# Keysight X-Series Signal Analyzers

This manual provides documentation for the following Analyzers:

PXA Signal Analyzer N9030A
EXA Signal Analyzer N9010A
MXE EMI Receiver N9038A
MXA Signal Analyzer N9020A
CXA Signal Analyzer N9000A

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# N9063A & W9063A Analog Demod Measurement Application Measurement Guide

KEYSIGHT TECHNOLOGIES

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## 2 Concepts

# 1 Demodulating AM, FM, ΦM, FM Stereo/RDS Signals

The Analog Demod measurement application provides the capability of demodulating AM (amplitude modulated), FM (frequency modulated), ΦM (phase modulated), and FM Stereo/RDS (Radio Data System) signals. These measurements provide functionalities that can generally be categorized as follows:

- Demodulating a modulated carrier and playing the modulating signal over a speaker (sometimes referred to as **tune and listen**)
- Displaying demodulated signals in both time and frequency domains
- Displaying modulation metrics
- Displaying the RDS information in FM Stereo/RDS signals

The following topics can be found in this section:

# Setting Up and Making a Measurement

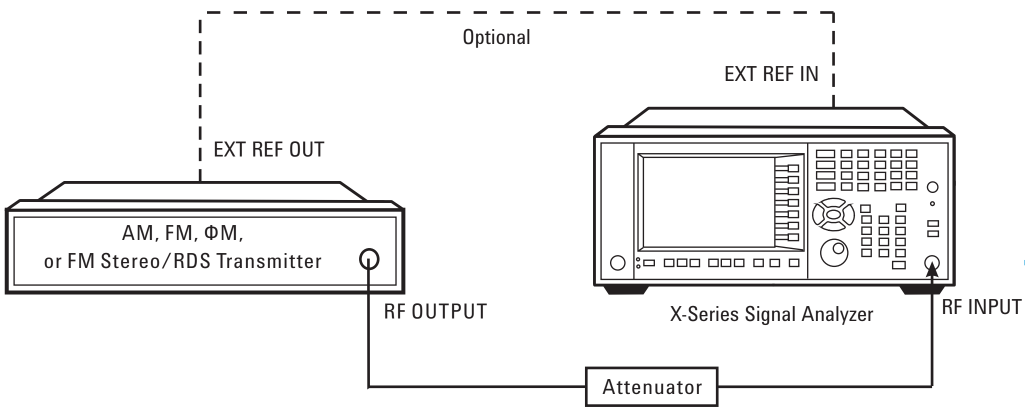
## Making the Initial Signal Connection

Set the AM, FM, ΦM, or FM Stereo/RDS transmitter under test to transmit the RF power. Connect the transmitting signal to the signal analyzer as below.

**CAUTION** Before connecting a signal to the analyzer, make sure the analyzer can safely accept the signal level provided. The signal level limits are marked next to the RF Input connector on the front panel.

1. Connect the output AM, FM, ΦM, or FM Stereo/RDS transmitter to the RF input port of the signal analyzer using appropriate cables, attenuators, and adapters.
2. (Optional) If there is a frequency reference port on the transmitter, connect it to the EXT REF IN port on the signal analyzer for frequency synchronization.

*Figure 1-1 AM, FM, ΦM, or FM Stereo/RDS Measurement System*




After making the connection, see the **Input/Output** key menu for details on selecting input ports and the **AMPTD Y Scale** menu for details on setting internal attenuation to prevent overloading the analyzer.

## Using Analyzer Mode and Measurement Presets

To set your current measurement mode to a known factory default state, press **Mode Preset**. This initializes the analyzer by returning the mode setup and all of the measurement setups in the mode to the factory default parameters.

To preset the parameters that are specific to an active, selected measurement, press **Meas Setup**, **Meas Preset**. This returns all the measurement setup parameters to the factory defaults, but only for the currently selected measurement.

### The 3 Steps to Set Up and Make Measurements

All measurements can be set up using the following three steps. The sequence starts at the Mode level, is followed by the Measurement level, then finally, the result displays may be adjusted.

*Table 1-1 The 3 Steps to Set Up and Make a Measurement*

| Step | Action | Notes |
|---|---|---|
| **1 Select and Set Up the Mode** | a. Press **Mode**.<br>b. Press **Analog Demod.**<br>c. Press **Mode Preset**.<br>d. Press **Mode Setup**. | All licensed, installed modes available are shown under the **Mode** key.<br>Using **Mode Setup**, make any required adjustments to the mode settings. These settings will apply to all measurements in the mode. |
| **2 Select and Set Up the Measurement** | a. Press **Meas.**<br>b. Select the specific measurement to be performed.<br>c. Press **Meas Setup**. | The measurement begins as soon as any required trigger conditions are met. The resulting data is shown on the display or is available for export.<br>Use Meas Setup to make any required adjustment to the selected measurement settings. The settings only apply to this measurement. |
| **3 Select and Set Up a View of the Results** | Press **View/Display**. Select a display format for the current measurement data. | Depending on the mode and measurement selected, other graphical and tabular data presentations may be available. **X-Scale** and **Y-Scale** adjustments may also be made now. |

**NOTE** A setting may be reset at any time, and will be in effect on the next measurement cycle or view.

*Table 1-2 Main Keys and Functions for Making Measurements*

| Step | Primary Key | Setup Keys | Related Keys |
|---|---|---|---|
| **1** Select and set up a mode. | **Mode** | **Mode Setup, FREQ Channel** | **System** |
| **2** Select and set up a measurement. | **Meas** | **Meas Setup** | **Sweep/Control**, **Restart**, **Single**, **Cont** |

*Table 1-2 Main Keys and Functions for Making Measurements*

| Step | Primary Key | Setup Keys | Related Keys |
|---|---|---|---|
| **3** Select and set up a view of the results. | **View/Display** | **SPAN X Scale**, **AMPTD Y Scale** | **Peak Search,** **Quick Save**, **Save**, **Recall**, **File**, **Print** |

**NOTE**

If you encounter a problem, or get an error message, see the guide "**Instrument Messages**", which is provided on the Documentation CD ROM, and in the instrument here:

C:\Program Files\Keysight\SignalAnalysis\Infrastructure\Help\bookfiles.

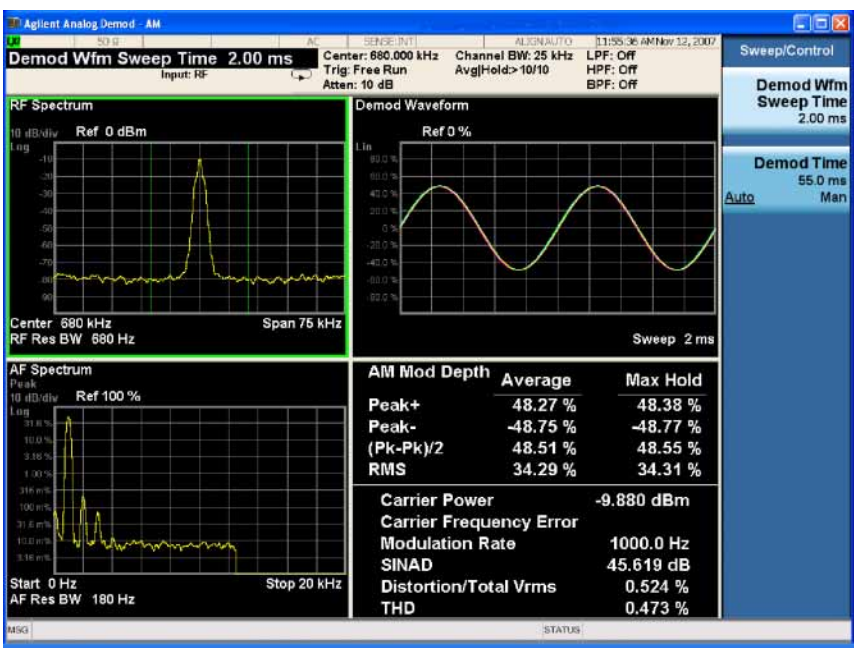
# Demodulating an AM Signal

This section demonstrates how to demodulate and listen to an AM signal. You can tune to an AM signal and view the results of the detector output displayed in the quad-view window or in single-window format.

Alternatively, the demodulated signal is also available as an audio output (to the speaker or headphone jack) and as video output (on the rear panel).

The signal under test is a 680 kHz signal with AM depth of 50% and AM rate of 1 kHz. Note that if you are using a broadcast AM signal in the United States, for example, the AM channels are broadcasting between 550 kHz and 1650 kHz.

| Step | Action | Notes |
|---|---|---|
| **1** Select Analog Demod mode. | Press **Mode**, **Analog Demod.** | |
| **2** Preset the mode. | Press **Mode Preset.** | |
| **3** Select AM measurement. | Press **Meas**, **AM.** | |
| **4** Set the center frequency of the AM signal. | Press **FREQ Channel**, **Center Freq**, **680**, **kHz.** | |
| **5** Adjust the sweep time and view the measurement results as in the figure below. | Press **Sweep/Contro**l, **Demod Wfm Sweep Time**, **2**, **ms.** | |




| | | |
|---|---|---|
| **6** Listen to the demodulated AM signal. | Press **Meas Setup**, **Demod to Speaker.** | You may need to adjust the volume as necessary. |

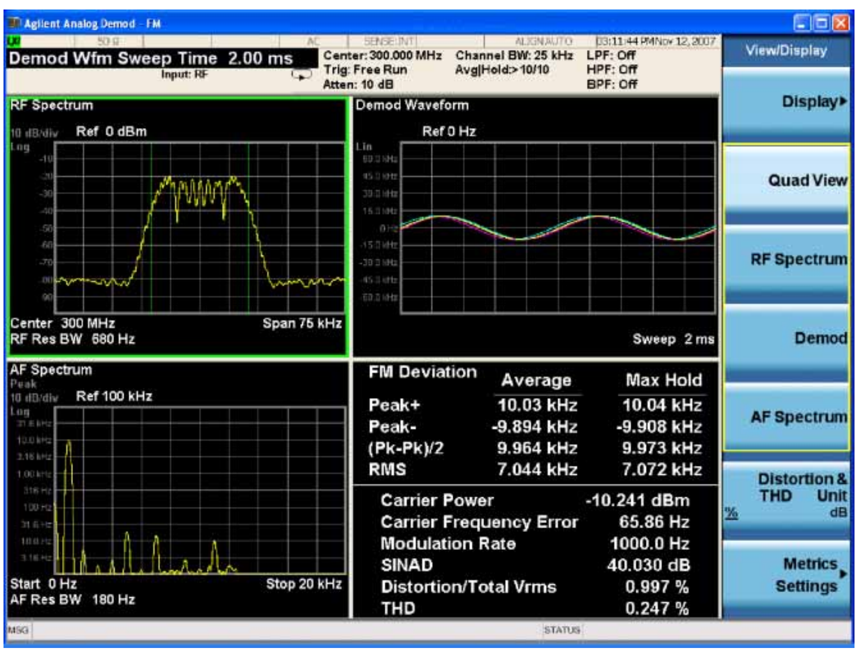
# Demodulating an FM Signal

This section demonstrates how to demodulate and listen to an FM signal. You can tune to an FM signal and view the results of the detector output displayed in the quad-view window or single-window format.

Alternatively, the demodulated signal is also available as an audio output (to the speaker or headphone jack) and as video output (on the rear panel).

The signal under test is a signal at 300 MHz with FM deviation of 10 kHz and FM rate of 1 kHz. Note that if you are using a broadcast FM signal in the United States, for example, the FM channels are broadcasting between 87.7 MHz and 107.7 MHz.

| Step | Action | Notes |
|---|---|---|
| **1** Select Analog Demod mode. | Press **Mode**, **Analog Demod.** | |
| **2** Preset the mode. | Press **Mode Preset.** | |
| **3** Select FM measurement. | Press **Meas**, **FM.** | |
| **4** Set the center frequency to the center of the FM signal. | Press **FREQ Channel**, **Center Freq**, **300**, **MHz.** | |
| **5** Adjust the sweep time and view the measurement result as in the figure below. | Press **Sweep**, **Demod Wfm Sweep Time**, **2**, **ms.** | |




| Step | Action | Notes |
|---|---|---|
| **6** Listen to the demodulated FM signal. | Press **Meas Setup**, **Demod to Speaker.** | You may need to adjust the volume as necessary. |

# Demodulating an FM Stereo/RDS Signal

This section demonstrates how to demodulate and listen to an FM Stereo signal and view key messages carried in RDS (Radio Data System). You can tune to an FM Stereo/RDS signal and view the measurement results of the multiplexed signal, the mono signal, the stereo signal, the left and right channel of the stereo signal, and the RDS messages in separate views.

Alternatively, the demodulated FM Stereo signal is also available as an audio output (to the speaker or headphone jack).

Measurement procedures for two typical FM Stereo/RDS signals are introduced here:

"Measuring L Only FM Stereo/RDS Signals" on page 13

"Measuring L=R FM Stereo/RDS Signals" on page 19

## Measuring L Only FM Stereo/RDS Signals

The parameters of the signal under test are as below.

FM reference deviation: 75 kHz

Pilot deviation: 10%

Pilot frequency: 19 kHz

Stereo frequency: 38 kHz

Left only tone: 1.0 kHz

RDS deviation: 6%

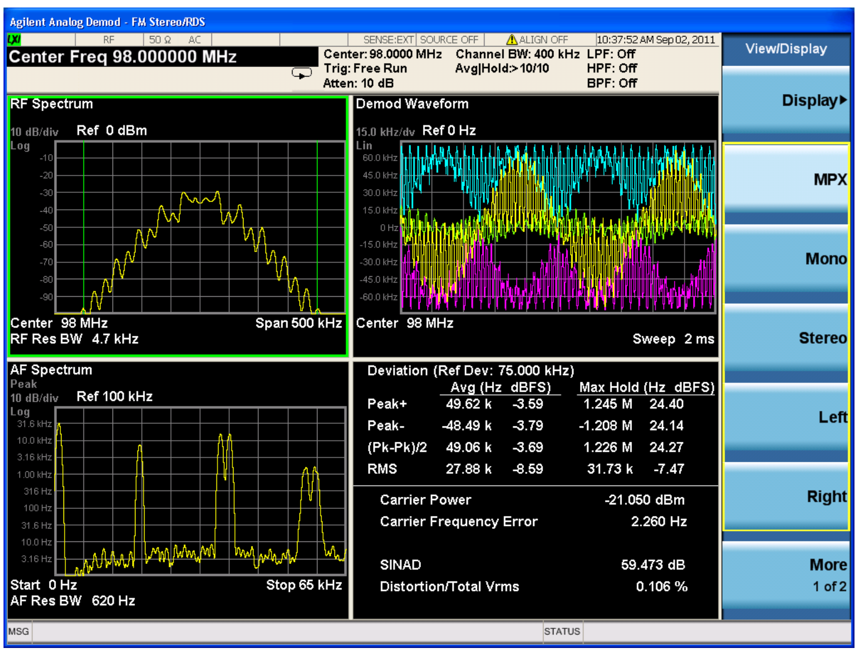
RDS frequency: 57 kHz

| Step | Action | Notes |
|---|---|---|
| **1** Select Analog Demod mode. | Press **Mode**, **Analog Demod.** | |
| **2** Preset the mode. | Press **Mode Preset.** | |
| **3** Select FM Stereo/RDS measurement. | Press **Meas**, **FM Stereo/RDS.** | |
| **4** Set the center frequency to the center of the signal and set the AF stop frequency. | Press **FREQ Channel**, **Center Freq**, 98, **MHz.**<br>Press **FREQ Channel**, **AF Stop Freq**, 65, **kHz.** | AF start frequency and AF stop frequency settings determine the span of the X axis in AF Spectrum window in MPX, Mono, Stereo, Left, and Right views. |
| **5** Set the FM reference deviation. | Press **Meas Setup**, **Advanced**, **Ref Deviation**, 75, **kHz.** | |

| Step | Action | Notes |
| --- | --- | --- |
| **6** View the measurement result of the multiplexed signal. | Press **View/Display**, **MPX**. | To display only the current trace in the Demod Waveform window, press **Meas Setup** and toggle **Avg/Hold Num** to **Off**. |

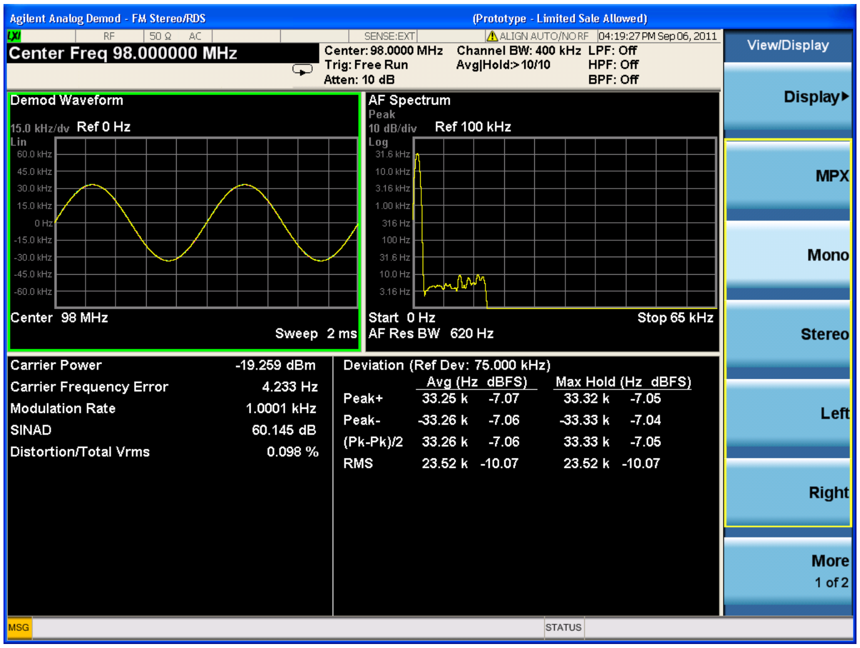
The figure below shows measurement results of the multiplexed signal, including mono part, stereo part, RDS/RBDS, and pilots. There are four windows:

- RF Spectrum window (top left) displays the RF spectrum of the multiplexed signal.
- Demod Waveform window (top right) displays the baseband modulating signal in time domain. There are four traces in this window: maximum trace (in cyan), minimum trace (in magenta), average trace (in green), and current trace (in yellow).
- AF Spectrum window (bottom left) displays the modulating signal in frequency domain.
- Metric window (bottom right) displays the numeric measurement results.

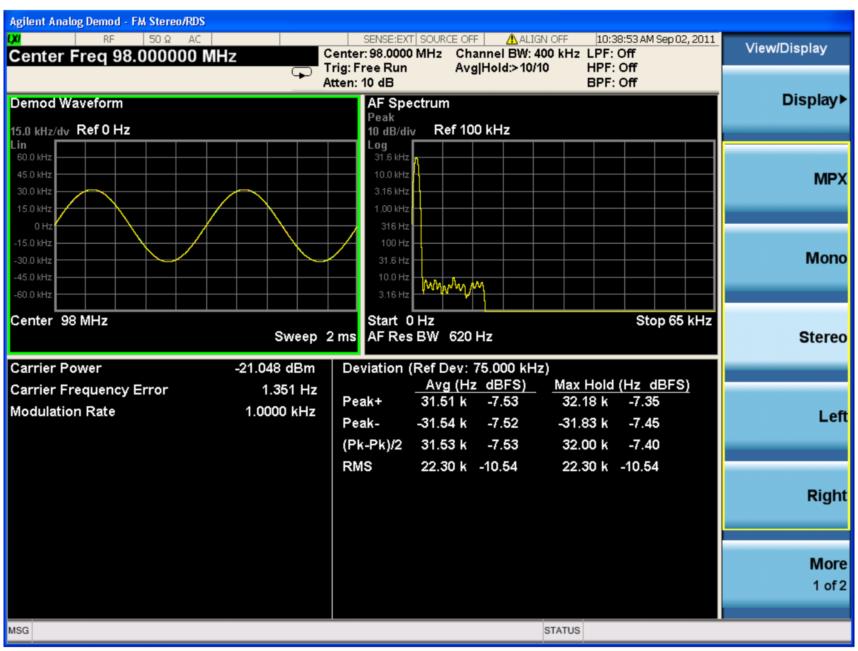



| | | |
| --- | --- | --- |
| **7** View the mono part of the multiplexed signal which corresponds to L+R. | Press **View/Display**, **Mono**. | |

| Step | Action | Notes |
|---|---|---|

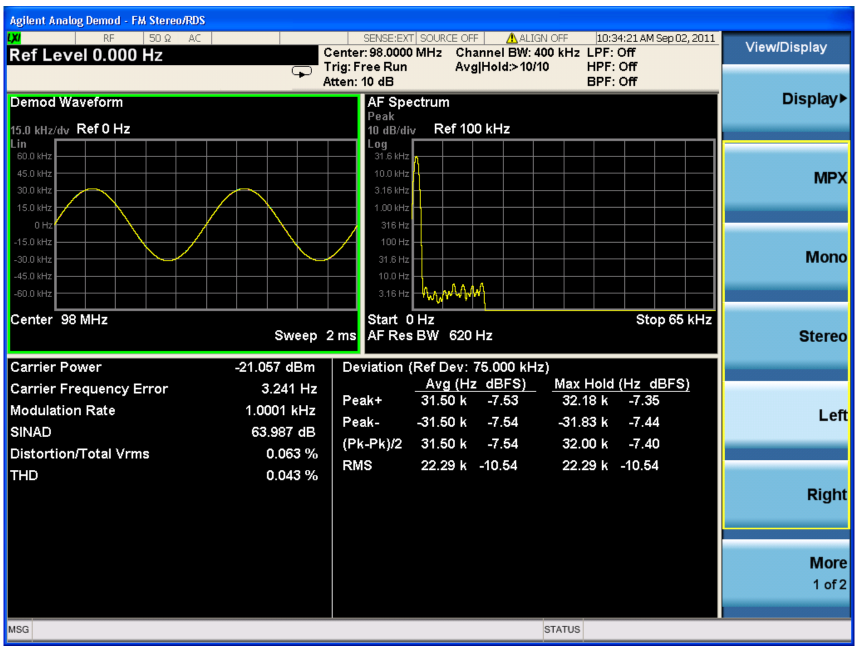



| Step | Action | Notes |
|---|---|---|
| **8** View the stereo part of the multiplexed signal which corresponds to L-R. | Press **View/Display**, **Stereo**. | |



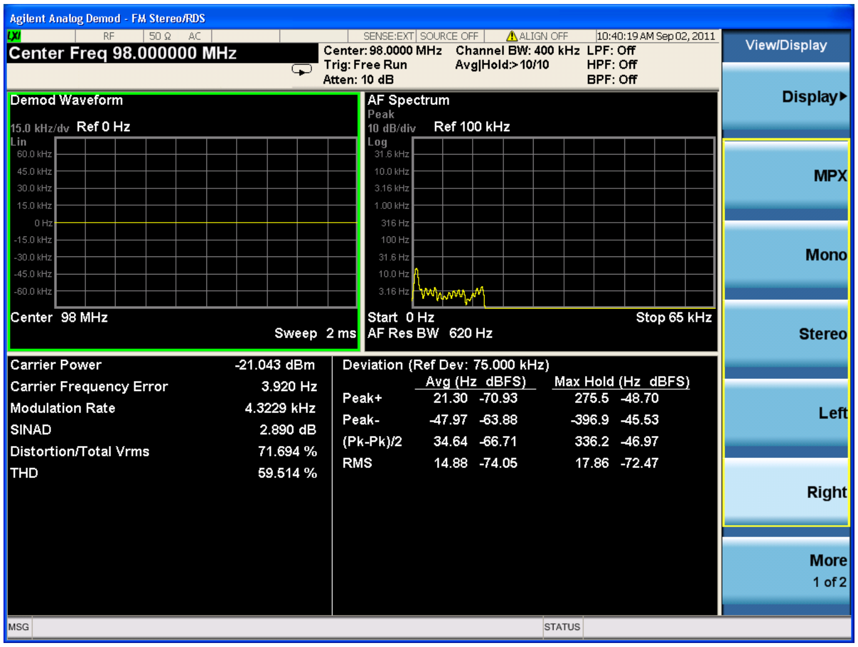

| Step | Action | Notes |
|---|---|---|
| **9** (Optional) Set the baseband filters to improve the measurement results. | Press **Meas Setup**, **Filters**. | The highpass filter, lowpass filter, and bandpass filter can be combined as you like. |

| Step | Action | Notes |
|---|---|---|
| **10** If pre-emphasis is used in the signal under test, set to use de-emphasis in the signal analyzer. | Press **Meas Setup**, **Filters**, **De-Emphasis** and choose the appropriate de-emphasis filter. | |
| **11** View measurement results of the left channel. | Press **View/Display**, **Left**. | |



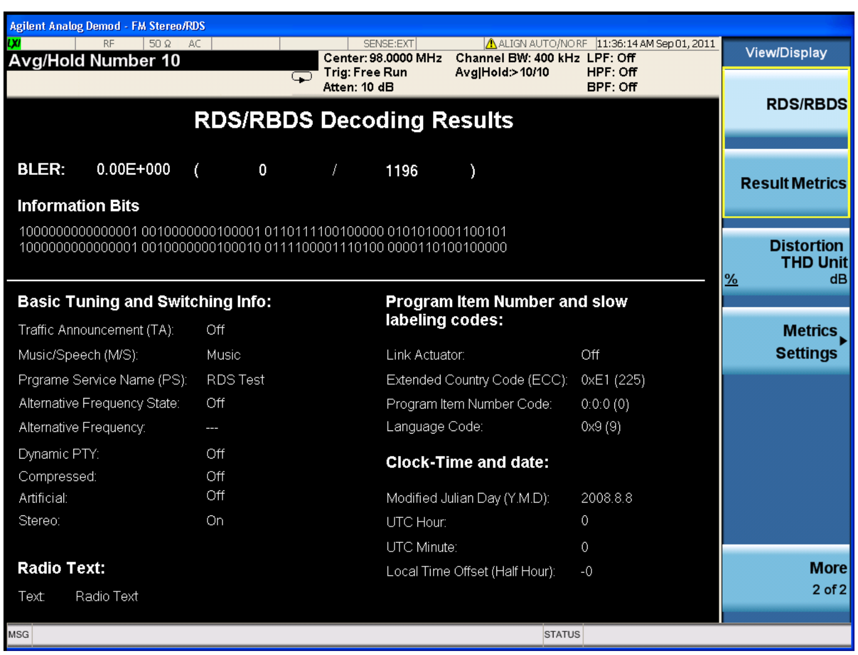

| Step | Action | Notes |
|---|---|---|
| **12** View measurement results of the right channel. | Press **View/Display**, **Right**. | The audio in the test signal is an L-only tone, so in the results of the right channel, the demod waveform is almost zero. |

| Step | Action | Notes |
|---|---|---|



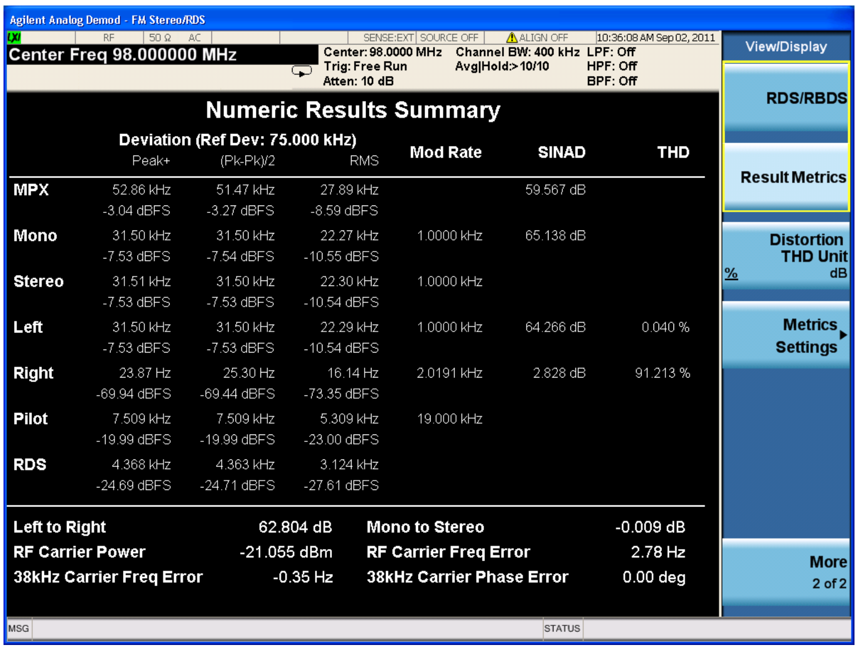

| Step | Action | Notes |
|---|---|---|
| **13** View the RDS/RBDS results. | Press **View/Display**, **RDS/RBDS**. | |

The figure below displays the BLER result and the information bits in the upper part and key RDS messages like basic tuning and switch information, radio text, and so on in the lower part. For more information, refer to "Basic Structure of RDS" on page 31 and "BLER" on page 31.



| Step | Action | Notes |
|---|---|---|
| **14** View a summary of the numeric measurement results. | Press **View/Display**, **Result Metrics.** | |

**NOTE** In this view, the left to right separation result is displayed as "Left to Right" and the mono to stereo crosstalk is displayed as "Mono to Stereo". Normally, left to right separation test is taken when the audio signal under test is L only or R only; mono to stereo crosstalk test is taken when the audio signal under test is L=R or L=-R.




| Step | Action | Notes |
|---|---|---|
| **15** Listen to the demodulated FM stereo signal. | Press **Meas Setup**, **Demod to Speaker.** | You may need to adjust the volume as necessary. |

## Measuring L=R FM Stereo/RDS Signals

The parameters of the signal under test are as below.

FM reference deviation: 75 kHz

Pilot deviation: 10%

Pilot frequency: 19 kHz

Stereo frequency: 38 kHz

Left = Right tone: 1.0 kHz

RDS deviation: 6%

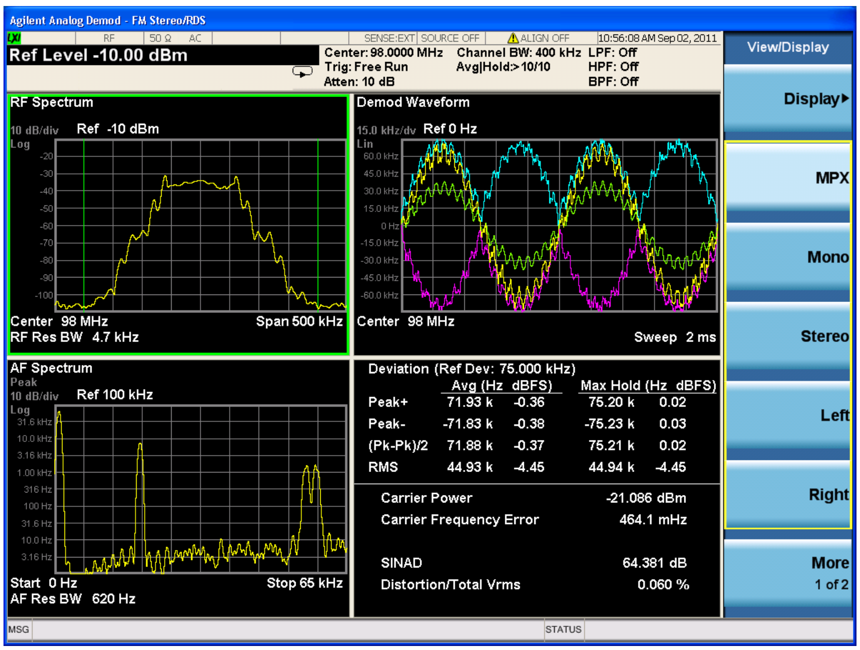
RDS frequency: 57 kHz

| Step | Action | Notes |
|---|---|---|
| **1** Select Analog Demod mode. | Press **Mode**, **Analog Demod**. | |
| **2** Preset the mode. | Press **Mode Preset.** | |
| **3** Select FM Stereo/RDS measurement. | Press **Meas**, **FM Stereo/RDS.** | |
| **4** Set the center frequency to the center of the signal and set the AF stop frequency. | Press **FREQ Channel**, **Center Freq**, 98, **MHz.**<br>Press **FREQ Channel**, **AF Stop Freq**, 65, **kHz.** | AF start frequency and AF stop frequency settings determine the span of the X axis in AF Spectrum window in MPX, Mono, Stereo, Left, and Right views. |
| **5** Set the FM reference deviation. | Press **Meas Setup**, **Advanced**, **Ref Deviation**, 75, **kHz.** | |
| **6** View the measurement result of the multiplexed signal. | Press **View/Display**, **MPX.** | To display only the current trace in the Demod Waveform window, press **Meas Setup** and toggle **Avg/Hold Num** to **Off.** |

| Step | Action | Notes |
|---|---|---|

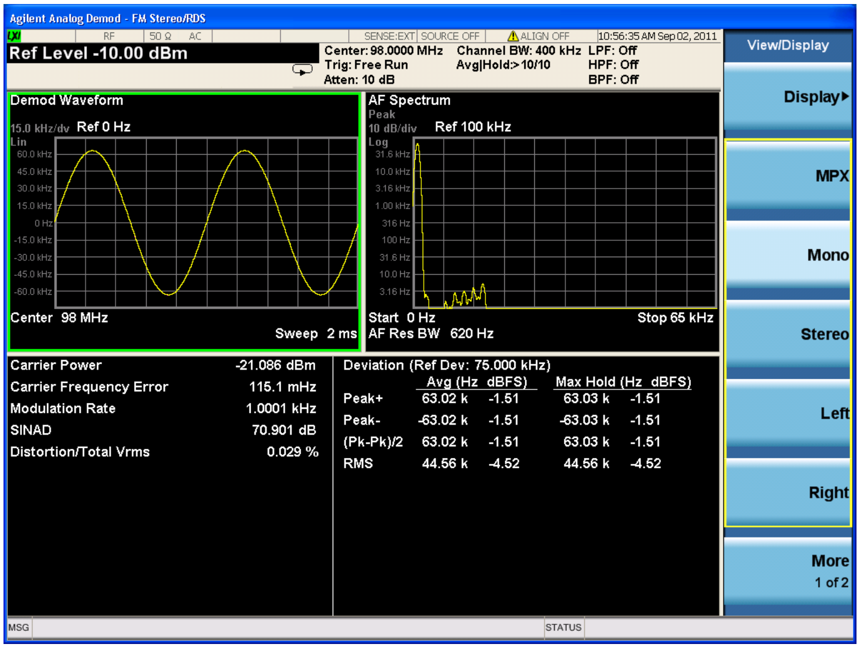
The figure below shows measurement results of the multiplexed signal, including mono part, stereo part, RDS/RBDS, and pilots. There are four windows:

- RF Spectrum window (top left) displays the RF spectrum of the multiplexed signal.
- Demod Waveform window (top right) displays the baseband modulating signal in time domain. There are four traces in this window: maximum trace (in cyan), minimum trace (in magenta), average trace (in green), and current trace (in yellow).
- AF Spectrum window (bottom left) displays the modulating signal in frequency domain.
- Metric window (bottom right) displays the numeric measurement results.

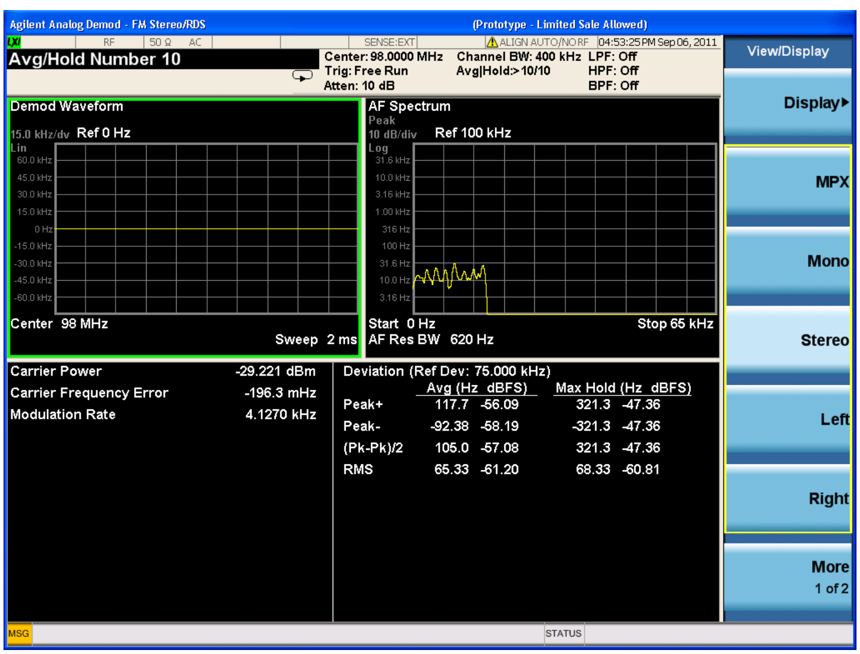



| | | |
|---|---|---|
| 7 View the mono part of the multiplexed signal which corresponds to L+R. | Press **View/Display**, **Mono**. | |

| Step | Action | Notes |
| --- | --- | --- |

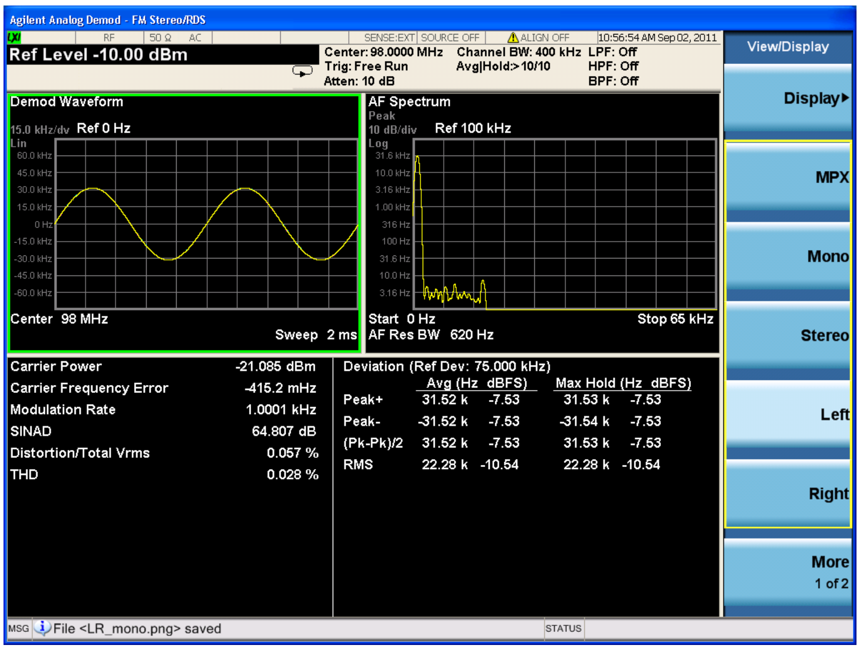



| | | |
| --- | --- | --- |
| **8** View the stereo part of the multiplexed signal which corresponds to L- R. | Press **View/Display**, **Stereo**. | |




| | | |
| --- | --- | --- |
| **9** (Optional) Set the baseband filters to improve the measurement results. | Press **Meas Setup**, **Filters**. | The highpass filter, lowpass filter, and bandpass filter can be combined as you like. |

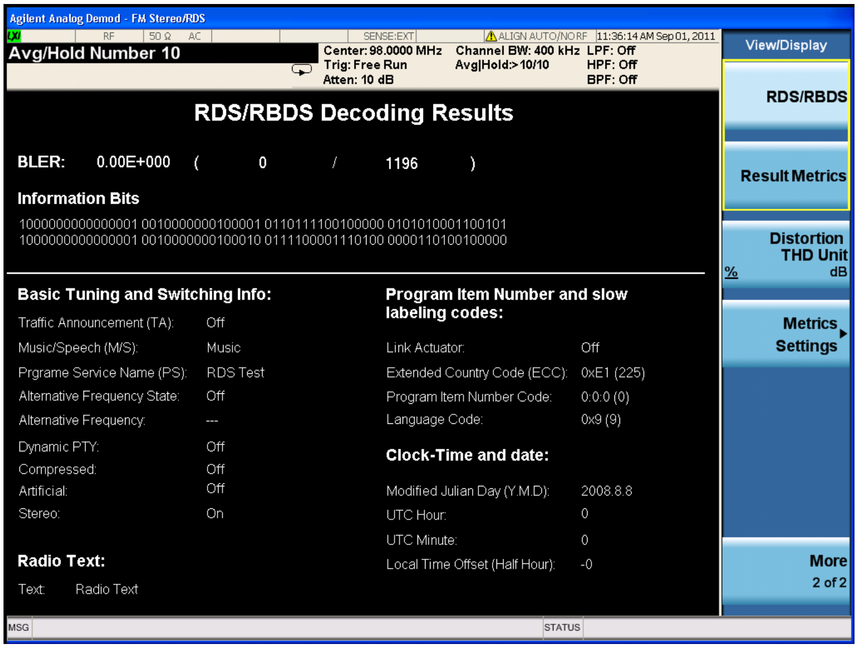
| Step | Action | Notes |
|---|---|---|
| **10** If pre-emphasis is used in the signal under test, set to use de-emphasis in the signal analyzer. | Press **Meas Setup**, **Filters**, **De-Emphasis** and choose the appropriate de-emphasis filter. | |
| **11** View the measurement results of the left channel. | Press **View/Display**, **Left**. | In this test case, the left channel equals to the right channel. |




| | | |
|---|---|---|
| **12** View the RDS/RBDS results. | Press **View/Display**, **RDS/RBDS**. | |

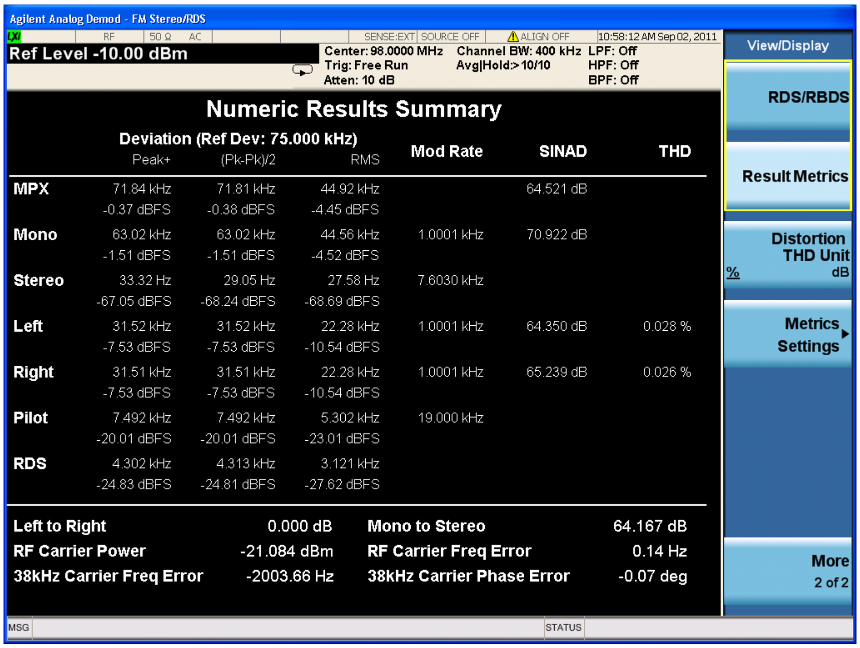
| Step | Action | Notes |
|---|---|---|

The figure below displays the BLER result and the information bits in the upper part and key RDS messages like basic tuning and switch information, radio text, and so on in the lower part. For more information, refer to "Basic Structure of RDS" on page 31 and "BLER" on page 31.




| Step | Action | Notes |
|---|---|---|
| 13 View a summary of the numeric measurement results. | Press **View/Display**, **Result Metrics.** | |

| Step | Action | Notes |
|---|---|---|
| **NOTE** | In this view, the left to right separation result is displayed as "Left to Right" and the mono to stereo crosstalk is displayed as "Mono to Stereo". Normally, left to right separation test is taken when the audio signal under test is L only or R only; mono to stereo crosstalk test is taken when the audio signal under test is L=R or L=-R. | |



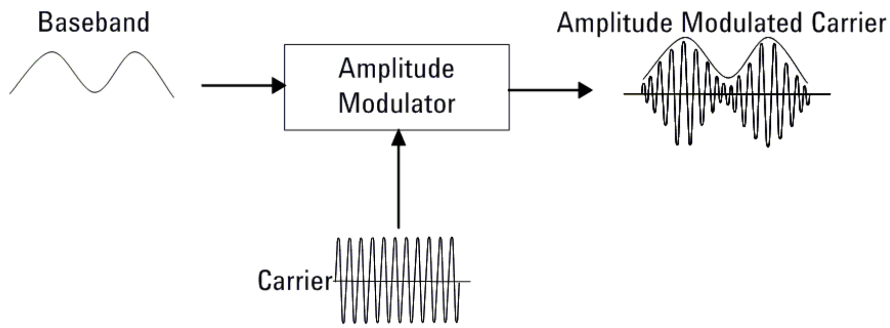

| | | |
|---|---|---|
| **14** Listen to the demodulated FM stereo signal. | Press **Meas Setup**, **Demod to Speaker.** | You may need to adjust the volume as necessary. |

# 2 Concepts

The following topics can be found in this section:

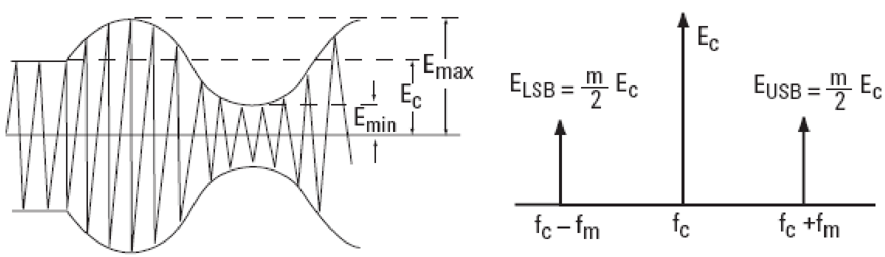
# AM Concepts

*Figure 2-1* *AM waveform*




In AM (Amplitude Modulation), the instantaneous amplitude of the modulated carrier signal changed in proportion to the instantaneous amplitude of the information signal.

*Figure 2-2* *Calculation AM index in time and frequency domain*




The modulation index "m" represents the amount of the modulation or the degree to which the information signal modulates the carrier signal. The index for an AM signal can be calculated from the amplitudes of the carrier and either of the sidebands by the equation:

**Equation 2-1**

$$m = \frac{E_{max} - E_c}{E_c} = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} = \frac{E_{USB} + E_{LSB}}{E_c} = \frac{2E_{SB}}{E_c}$$

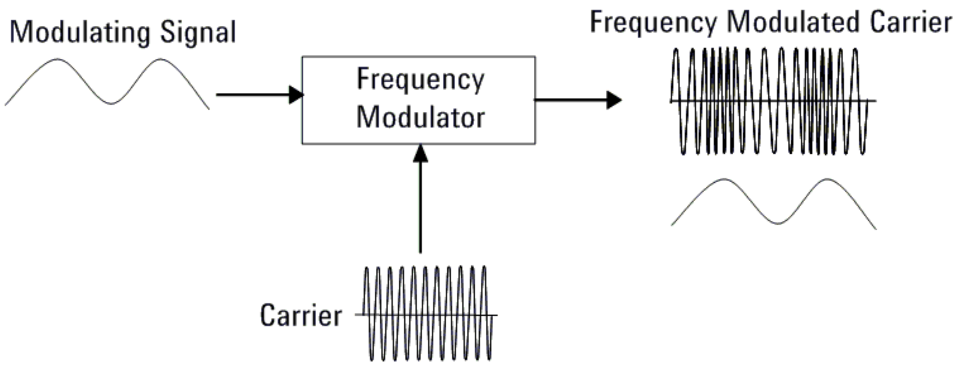
For 100% modulation, the modulation index is 1.0, and the amplitude of each sideband will be one-half of the carrier amplitude expressed in voltage. On a decibel power scale, each sideband will thus be 6 dB less than the carrier, or one-fourth the power of the carrier. Since the carrier power does not change with amplitude modulation, the total power in the 100% modulated wave is 50% higher than in the unmodulated carrier. The relationship between m and the logarithmic display can be expressed as:

**Equation 2-2**

$$(E_{SB}/E_c)dB + 6dB = 20\mathbf{log}\,m$$

# FM Concepts

*Figure 2-3* *FM waveform*




FM (Frequency Modulation) and PM (Phase Modulation) belong to angle modulation. In FM, the instantaneous frequency deviation of the modulated carrier signal changed in proportion to the instantaneous amplitude of the modulating signal. And in PM, the instantaneous phase deviation of the modulated carrier with respect to the phase of the unmodulated carrier is directly proportional to the instantaneous amplitude of the modulating signal.

The modulation index for angle modulation, $\beta$, is expressed by this equation:

**Equation 2-3**

$$\beta = \Delta f_p / f_m = \Delta\phi_p$$

Where Δfp is the peak frequency deviation, fm is the frequency of the modulating signal, and Δϕp is the peak phase deviation.

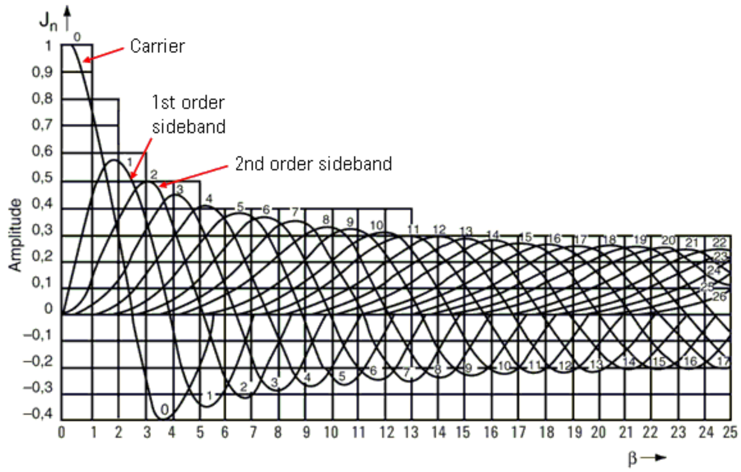
This expression tells us that the angle modulation index is really a function of phase deviation, even in the FM case. Also, the definitions for frequency and phase modulation do not include the modulating frequency. In each case, the modulated property of the carrier, frequency or phase, deviates in proportion to the instantaneous amplitude of the modulating signal, regardless of the rate at which the amplitude changes. However, the frequency of the modulating signal is important in FM and is included in the expression for the modulating index because it is the ratio of peak frequency deviation to modulation frequency that equates to peak phase.

Unlike the modulation index for AM, there is no specific limit to the value of $\beta$, since there is no theoretical limit to the phase deviation; thus there is no equivalent of 100% AM. However, in real world systems there are practical limits.

Unlike AM, which is a linear process, angle modulation is nonlinear. This means that a single sine wave modulating signal, instead of producing only two sidebands, yields an infinite number of sidebands spaced by the modulating frequency.

The Bessel function graph shows the amplitudes of the carrier and the sidebands as a function of modulation index, β. The spectral components, including the carrier, change their amplitudes as the modulation index varies.

*Figure 2-4* *Carrier and sideband amplitude for angle-modulated signals*




In theory, for distortion-free detection of the modulating signal, all the sidebands must be transmitted. However, in practice, the sideband amplitudes become negligibly small beyond a certain frequency offset from the carrier, so the spectrum of a real-world FM signal is not infinite.

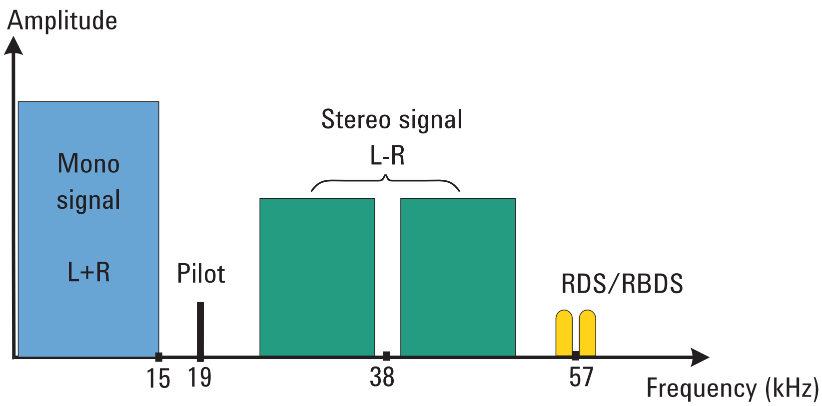
# FM Stereo/RDS Concepts

FM stereo is an enhancement of FM by using stereo multiplexing. An FM stereo signal carries stereophonic programmes in which different contents are transmitted for L (left) and R (right) audio channels.

RDS (Radio Data System) is the text information such as traffic, weather, and radio station information carried in FM signals. This information can be displayed on the screen of the end-user's device.

Figure 2-5 shows the baseband spectrum of the FM stereo signal including RDS data.

*Figure 2-5* *Baseband spectrum of the FM Stereo/RDS signal*




## FM Stereo

The FM stereo multiplexed signal consists of a mono (L+R) signal, a stereo (L-R) signal, and a pilot signal.

As shown in Figure 2-5, the mono (L+R) signal occupies the lower part of the baseband spectrum (50 Hz ~ 15 kHz) to keep backward compatibility with the previously monophonic FM systems. The (L-R) signal is amplitude modulated onto a suppressed subcarrier at 38 kHz. A pilot signal is transmitted at 19 kHz and is used by the receiver to identify a stereo transmission and reconstruct L and R audio signals from the multiplexed signal.

In the receiver, the (L+R) signal is added to the (L-R) signal to get the L signal, and subtracts the (L-R) signal to get the R signal.

## RDS/RBDS

The standard documents for RDS and RBDS are as follows:

- IEC 62106: Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87.5 to 108.0 MHz.
- EIA/NAB NRSC: United States RBDS standard - Specification of the radio broadcast data system (RBDS).

RBDS is the United States version of RDS. Both RDS and RBDS are intended for application to VHF/FM sound broadcasts in the range 87.5 MHz to 108.0 MHz which may carry either stereophonic or monophonic programmes.

The main objectives of RDS/RBDS:

- To enhance functionality for FM receivers;
- To make the receivers more user-friendly by using features such as PI (programme identification), PS (programme service) name display, and if applicable, automatic tuning for portable and car radios.

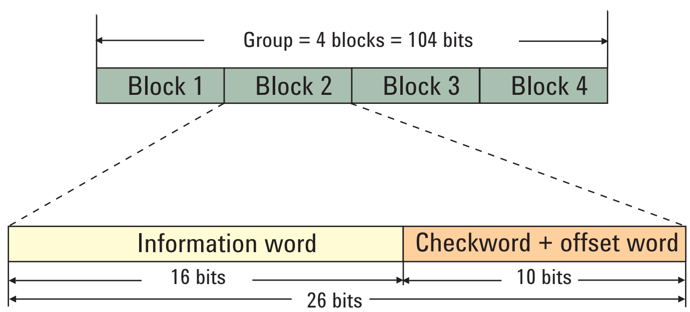
As shown in Figure 2-5, RDS/RBDS uses the 57 kHz subcarrier to carry the data at 1.1875 kbps bitrate. The 57 kHz is chosen to be the third harmonic of the pilot tone. The deviation range of the FM carrier due to the unmodulated RDS/RBDS subcarrier is from $\pm 1.0\ kHz$ to $\pm 7.5\ kHz$ .

### Basic Structure of RDS

The basic structure of RDS is shown in Figure 2-6, in which the largest element is called a group including 4 blocks of 26 bits each. Each block comprises an information word (16 bits) and a checkword (10 bits).

The information word is used to transmit information to the end user. The 10-bit checkword plus offset word are used to provide error protection and block and group synchronization information.

*Figure 2-6* *Basic structure of RDS*




### BLER

BLER (block error rate) is the ratio of the number of un-correctable blocks to the total number of blocks received. Normally, BLER should be less than 5%.

# Demodulating an AM Signal Using the Analyzer as a Fixed Tuned Receiver (Time-Domain)

The X-Series signal analyzer can be used to recover amplitude modulation on a carrier signal.

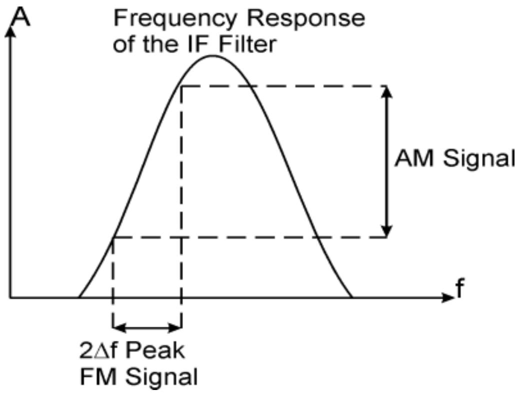
The following functions establish a clear display of the waveform:

- Triggering stabilizes the waveform trace by triggering on the modulation envelope. If the modulation of the signal is stable, video trigger synchronizes the sweep with the demodulated waveform.
- Sweep time to view the rate of the AM signal.
- RBW and VBW are selected according to the signal bandwidth.

# Demodulating an FM Signal Using the Analyzer as a Fixed Tuned Receiver (Time-Domain)

To recover the frequency modulated signal, an analyzer can be used as a manually tuned receiver. However, in contrast to AM, the signal is not tuned into the passband center, but to one slope of the filter curve as shown in Figure 2-7.

*Figure 2-7* *Determining FM Parameters using FM to AM Conversion*




Here the frequency variations of the FM signal are converted into amplitude variations (FM to AM conversion). The reason we want to measure the AM component is that the envelope detector responds only to AM variations. There are no changes in amplitude if the frequency changes of the FM signal are limited to the flat part of the RBW (IF filter). The resultant AM signal is then detected with the envelope detector and displayed in the time domain.

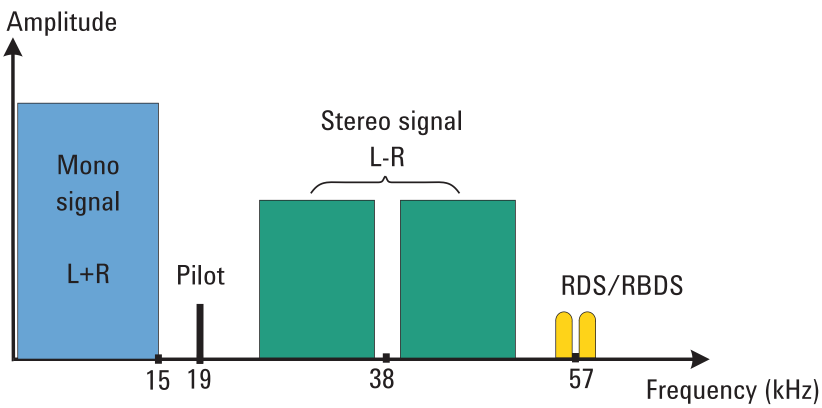
# Demodulating an FM Stereo/RDS Signal Using the Analyzer as a Fixed Tuned Receiver (Time-Domain)

FM Stereo/RDS signal contains mono part, stereo part, RDS/RBDS, and pilots. The process of demodulating FM Stereo/RDS signal is more complicated than simple FM signal and is described as below.

1. Perform the FM demodulation to obtain the baseband modulating signal. The demodulating method is the same to Demodulating an FM Signal Using the Analyzer as a Fixed Tuned Receiver (Time-Domain) on page 33.

   The baseband modulating signal should look like Figure 2-8.

*Figure 2-8* *Baseband modulating signals of the FM Stereo/RDS signal*




2. Recover the L (left channel) and R (right channel) of the audio signal.
   a. Demodulate the L+R part.
   b. Extract the 19 kHz pilot and multiply it to recover the 38 kHz subcarrier.
   c. Perform the DSBSC (Double-Sideband Suppressed Carrier) AM demodulation to get the L-R signal.
   d. Get the L and R signals from (L-R) and (L+R).
3. Multiply the 19 kHz pilot to recover the 57 kHz subcarrier, demodulate the RDS /RBDS bits, and then calculate the BLER.
4. Apply the de-emphasis or audio filters including highpass, lowpass, bandpass (CCITT, A-Weighted) filters to the audio signal (L and R).
5. Calculate measurement parameters like SINAD, Distortion, THD and so on.

# Modulation Distortion Measurement Concepts

## Purpose

This measurement is used to measure the amount of modulation distortion contained in the modulated signal by determining the ratio of harmonic and noise power to fundamental power. This measurement verifies the modulation quality of the signal from the DUT.

## Measurement Technique

Modulation Distortion is defined as:

**Equation 2-4**

$$\%_{ModulationDistortion} = \sqrt{\frac{P_{total} - P_{signal}}{P_{total}}} \times \mathbf{100}\%$$

where: $P_{total}$ = the power of the total signal,

$P_{signal}$ = the power of the wanted modulating signal, and

$P_{total}$ - $P_{signal}$ = total unwanted signal which includes harmonic distortion and noise.

First, the received signal is demodulated and filtered to remove DC. Then the filtered signal is transformed by an FFT into frequency domain. Next, total power in the total filter band is measured as $P_{total}$, the peak power of the modulated signal is computed as $P_{signal}$, the square root of the ratio of $P_{total}$ - $P_{signal}$ to $P_{total}$ is calculated. The result is the signal’s modulation distortion. It can be expressed as dB or %.

# Modulation SINAD Measurement Concepts

## Purpose

Modulation SINAD (SIgnal to Noise And Distortion) measures the amount of Modulation SINAD contained in the modulated signal by determining the ratio of fundamental power to harmonic and noise power. Modulation SINAD is the reciprocal of the modulation distortion provided by the Modulation Distortion measurement. This is another way to quantify the quality of the modulation process.

## Measurement Technique

Modulation SINAD is defined as:

**Equation 2-5**

$$dB_{ModulationSINAD} = 20 \times \log \sqrt{\frac{P_{total}}{P_{total} - P_{signal}}}$$

where: $P_{total}$ = the power of the total signal,

$P_{signal}$ = the power of the wanted modulating signal, and

$P_{total}$ - $P_{signal}$ = the total unwanted signals which include harmonic distortion and noise.

First, the received signal is demodulated and filtered to remove DC, then the filtered signal is transformed by an FFT into frequency domain. Next, total power in the total filter band is measured as $P_{total}$, the peak power of the modulated signal is computed as $P_{signal}$, the square root of the ratio of $P_{total}$ to $P_{total}$ - $P_{signal}$ is calculated. The result is the signal’s Modulation SINAD. It can be expressed as dB.