library. User-defined libraries can differ from the library used to create the box documented here. If so, what appears here may differ from the your dialog box.

The Module Recognition dialog box is composed of four major sections:

1. [Mod Rec Pending List \(page 8\)](#)
2. [Active List \(page 10\)](#)
3. [Monitor Display \(page 18\)](#)
4. [Results \(page 19\)](#)

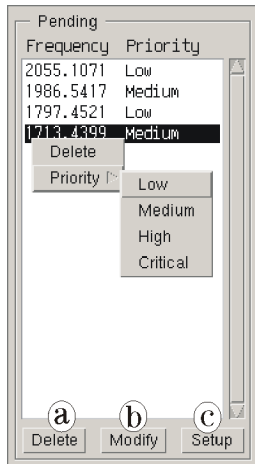
Modulation Recognition Dialog Box

Mod Rec Pending List

The Pending List displays a list of signals that are waiting for modulation recognition processing.

Modulation recognition processing is assigned in two ways:

- Manually, using a trace pane marker. See [Manual Mod Rec Assignments \(page 25\)](#).
- Automatically using an alarm task. See [MR1 Alarm Task \(page 21\)](#).



Each entry in this list has two parameters:

- **Frequency** shows the pending signal's frequency.
- **Priority** shows the pending signal's current priority. This can be changed with the Modify button or using the popup menu.

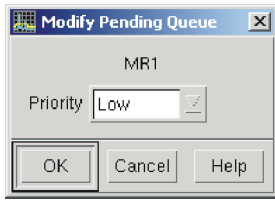
Beneath the Pending List are three buttons:

- Delete** Click this button to remove the highlighted entry from the Pending List. If no entry is selected (highlighted), this button has no effect.
- Modify** Clicking this button to display a dialog box used to change the priority of the selected item(s).
- Setup** Clicking on this button displays the [Mod Rec Setup Pending Signal \(page 9\)](#) dialog box. This allow you to set queue parameters: Aging, Max Queue Length, and Merge Frequency.

Pending List Popup Menu

The Pending List popup menu is displayed by selecting one or more signals in the list by clicking on it, then right-clicking on that highlighted signal. This pop-up menu allows you to delete the entry from the Pending List or change that entry's priority.

Mod Rec Modify Pending Signal

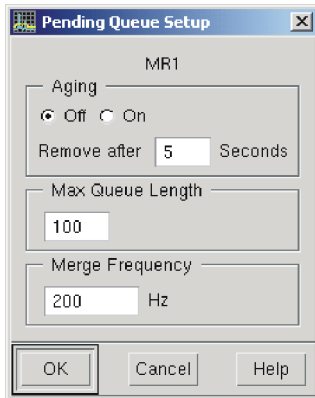


This dialog box is used to change the priority of a signal waiting in the Mod Rec Pending queue.

When the dialog box displays, click the Priority menu to select the desired priority, then click OK.

Mod Rec Setup Pending Signal

This dialog box defines the properties of the Mod Rec Pending Queue.



Aging Specifies whether signals are removed from the pending queue after a period of time and the time value. This allows you avoid processing signals that are known to have short duration after they have been in the pending queue too long. Aging can also be accomplished by setting the [MR1 Alarm Task \(page 21\)](#) duration value.

Max Queue Length Specifies the maximum number of entries allowed in the pending signal queue. When the system has more entries for the pending list than are allowed by this setting, the new entries are ignored.

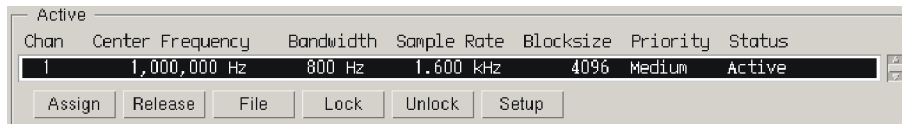
Merge Frequency Specifies a frequency range within which multiple entries are recognized as one. If a new signal appears within this range of any of the assigned (active) or pending entries, the new entry is ignored.

This value is applied to both the high and low sides of the tuned frequency, not centered on it.

Modulation Recognition Dialog Box

Active List

This is the list of current modulation processing assignments. (For ModRec 1 there is only one entry in the list.)



The Active display shows the currently active signals being processed by the Mod Rec software. It is composed of a channel list and several buttons. These are described in the following.

The Table Columns

Each entry has the following fields:

Chan The channel number. Channels are assigned to signal types when the N6820ES program starts. The MR1 library is limited to one channel.

Frequency The effective center frequency of the data being processed. This value may be specified by an alarm task or it may be assigned manually by clicking the entry and then clicking the [Assign \(page 12\)](#) button.

Bandwidth This is the bandwidth of the measured data. This value may be specified by an alarm task or it can be assigned manually.

Sample Rate This is the rate at which the signal is sampled. This rate is calculated from the bandwidth and oversampling. This rate can be changed by specifying oversampling.

Blocksize The size of the data block upon which the modulation recognition process works. The blocksizes range from 1024 complex pairs to 1,048,576 complex pairs in powers of two.

Priority Specifies the assignment entry's priority level.

Note Locked channels begin processing when the sweep *starts*. Channels that are *not* locked begin processing when they are *assigned*. If you stop the sweep and restart it, unlocked channels will *not* start processing when the sweep restarts. When channels are manually assigned, lock them to assure that they start and run properly.

- Status** The entry is either *Active* (processing) or *Idle* (unassigned).
Idle-to-Active transition occurs when:
- Signal assignment enters the Pending list (if not locked)
 - Manual assignment or reassignment occurs
 - Sweep is turned On (if locked and a frequency is associated with it)
- Active-to-Idle transition occurs when:
- Age release occurs (if not locked).
 - No-signal (if not locked; also has a time delay like age)
 - Manual release occurs
 - Sweep is turned Off (i.e., the search receiver stops sweeping)

The Buttons

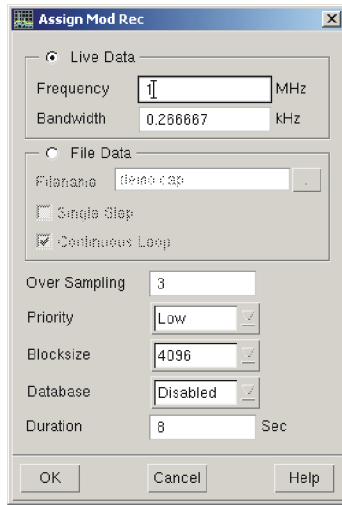
The buttons on the Active frame are as follows:

- Assign** Displays the [Assign \(page 12\)](#) dialog box, which is used to change the attribute(s) of a selected channel.
- Release** Changes the status of an assigned channel from *active* to *idle*.
- File** Displays the Playback Control dialog box which allows you to process a previously captured signal. The playback files must be first selected and loaded with the Assign Mod Rec dialog box.
- Lock** Changes the priority of a channel so that it won't be assigned a different frequency.
- Unlock** Changes the priority of a locked channel so that it may be reassigned.
- Setup** Displays the Modulation Setup dialog box, which is used to set parameters for the recognition process. See [Modulation Recognition Active Setup \(page 14\)](#).

Modulation Recognition Dialog Box

Assign

This dialog box allows you to change the Modulation Recognition parameters or to process a captured signal stored in a file.



The Live Data Used to request processing of real-time measurement data. This button also activates the Frequency and Bandwidth boxes.

Frequency Entry. Specifies the frequency of the signal to be processed.

Bandwidth Entry. Specifies the bandwidth of the signal to be processed.

File Data button This button requests processing of a file containing time data. These are typically created using the time snapshot feature.

This button also activates the Filename, Single Step, and Continuous Loop option in the dialog box.

Filename Entry. Specifies the file to assign to the Modulation Recognition process. You can also use the Filename button to pop up the filename browser.

Single Step Button. Used to play the data file through the Modulation Recognition process a single time.

Continuous Loop. Used to play the data recorded in the file through the Modulation Recognition process repeatedly.

Over Sampling This numeric entry specifies the over-sampling rate. (Can be set from 0.5 to 4.) The actual sample rate is proportional to the bandwidth multiplied by the oversampling setting, but is limited to the capabilities of the ADC.

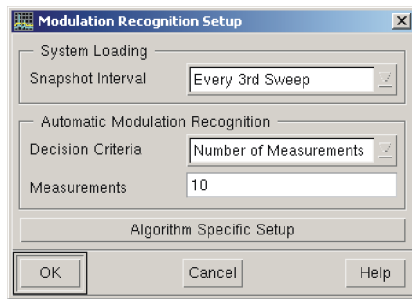
Priority This menu defines the channel's priority level within the channel list. The available values are: Low, Medium, High, Critical. Changing the priority could be used to avoid having the channel assignment changed (bumped) by a signal with a higher priority.

Blocksize Menu This menu defines the blocksize of data processed by the Mod Rec task from 1024 complex pairs to 1,048,576 complex pairs in powers of two. A blocksize of at least 4096 complex pairs is required to recognize some digital modulation formats. A blocksize of 8192 complex pairs improves recognition of signals with a narrow bandwidth relative to the sample rate. Larger blocksizes take longer to process.

- Database Menu** This menu allows you to enable saving the results of the Mod Rec task signal information in the signal database.
- Duration** This parameter specifies the amount of time that the signal is valid after the request is made. When the time elapses, any ongoing processing of the signal is halted or, if the request is still pending, the entry is removed from the [Mod Rec Pending List \(page 8\)](#).

Modulation Recognition Dialog Box

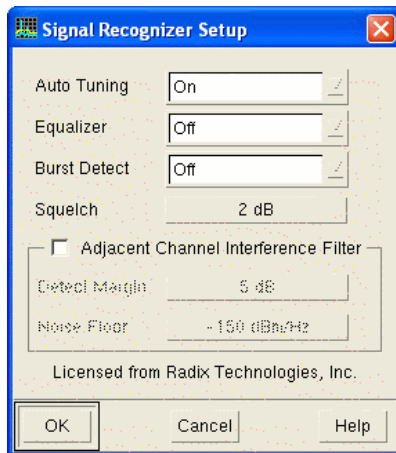
Modulation Recognition Active Setup



The Modulation Recognition Active Setup dialog box allows you to set or specify the following values.

- Snapshot Interval** This menu specifies how often the system stops the search to take a snapshot (collect time data). To take the snapshot the system reconfigures the tuner and ADC, which interrupts the sweep. The values allowed are every sweep, every second, third, fifth, tenth, and 20th sweep.
- Decision Criteria** This menu specifies whether the recognition process uses a specific number of measurements (specified in the box just beneath) to assess the signal of interest, or uses a simple majority vote.
- When the **Number of Measurements** menu option is selected, the Mod Rec task processes that number of measurements. It then classifies the modulation type based on the type that is reported most frequently.
 - When the **Simple Majority** menu option is selected, the Mod Rec task continues making measurements until more than half the results report the same modulation type. If no type attains a majority, the measurements continue until the duration is exceeded and processing (for the signal) is stopped.
- Measurements** This numeric entry box specifies the number of measurements the recognition process uses to determine the modulation type.
- Algorithm Specific Setup** This button displays the Algorithm Specific Setup dialog box. See [Signal Recognizer Setup \(page 15\)](#).

Signal Recognizer Setup



This dialog box controls the parameter settings for the modulation recognition algorithm being used. In the MR1 library the parameters are as follows:

Auto Tuning When Auto Tuning is enabled, the algorithm can recognize signals that are not centered within the frequency span. For this feature to function properly there should be no other signals within the frequency span and the signal of interest should occupy at least 1/10 of the frequency span.

When Auto Tuning is off, the Mod Rec task must be assigned with an accurate frequency (within 5% of the frequency span) and the signal should occupy at least 33% of the frequency span.

Equalizer When Equalizer is set to ON, it enables a "blind" equalizer. This process builds and applies an equalization filter. The equalization filter can improve detection of high-density digital modulation types that have become distorted. This equalization filter can slow Mod Rec processing, so it should only be used when the modulation type "Unknown Digital" is reported. See [page 26](#).

Burst Detect Burst Detect enables the recognition signals with bursts of modulation, such as Time Division Multiple Access (TDMA) signals. When Burst Detect is On, the modulation recognition algorithm only analyzes the portion of the time record that contains the burst. When Burst Detect is Off, the entire time record is processed. A larger BlockSize may be needed when Burst Detect is On.

Squelch Sets the minimum signal-to-noise ratio (SNR) for modulation recognition results. Signals with measured SNR values below this are classified as unknown. A default value of 2 dB is recommended. In noisy environments larger values can be used to reduce the number of false identifications. Squelch values larger than 5 dB inhibit the recognition of low SNR signals.

Adjacent Channel Interference Filter Allows recognition of signals when adjacent channels are occupied. When enabled, the NRC algorithm constructs a tight filter around the signal nearest the frequency span's center and processes that signal. The signal of interest should occupy at least 10% of the frequency span. In this mode the NRC algorithm cannot estimate the channel's noise level, so you must enter a **Noise Floor** value for the SNR computation (described later in this discussion).

When the Adjacent Channel Interference Filter is off, the algorithm uses the spectrum outside the signal-of-interest to automatically estimate the noise level.

Modulation Recognition Dialog Box

Note

Adjacent Channel Interference Filter can be used only on signals with single-peak spectra. *It cannot be used on FSK or other multi-peak signals* because it selects the peak nearest the frequency span center as the signal-of-interest and rejects the other valid signal peak or peaks.

Detect Margin

When the Adjacent Channel Interference Filter is enabled, this value is used to determine the presence of signal. Detect Margin is the level in dB above the Noise Floor value required for a signal to be detected and recognized. A default value of 5 dB is recommended. If you need to recognize only strong signals, this value can be raised by several dB to increase throughput.

Noise Floor

When the Adjacent Channel Interference Filter is enabled, the algorithm uses this value as a noise level estimate for the channel. This noise level is used in the computation of SNR and is the reference level for Detect Margin. Units are in dB of noise power density. To measure the noise floor, use the procedure described in Measuring the Noise Floor (next topic).

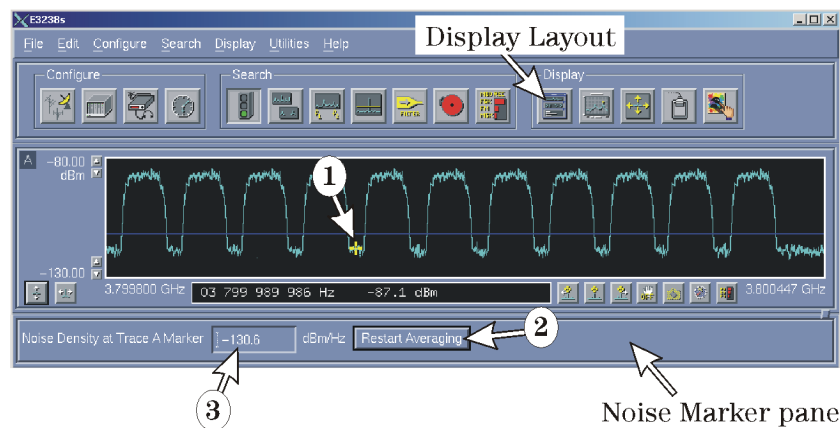
Measuring the Noise Floor

Agilent provides a special marker pane that can be used to measure the noise floor. To display this pane, click the Display Layout button and select the Noise Marker entry for the pane beneath the Trace A pane.

Note

You must enable the Noise Marker Pane by uncommenting out the following line in the C:\E3238s\e3238s.cfg file.

```
userPane: C:\e3238s\lib\noiseMarker.dll
```



The following procedure assumes that Trace A is displayed and the marker in Trace A is on. To determine the noise floor:

1. Position the marker on the noise floor between signals.
2. Click the Restart Averaging button and wait for two or three sweeps to occur.
3. Read the Noise Density value from the Noise Marker pane, then enter this value into the Noise Floor entry box of the [Signal Recognizer Setup](#) (page 15).

The Noise Density measurement requires averaging of accumulated values gained on successive sweeps. With every sweep you should see less change in the Noise Density value.

Modulation Recognition Dialog Box

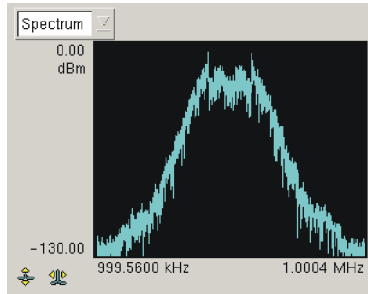
The averaging is an exponential algorithm. If you have changed the feed or sweep rate recently, there will be a lot of measurement data that is unusable. To clear this information, click the Restart Averaging button.

Note that just moving the marker restarts the averaging process. If you haven't changed the signal or sweep setup, you don't need to click the Restart Averaging button

Modulation Recognition Dialog Box

Monitor Display

The Monitor Display section of the Module Recognition screen shows the spectrum of the current active signal.



The Display section has the following elements:

- Spectrum Menu
- Display window
- Trace Scale Values
- Amplitude Autoscale Button
- Frequency Full Scale Button

Spectrum Menu This display currently has only one entry, Spectrum.

Display Window The Display Window displays the spectrum of the signal being processed by the Mod Rec task.

Trace Scale Values The numbers at the left side of the trace screen describe the amplitude range of the spectrum trace type. The numbers at the bottom of the trace screen describe the frequency range of the trace. These values can be changed by clicking on any of the values, or by clicking the scale buttons.

Amplitude Autoscale Button



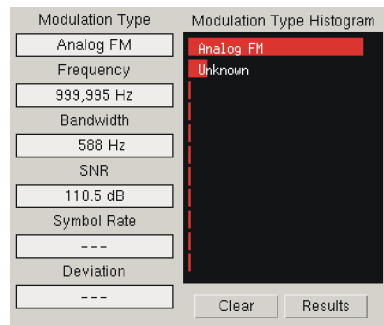
This button appears in the bottom-left corner of a trace pane. It sets the minimum and maximum amplitude values so that all of the trace is displayed. This button does *not* change the frequency span.

Frequency Full Scale Button



This button appears in the bottom-left corner of a trace pane. It sets the trace's frequency scale to match that of the snapshot bandwidth.

Results



The Results display shows the current modulation recognition processing results. The results are displayed as a histogram, or bar chart.

The following readouts show the current status of the active signal:

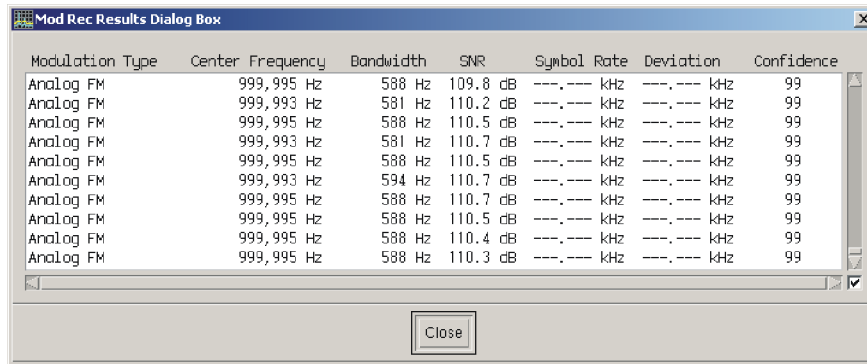
- Modulation Type** This is the best estimation of the type of modulation being used by the signal. The modulation type and notes related modulation types are contained in the following tables. The MR1 library categorizes the signal as one of the types listed on [page 26](#).
- Frequency** This is the center frequency of the signal.
- Bandwidth** This is the bandwidth of the signal.
- SNR** This is the signal-to-noise ratio of the signal. When the Adjacent Channel Interference Filter in the [Signal Recognizer Setup \(page 15\)](#) is off, the SNR is automatically computed from the noise level of the spectrum adjacent to the signal. When the Adjacent Channel Interference Filter is on, the SNR is relative to the value entered for ACI Noise Floor.
- Symbol Rate** This is the symbol rate for digital modulation formats.
- Deviation.** Deviation is the peak frequency deviation for FSK formats. This value can be converted to FSK tone spacing using the following rules:
- MSK or FSK: Multiply the deviation value by 2
 - 4-FSK: Multiply the deviation value by 2/3
 - 8-FSK: multiply by 2/7

Beneath the histogram are located the following buttons.

- Clear Button** This clears the results display and the results list.
- Results Button** This button displays the [Mod Rec Results \(page 20\)](#) dialog box.

Modulation Recognition Dialog Box

Mod Rec Results



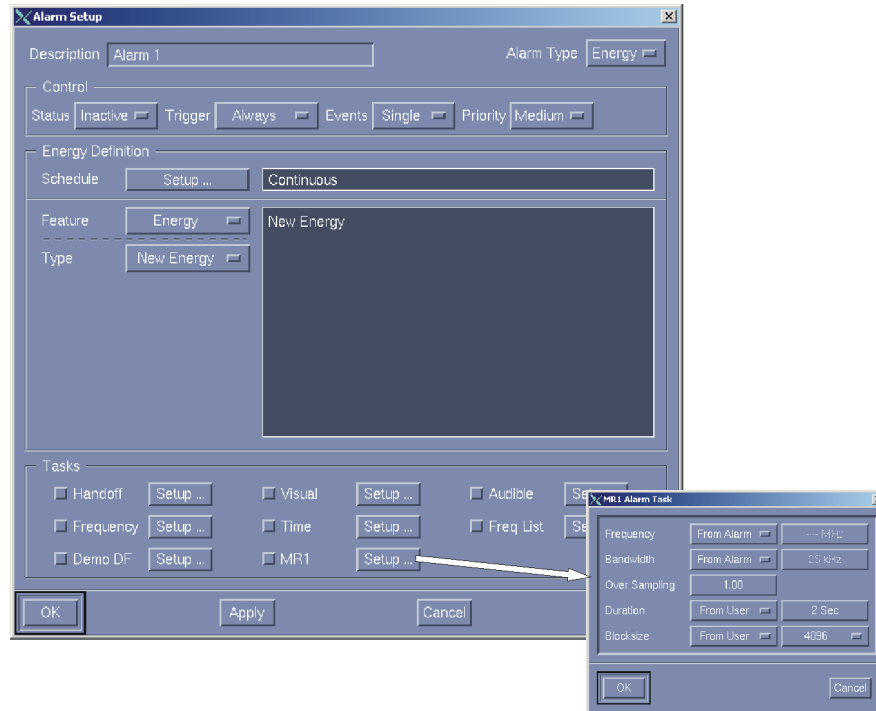
The screenshot shows a dialog box titled "Mod Rec Results Dialog Box" with a table of results. The table has seven columns: Modulation Type, Center Frequency, Bandwidth, SNR, Symbol Rate, Deviation, and Confidence. There are 12 rows of data, all for "Analog FM" modulation. The values for each column vary slightly across the rows, but the Confidence is consistently 99. A "Close" button is located at the bottom center of the dialog box.

Modulation Type	Center Frequency	Bandwidth	SNR	Symbol Rate	Deviation	Confidence
Analog FM	999,995 Hz	588 Hz	109.8 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,993 Hz	581 Hz	110.2 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,995 Hz	588 Hz	110.5 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,993 Hz	581 Hz	110.7 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,995 Hz	588 Hz	110.5 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,993 Hz	594 Hz	110.7 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,995 Hz	588 Hz	110.7 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,995 Hz	588 Hz	110.5 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,995 Hz	588 Hz	110.4 dB	---,--- kHz	---,--- kHz	99
Analog FM	999,995 Hz	588 Hz	110.3 dB	---,--- kHz	---,--- kHz	99

The Modulation Recognition Results Dialog Box displays a scrolling list of results of the Mod Rec task. This dialog box displays the same information as that displayed to the left of the Histogram, but in form that allows you to scroll back through entries. This information is captured in the signal database if the signal database is enabled.

MR1 Alarm Task

The Alarm Task dialog box is used to initiate a Module Recognition task when the alarm conditions are met. This dialog box is displayed by clicking the MR1 Setup button on the Alarm Setup Screen.



The MR1 Alarm Task dialog box has five parameters that the user can specify. These parameters are associated with the task that is added to the modulation recognition [Mod Rec Pending List \(page 8\)](#). Several of these parameters can match the ones used to trigger the alarm; some of them can be specified separately. Select “From Alarm” to obtain the value from the energy of the signal that generated the alarm. Select “From User” to force the parameter to a fixed value.

- Frequency** The frequency of the signal given to the Mod Rec task.
- Bandwidth** The bandwidth of the signal given to the Mod Rec task. The Bandwidth value and the Oversampling value determine the sample rate.
- Over Sampling** The over-sampling rate of the signal given to the Mod Rec task. The over-sampling value and the bandwidth value determine the sample rate. This value is a decimal number between 0.5 and 4.

MR1 Alarm Task

Duration The duration of the pending request given to the MR1 task. See [Duration \(page 13\)](#).

This is a three-element menu. The choices are

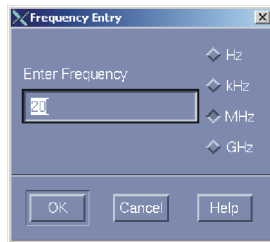
- From Alarm
- From User
- Up/Down.

The first two selections operate as described previously. The third option allows you to specify that the MR1 task be dropped when the signal energy transitions up or down.

The Up/Down setting allows you to remove the Mod Rec request immediately if the energy transitions from present to not present.

Blocksize This menu defines the blocksize of data processed by the Mod Rec task from 1024 complex pairs to 1,048,576 complex pairs in powers of two. A blocksize of at least 4096 complex pairs is required to recognize some digital modulation formats. A blocksize of 8192 complex pairs improves recognition of signals with a narrow bandwidth relative to the sample rate. Larger blocksizes take longer to process.

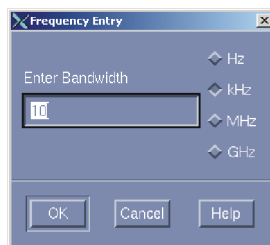
Frequency Entry



This dialog box appears when you click a button to enter a frequency or a bandwidth. To enter a value:

1. Enter the frequency value in the text box.
2. Click one of the frequency units radio buttons or type h, k, m, or g to select Hz, kHz, MHz, or GHz, respectively. You can also enter floating-point numbers in the form 1.23e4 (which is 12.3 kHz).
3. Click OK, or press the Enter/Return key.

Bandwidth Entry

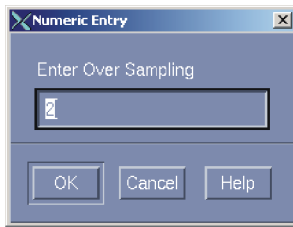


This dialog box appears when you click a button to enter a frequency or a bandwidth. This value and the Oversampling value determine the sample rate for modulation recognition processing. To enter a value:

1. Enter the frequency value in the text box.
2. Click one of the frequency units radio buttons or type h, k, m, or g to select Hz, kHz, MHz, or GHz, respectively. You can also enter floating-point numbers in the form 1.23e4 (which is 12.3 kHz).
3. Click OK, or press the Enter/Return key.

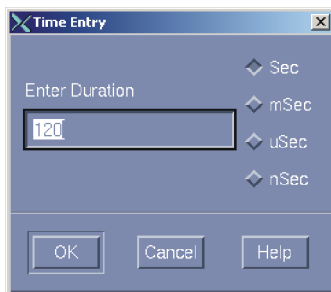
MR1 Alarm Task

MR1 Over Sampling Entry



This numeric entry field allows you to specify the oversampling rate. (Can be set from 0.5 to 4). This value and the Bandwidth value determine the sample rate for modulation recognition processing.

MR1 Duration Entry



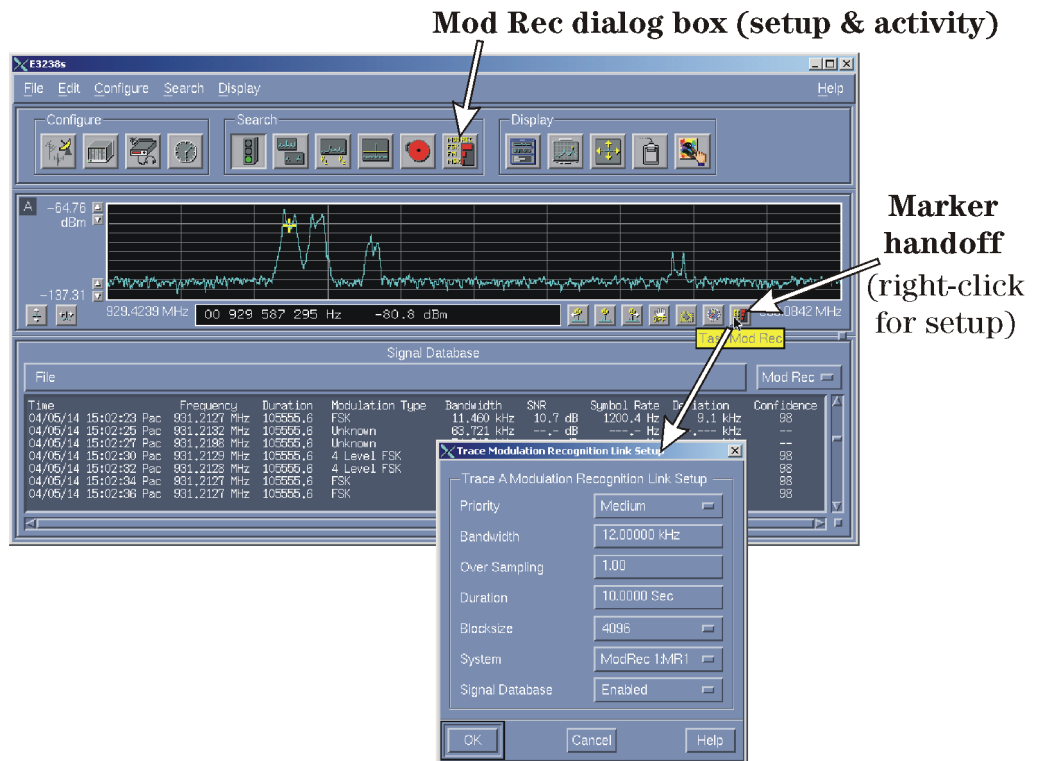
This dialog box appears when you click a button to enter a duration value. The duration value limits the age of the request for modulation recognition and limits the time spent processing the modulation recognition task. It is similar to the Aging value in the [Mod Rec Pending List \(page 8\)](#), but also applies after a signal is assigned to a channel for processing. To enter a value:

1. Enter the duration value in the text box.
2. Click one of the frequency units radio buttons or type s, m, u, or n to select Sec, mSec, uSec, or nSec, respectively. You can also enter floating-point numbers in the form 1.23e-4. Numeric values greater than 9999 are converted to scientific notation.
3. Click OK, or press the Enter/Return key.

MR1 Blocksize Entry

This menu allows you to specify the blocksize of the data passed to the Modulation Recognition task. The blocksizes range from 512 bytes to 1,048,576 bytes in powers of two.

Manual Mod Rec Assignments



1. Turn on the marker.
2. Right-click the ModRec marker button to view the setup dialog box.

Priority – if more than one trace is handing off ModRec processing, you can designate importance of one over others.

Bandwidth – specifies the width of the signal to be processed

Over Sampling – used to tweak bandwidth. May be any value between 1 and 4, including non-integers.

Duration – how long the signal is valid. See [Duration \(page 13\)](#).

Block Size – the processing is done in blocks (FFT). Size is powers of two. This is equivalent to specifying resolution bandwidth.

System – specifies which ModRec function to be used (when more than one is installed).

Signal Database – specifies whether to put the results in the signal database (shown in the lower pane).

3. Position the marker on the signal to be processed.
4. Click the ModRec task (handoff) button.

Modulation Types

The recognized modulation types are defined as follows:

Analog Modulation Types:

Modulation Type	Description
AM (Amplitude Modulation)	Amplitude modulated RF carrier. Usually carries speech, music, or other audio. Can also carry analog data, such as telemetry, fax, or imagery such as slow-scan television (SSTV). Wider bandwidth AM (wider than normal audio bandwidths of 4 – 25 kHz) probably carries data. May be identified as Pure Carrier during silences or low-level modulation inputs.
AM DSBSC (Amplitude Modulation/Double Side-Band Suppressed Carrier)	Similar to AM, but with the carrier suppressed to achieve greater power efficiency. Requires special carrier-insertion receiver processing to retrieve intelligible speech/traffic. May be identified as NOISE or UNKNOWN during silences or low-level modulation inputs.
LSB (Lower Single Side-Band)	Similar to AM, but with carrier and the upper side-band suppressed. More likely to carry speech than any form of analog data. May be identified as NOISE or UNKNOWN during silences or low-level modulation inputs.
USB (Upper Single Side-Band)	Similar to AM, but with carrier and the lower side-band suppressed. More likely to carry speech than any form of analog data. May be identified as NOISE or UNKNOWN during silences or low-level modulation inputs.
Analog FM (Analog Frequency Modulation)	Frequency modulated RF carrier. Usually carries speech, music, or other audio. Can also carry analog data, such as telemetry, imagery, or sensor data. Can also carry digital data, such as multi-tone modulations or multilevel FSK if other than 2, 3, 4, or 8FSK. May be identified as Pure Carrier during silences or low-level modulation.
Manual Morse	Morse code at word-per-minute (WPM) rate ranging from 35 WPM to 150 WPM. May be identified as Pure Carrier during tune-up (long dash), and NOISE or UNKNOWN during long keying pauses.
Machine Morse	Morse code at word-per-minute (WPM) rate ranging from 35 WPM to 150 WPM. May be identified as Pure Carrier during tune-up (long dash), and NOISE or UNKNOWN during long keying pauses.
Noise	This message indicates that the algorithm failed to detect any signal structure, or found only very weak structure with noise characteristics dominating. Often indicates a very low SNR input.
Pure Carrier	Unmodulated carrier, indicative of idle signal or signal during tune-up. Other modulation types may be identified as Pure Carrier if the Bandwidth (which controls Sample Rate) is too large.
Unknown	This message indicates that algorithm detected signal structure, but could not find a clear match to any of the supported modulation types. Often indicates low SNR or co-channel interference (overlapped signals). Can also indicate signal distortion, such as caused by multipath reception. Some modulation types may be identified as Unknown if the Bandwidth (which controls sample rate) is too small, causing a portion of the signal spectrum to be missed.
Unknown Digital	This message indicates that algorithm acquired carrier and symbol sync, but was unable to resolve the constellation of the signal due to severe spreading of the constellation points. Constellation spread is usually caused by low SNR, co-channel interference, distortion effects such as multipath reception, or combinations of these factors. The signal could be any form of QAM or any form of PSK, or an unsupported digital signal.

Digital Modulation Types - Phase Shift Keying:

Modulation Type	Description
BPSK (Binary Phase-Shift Keying)	Two-level phase-shift keying (PSK) used to transmit digital data at 1 bit per symbol. Related to QPSK, 8PSK. Used in satellite links.
QPSK (Quadrature Phase-Shift Keying)	Four-level phase-shift keying (PSK) used to transmit digital data at 2 bits per symbol. Used in satellite links.
PI/4 QPSK	Modified QPSK with a 45-degree constellation phase-reference shift on alternate symbols. Widely used (for example by IS-136 “digital AMPS” cellular) to transmit digital data at 2 bits per symbol with tighter sidelobes than standard QPSK.
8 Level PSK	Eight-level phase-shift keying (PSK) used to transmit digital data at 3 bits per symbol
16 Level PSK	Sixteen-level phase-shift keying (PSK) used to transmit digital data at 4 bits per symbol. Requires high SNR at the receiving node to achieve a reliable data link.

Digital Modulation Types – Frequency Shift Keying:

Modulation Type	Description
FSK (Frequency-Shift Keying)	Two-level frequency-shift keying (FSK) used to transmit digital data at 1 bit per symbol by switching between two frequencies. Also called Binary FSK (BFSK). Includes coherent (continuous phase) FSK and non-coherent FSK, without distinction. Covers a wide range of modulation index (D/B), ranging from D/B=0.35 to D/B=20. D/B represents the frequency deviation to bit rate ratio. The frequency deviation (also called frequency shift) is the separation between the mark and space frequencies, and the bit rate is the signal keying rate. Related to MSK.
MSK Minimal-Shift Keying	Minimal-shift keying (MSK) is defined as binary FSK with D/B value less than or equal to 0.6. This is a modern, spectrally efficient (narrowband) form of FSK. This includes Gaussian minimal-shift keying (GMSK) such as used by GSM, as well as staggered QPSK (SQPSK) signals.
3 Level FSK	Three-level frequency-shift keying used to transmit digital data at 1 bit per symbol. The third state is used either as a resting frequency or to send parity information to help detect or correct errors
4 Level FSK	Four-level frequency-shift keying used to transmit digital data at 2 bits per symbol using 4 frequencies. Used by some paging protocols.
8 Level FSK	Eight-level frequency-shift keying used to transmit digital data at 3 bits per symbol. Used in the HF radio Automatic Link Establish (ALE) protocol.

Modulation Types

Digital Modulation Types – Other:

Modulation Type	Description
OOK (On-Off Keying)	Two-level pulse amplitude modulation (PAM) used to transmit digital data at 1 bit per symbol. Also referred to as two-level amplitude shift keying (ASK). Includes signals with two nonzero amplitude levels, as well as those where one of the amplitude levels is zero, corresponding to a signal OFF state.
4PAM	Four-level pulse amplitude modulation (PAM) used to transmit digital data at 2 bits per symbol. Also referred to as four-level amplitude shift keying (ASK). Includes signals with four nonzero amplitude levels, as well as those where one of the amplitude levels is zero, corresponding to a signal OFF state
16 QAM	Quadrature amplitude modulation (QAM) with a square (4 x 4)16-level constellation, used to transmit digital data at 4 bits per symbol. Often found on digital modems or high-capacity digital data links.
32 QAM	Quadrature amplitude modulation (QAM) with a non-square 32-level constellation, used to transmit digital data at 5 bits per symbol. Constellation is 6 x 6 with the four corners removed. Often found on digital modems or high-capacity digital data links.
64 QAM	Quadrature amplitude modulation (QAM) with a square (8 x 8) 64-level constellation, used to transmit digital data at 6 bits per symbol. Requires higher SNR for reliable data communications. Often found on digital modems or high-capacity digital data links.
128 QAM	Quadrature amplitude modulation (QAM) with a non-square 128-level constellation, used to transmit digital data at 8 bits per symbol. Requires high SNR and a low distortion channel for reliable data communications. Often found on digital modems or high-capacity digital data links.
256 QAM	Quadrature amplitude modulation (QAM) with a square (16 x 16) 256-level constellation, used to transmit digital data at 8 bits per symbol. Requires high SNR and a low distortion channel for reliable data communications. Often found on digital modems or high-capacity digital data links.
V.29	A form of Quadrature amplitude modulation (QAM) often used for facsimile transmissions.

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