

Agilent X-Series Signal Analyzer

This manual provides documentation for the following analyzers:

PXA Signal Analyzer N9030A

MXA Signal Analyzer N9020A

EXA Signal Analyzer N9010A

CXA Signal Analyzer N9000A

MXE EMI Receiver N9038A

N9063A & W9063A Analog Demod Measurement Application Measurement Guide



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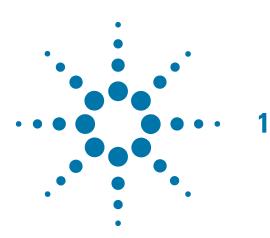
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Demodulating AM, FM, Φ **M, FM Stereo/RDS Signals**

The Analog Demod measurement application provides the capability of demodulating AM (amplitude modulated), FM (frequency modulated), Φ M (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" on page 8

"Demodulating an AM Signal" on page 11

"Demodulating an FM Signal" on page 12

"Demodulating an FM Stereo/RDS Signal" on page 13

Setting Up and Making a Measurement

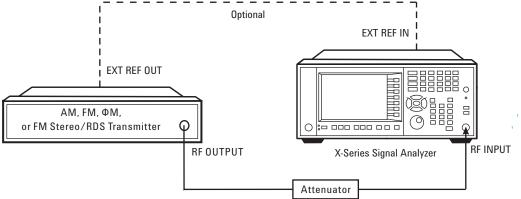
Making the Initial Signal Connection

Set the AM, FM, Φ M, 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, Φ M, 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, ϕ M, 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. b. Press Analog Demod. c. Press Mode Preset. d. Press Mode Setup. 	All licensed, installed modes available are shown under the Mode key. 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. b. Select the specific measurement to be performed. 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. 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
	Main Reys and Fanctions 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\Agilent\SignalAnalysis\Infrastructure\Help\bookfiles.

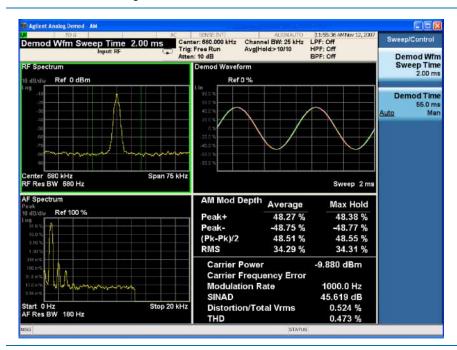
Demodulating an AM Signal

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 Demo	od mode. Press Mode , Ana	alog Demod.	
2 Preset the mode.	Press Mode Pres	set.	
3 Select AM measure	ement. Press Meas , AM		
4 Set the center frequencies the AM signal.	iency of Press FREQ Char 680, kHz.	nnel, Center Freq,	
5 Adjust the sweep ti view the measurem results as in the figu	ent Wfm Sweep Tim		



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.	

			03:11:44 PMNov 12, 2007 LPF: Off HPF: Off	View/Display
	n: 10 dB Demod Waveform		BPF: Off	Display
IB dB/div Ref 0 dBm	Ref 0 Hz			
109 10 30 30 30	Lin 60.0 SHz 45.0 Mtz 30.0 Mtz 16.0 Mtz			Quad View
	0 H2 -15 10 Mtz -30 2 Mtz -45 3 Mtz -53 2 Mtz		\sim	RF Spectrur
Center 300 MHz Span 75 kHz RF Res BW 680 Hz			Sweep 2 ms	Demo
AF Spectrum Peak 09 aBxdav Ref 100 kHz 109 10.014 1	FM Deviation Peak+ Peak- (Pk-Pk)/2	Average 10.03 kHz -9.894 kHz 9.964 kHz	Max Hold 10.04 kHz -9.908 kHz 9.973 kHz	AF Spectrur
100101	RMS Carrier Powe Carrier Freq Modulation	uency Error	7.072 kHz -10.241 dBm 65.86 Hz 1000.0 Hz	Distortion THD Un % d
Start 0 Hz Stop 20 kHz AF Res BW 180 Hz	SINAD Distortion/To THD		40.030 dB 0.997 % 0.247 %	Metrics Settings

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%

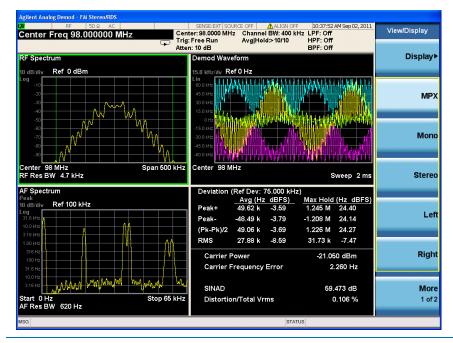
RDS frequency: 57 kHz

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	Press FREQ Channel, Center Freq , 98, MHz .	AF start frequency and AF stop frequency settings determine the
set the AF stop frequency.	Press FREQ Channel, AF Stop Freq, 65, kHz.	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.

gilent Analog Demod - FM Stereo/RDS RF 50 Ω AC	SENSE:E		- Limited Sale Allowed) AUTO/NORF 04:19:27 PM Sep 06, 20	11
enter Freq 98.000000 MHz	Center: 98.000 Trig: Free Run Atten: 10 dB	0 MHz Channel BW:	: 400 kHz LPF: Off	View/Display
emod Waveform i.0 kHz/dv Ref 0 Hz	Peak 10 dB/	ectrum liv Ref 100 kHz		Display►
n 00.0 H/z 50.0 H/z 50.0 H/z	31.6 kr 10.0 kr 3.16 kr 10.0 kr 1.00 kr			MPX
0 Hz 00 Hz	316 H 100 H 31.6 H 10.0 H 3.16 H 3.16 H			Mono
enter 98 MHz	Sweep 2 ms AF Re	0 Hz s BW 620 Hz	Stop 65 kF	z Stereo
lodulation Rate 1.000 INAD 60.1	9 dBm Deviation 233 Hz Peak+ 01 kHz Peak- 145 dB (Pk-Pk)/2 098 % RMS	(Ref Dev: 75.000 kł <u>Avg (Hz dBFS)</u> 33.25 k -7.07 -33.26 k -7.06 33.26 k -7.06 23.52 k -10.07		Left
		20.02 K -10.07	20.02 8 -10.07	Right
				More

8 View the stereo part of the multiplexed signal which corresponds to L-R.

Press View/Display, Stereo.

Agilent Analog Demod - FM Stereo/RDS X RF 50 Ω AC Center Freq 98.000000 MHz		Center: 98.0000	MHz Channel BW:	400 kHz LPF: Off	1Sep02,2011	View/Display
Demod Waveform 15.0 kHz/dv Ref 0 Hz		Trig: Free Run Atten: 10 dB AF Sper Peak 10 dB/div	Avg Hold≫10 trum Ref 100 kHz	/10 HPF: Off BPF: Off		Display►
Lin 60.0 Htz 45.0 Htz 30.0 Htz 15.0 Htz		Log 31.6 kHz 10.0 kHz 3.16 kHz 1.00 kHz				MPX
0 Hz -15 0 Hz -30 0 Hz -45 0 Hz -60 0 Hz		316 Hz 100 Hz 31.6 Hz 10.0 Hz 3.16 Hz	MMWMUM			Mono
Center 98 MHz	Sweep : 1.048 dBm	2 ms AF Res			op 65 kHz	Stereo
Carrier Frequency Error	1.048 dBm 1.351 Hz 1.0000 kHz	Peak+ Peak- (Pk-Pk)/2	Avg (Hz dBFS) 31.51 k -7.53 31.54 k -7.52 31.53 k -7.53	Max Hold (Hz 32.18 k -7.3 -31.83 k -7.4 32.00 k -7.4	5 5 0	Left
		RMS	22.30 k -10.54	22.30 k -10.5	4	Right
MSG				STATUS		More 1 of 2

9 (Optional) Set the baseband filters to improve the measurement results.

Press Meas Setup, Filters.

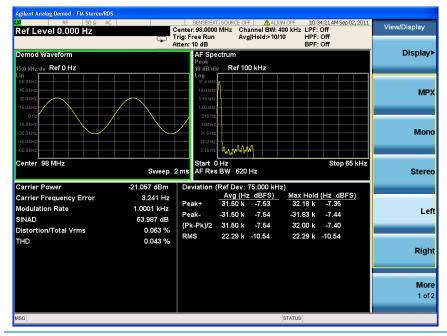
The highpass filter, lowpass filter, and bandpass filter can be combined as you like.

Demodulating AM, FM, Φ M, FM Stereo/RDS Signals **Demodulating an FM Stereo/RDS Signal**

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.



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.

RF 50Ω AC Center Freq 98.000000 M	MHz Ce Tri	SENSE:EXT SOUR nter: 98.0000 MHz g: Free Run en: 10 dB		400 kHz LPF /10 HPF	1:40:19 AM Sep 02, 2011 	View/Display
Demod Waveform 5.0 kHz/dv Ref 0 Hz in		AF Spectrum Peak 10 dB/div R	n ef 100 kHz			Display►
60.0 kHz		31.6 kHz 10.0 kHz 3.16 kHz 1.00 kHz				МРХ
0 Hz		316 Hz 100 Hz 31.6 Hz 10.0 Hz 3.16 Hz	M.M.			Mono
Center 98 MHz	Sweep 21	Start 0 Hz			Stop 65 kHz	Stereo
Carrier Power Carrier Frequency Error Modulation Rate SINAD Distortion/Total Vrms	3.920 Hz 4.3229 kHz 2.890 dB	Peak+ 2 Peak4 (Pk-Pk)/2 34	g (Hz dBFS) 1.30 -70.93 7.97 -63.88 1.64 -66.71	<u>Max Hol</u> 275.5 -396.9 336.2	d (Hz_dBFS) 5 -48.70 9 -45.53 2 -46.97	Left
ΉD	59.514 %	RMS 14	1.88 -74.05	17.86	5 -72.47	Right
						More 1 of 2
sg				STATUS		

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.

Agilent Analog Demod - FM Stereo/RJ XI RF 50 Q A Avg/Hold Number 10		Center:	ENSE:EXT	Channel BW: 400 kH		View/Displa	ay
	(Trig: Fre Atten: 10		Avg Hold:>10/10	HPF: Off BPF: Off		
	RDS/RBD	S Deco	oding R	esults		RDS/RI	BDS
BLER: 0.00E+000	(0		1196)		Result Met	trics
Information Bits							
1000000000000001 0010000 10000000000000						Distor THD	
Basic Tuning and Swite	hing Info:		Progran	n Item Number ar	nd slow	<u>%</u>	dE
Traffic Announcement (TA):	Off		labeling	codes:		Metr	rics
Music/Speech (M/S):	Music		Link Actua	tor:	Off	Settin	
Prgrame Service Name (PS):	RDS Test		Extended	Country Code (ECC):	0xE1 (225)		
Alternative Frequency State:	Off		Program It	em Number Code:	0:0:0 (0)		
Alternative Frequency:			Language	Code:	0x9 (9)		
Dynamic PTY: Compressed:	Off Off		Clock-T	ime and date:			
Artificial:	Off		Modified J	ulian Day (Y.M.D):	2008.8.8		
Stereo:	On		UTC Hour:				
			UTC Minut	e:			
Radio Text:			Local Time	e Offset (Half Hour):		N	More
Text: Radio Text						2	2 of 2
ASG				STATU	IS		

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 seperation result is displayed as "Left to Right" and the mono to stereo crosstalk is displayed as "Mono to Stereo". Normally, left to right seperation 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.

			Trig: Free R Atten: 10 dB	51	BI	PF: Off PF: Off	RDS/RBI
		Numeri	c Results	Summary			KD3/KDI
	Deviation Peak+	n (Ref Dev: 75 (Pk-Pk)/2	.000 kHz) RMS	Mod Rate	SINAD	THD	DesuitMatri
MPX	52.86 kHz -3.04 dBFS	51.47 kHz -3.27 dBFS	27.89 kHz -8.59 dBFS		59.567 dB		Result Metri
Mono	31.50 kHz -7.53 dBFS	31.50 kHz -7.54 dBFS	22.27 kHz -10.55 dBFS	1.0000 kHz	65.138 dB		Distortio THD U
Stereo	31.51 kHz -7.53 dBFS	31.50 kHz -7.53 dBFS	22.30 kHz -10.54 dBFS	1.0000 kHz			<u>%</u>
.eft	31.50 kHz -7.53 dBFS	31.50 kHz -7.53 dBFS	22.29 kHz -10.54 dBFS	1.0000 kHz	64.266 dB	0.040 %	Metric Setting
Right	23.87 Hz -69.94 dBFS	25.30 Hz -69.44 dBFS	16.14 Hz -73.35 dBFS	2.0191 kHz	2.828 dB	91.213 %	
Pilot	7.509 kHz -19.99 dBFS	7.509 kHz -19.99 dBFS	5.309 kHz -23.00 dBFS	19.000 kHz			
RDS	4.368 kHz -24.69 dBFS	4.363 kHz -24.71 dBFS	3.124 kHz -27.61 dBFS				
eft to Ri	-			no to Stereo		-0.009 dB	
	er Power arrier Freq Eri	-21.05 or -0		Carrier Freq E Hz Carrier Pha		2.78 Hz 0.00 deg	M (2)

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%

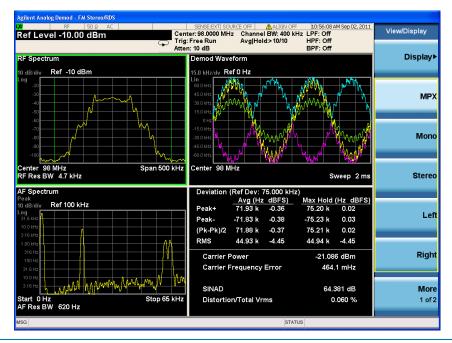
RDS frequency: 57 kHz

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	Press FREQ Channel, Center Freq, 98, MHz.	AF start frequency and AF stop frequency settings determine the
set the AF stop frequency.	Press FREQ Channel, AF Stop Freq, 65, kHz.	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.

Ref Level -10.00 dBm		00 MHz Channel BW		View/Display
Demod Waveform 15.0 kHz/dv Ref 0 Hz Lin	AF Sp Peak 10 dB/ Log	oectrum div_ Ref 100 kHz		Display►
60.0 HHz 45.0 HHz 30.0 HHz 15.0 HHz 0 Hz	31.6 ki 10.0 ki 3.16 ki 1.00 ki 3.16 ki 3.16 ki			МРХ
-1501Hz -3000Hz -4501Hz -6001Hz	100 F 31.6 F 10.0 F 3.16 F			Mono
Center 98 MHz Carrier Power -21.0		0 Hz es BW 620 Hz (Ref Dev: 75.000 kl	Stop 65 kH Hz)	z Stereo
Modulation Rate 1.0 SINAD 70	5.1 mHz 001 kHz .901 dB 0.029 % RMS	Avg (Hz dBFS) 63.02 k -1.51 -63.02 k -1.51 63.02 k -1.51 44.56 k -4.52	<u>Max Hold (Hz dBFS)</u> 63.03 k -1.51 -63.03 k -1.51 63.03 k -1.51 44.56 k -4.52	Left
				Right
				More

8 View the stereo part of the multiplexed signal which corresponds to L- R.

Press View/Display, Stereo.

Agilent Analog Demod - FM Stereo/RDS XI RF 50 Ω AC Avg/Hold Number 10	Ce Tri	SENSE:EXT enter: 98.0000 MH; ig: Free Run	🛕 ALIGN A			View/Display
Demod Waveform 15.0 kHz/dv Ref 0 Hz	Att		m Ref 100 kHz	BPF: Off		Display
Lin 60.0 MHz 45.0 MHz 30.0 MHz		Log 31.6 kHz 10.0 kHz 3.16 kHz 1.00 kHz				MP
0 Hz		316 Hz 100 Hz 31.6 Hz 10.0 Hz	ywy			Mon
Center 98 MHz		Start 0 Hz MS AF Res BW			Stop 65 kHz	Stere
Carrier Power Carrier Frequency Error Aodulation Rate	-29.221 dBm -196.3 mHz 4.1270 kHz	Peak+ 1 Peak9 (Pk-Pk)/2 1	vg (Hz dBFS) 117.7 -56.09 92.38 -58.19 105.0 -57.08	Max Hold (Hz 321.3 -47 -321.3 -47 321.3 -47	.36 .36 .36	Le
		RMS 6	5.33 -61.20	68.33 -60	.81	Rigl
						Moi 1 of
sg				STATUS		

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.

Demodulating AM, FM, ΦM, FM Stereo/RDS Signals **Demodulating an FM Stereo/RDS Signal**

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.

Ref Level -10.00 dBm	Τ	SENSE:EXT S enter: 98.0000 M rig: Free Run		V: 400 kHz LPF: 10/10 HPF	Off	1 View/Display
Demod Waveform 15.0 kHz/dv Ref 0 Hz	A	tten: 10 dB AF Spectr Peak 10 dB/div	um Ref 100 kHz	BPF	: Off	Display
Lin 60.0 Hrtz 45.0 Hrtz 30.0 Hrtz 15.0 Hrtz		Log 31.6 kHz 10.0 kHz 3.16 kHz 1.00 kHz				MP)
0 Hz -15 0 Hz -30.0 Hz -45.0 Hz -60.0 Hz		316 Hz 100 Hz 31.6 Hz 10.0 Hz 3.16 Hz	AND ALLO A			Mone
Center 98 MHz	Sweep 2	Start 0 H Ms AF Res B	z W 620 Hz		Stop 65 kH;	Stered
Carrier Power Carrier Frequency Error Modulation Rate SINAD Distortion/Total Vrms	-21.085 dBm -415.2 mHz 1.0001 kHz 64.807 dB 0.057 %	Peak+ 3 Peak3 (Pk-Pk)/2 3	f Dev: 75.000 I Avg (Hz dBFS 1.52 k -7.53 1.52 k -7.53 1.52 k -7.53) <u>Max Hold</u> 31.53 k -31.54 k 31.53 k	-7.53	Lef
THD	0.028 %	RMS 2	2.28 k -10.54	22.28 k	-10.54	Righ
						More 1 of 2
usg 🕕 File <lr mono.png=""> save</lr>	a d			STATUS		

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.

Agilent Analog Demod - FM Stereo/R						
VIII RF 50 Ω A Avg/Hold Number 10		Center: 98	SE:EXT	Channel BW: 400 kH:		View/Display
	RDS/RBL	Atten: 10	dB	Avg Hold>10/10	HPF: Off BPF: Off	RDS/RBDS
BLER: 0.00E+000	(0		1196			
Information Bits	(0		1150)		Result Metrics
1000000000000001 0010000 10000000000000						Distortion THD Unit % dB
Basic Tuning and Swite	ching Info:			n Item Number an	d slow	_
Traffic Announcement (TA):	Off		labeling	codes:		Metrics
Music/Speech (M/S):	Music		Link Actua	tor:	Off	Settings
Prgrame Service Name (PS):	RDS Test		Extended	Country Code (ECC):	0xE1 (225)	
Alternative Frequency State:	Off		Program It	em Number Code:	0:0:0 (0)	
Alternative Frequency.			Language	Code:	0x9 (9)	
Dynamic PTY: Compressed:	Off Off		Clock-T	ime and date:		
Artificial:	Off		Modified J	ulian Day (Y.M.D):	2008.8.8	
Stereo:	On		UTC Hour:			
			UTC Minut	e:		
Radio Text:			Local Time	e Offset (Half Hour):		More
Text: Radio Text						2 of 2
MSG				STATU		
mod				STATU		

13 View a summary of the numeric measurement results.

Press View/Display, Result Metrics.

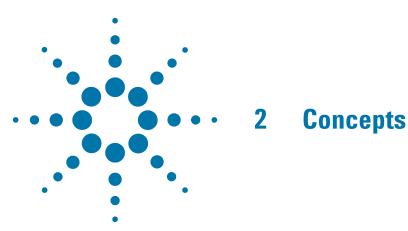
Step	Action	Notes
NOTE	stereo crosstalk is displayed as "Mono to	sult is displayed as "Left to Right" and the mono to Stereo". Normally, left to right seperation test is L only or R only; mono to stereo crosstalk test is L=R or L=-R.

ef Leve	⊮ 50 Ω el -10.00 dBm	AC			I BW: 400 kHz LF d:>10/10 HI	10:58:12 AM Sep 02, 2011 PF: Off PF: Off PF: Off	View/Display	
		Numeri	c Results	Summary			RDS/RBI	
	Deviation Peak+	n (Ref Dev: 75 (Pk-Pk)/2	.000 kHz) RMS	Mod Rate	SINAD	THD	_	
MPX	71.84 kHz -0.37 dBFS	71.81 kHz -0.38 dBFS	44.92 kHz -4.45 dBFS		64.521 dB		Result Metri	
Viono	63.02 kHz -1.51 dBFS	63.02 kHz -1.51 dBFS	44.56 kHz -4.52 dBFS	1.0001 kHz	70.922 dB		Distortio THD U	
Stereo	33.32 Hz -67.05 dBFS	29.05 Hz -68.24 dBFS	27.58 Hz -68.69 dBFS	7.6030 KHz			<u>%</u>	
_eft	31.52 kHz -7.53 dBFS	31.52 kHz -7.53 dBFS	22.28 kHz -10.54 dBFS	1.0001 kHz	64.350 dB	0.028 %	Metric Setting	
Right	31.51 kHz -7.53 dBFS	31.51 kHz -7.53 dBFS	22.28 kHz -10.54 dBFS	1.0001 kHz	65.239 dB	0.026 %		
Pilot	7.492 kHz -20.01 dBFS	7.492 kHz -20.01 dBFS	5.302 kHz -23.01 dBFS	19.000 kHz				
RDS	4.302 kHz -24.83 dBFS	4.313 kHz -24.81 dBFS	3.121 kHz -27.62 dBFS					
.eft to Ri	•			no to Stereo		64.167 dB		
	er Power arrier Freq Err	-21.08 or -2003		Carrier Freq E Hz Carrier Pha		0.14 Hz -0.07 deg	M d 2 d	
G					STATUS			

14 Listen to the demodulated FM stereo signal.

Press Meas Setup, Demod to Speaker.

You may need to adjust the volume as necessary.



The following topics can be found in this section:

AM Concepts on page 26

FM Concepts on page 28

FM Stereo/RDS Concepts on page 30

Demodulating an AM Signal Using the Analyzer as a Fixed Tuned Receiver (Time-Domain) on page 32

Demodulating an FM Signal Using the Analyzer as a Fixed Tuned Receiver (Time-Domain) on page 33

"Demodulating an FM Stereo/RDS Signal Using the Analyzer as a Fixed Tuned Receiver (Time-Domain)" on page 34

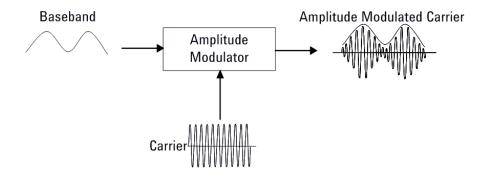
Modulation Distortion Measurement Concepts on page 35

Modulation SINAD Measurement Concepts on page 36

AM Concepts

Figure 2-1

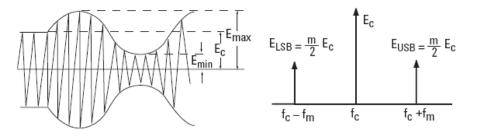
AM waveform



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:

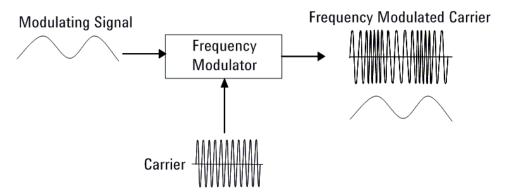
Equation 2-2

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

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, β , 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 $\Delta \phi p$ 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 β , 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.



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.

Figure 2-4

Carrier and sideband amplitude for angle-modulated signals

FM Stereo/RDS Concepts

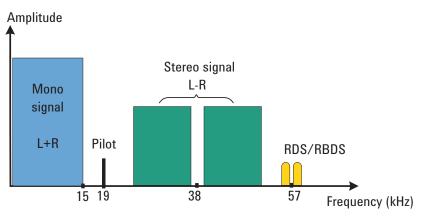
FM stereo is an enhancement of FM by using stereo multiplexing. An FM stereo signal carries stereophonic programmes in which different contents are transmitted for L (left) and R (right) audio channels.

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 \sim 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 ± 1.0 kHz to ± 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.

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%.

Figure 2-6 Basic structure of RDS

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:

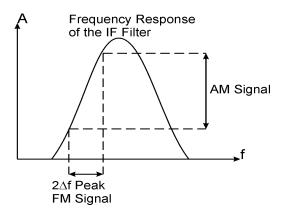
- Triggering stabilizes the waveform trace by triggering on the modulation envelope. If the modulation of the signal is stable, video trigger synchronizes the sweep with the demodulated waveform.
- Sweep time to view the rate of the AM signal.
- RBW and VBW are selected according to the signal bandwidth.

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.

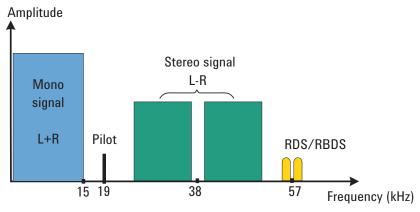
Demodulating an FM Stereo/RDS Signal Using the Analyzer as a Fixed Tuned Receiver (Time-Domain)

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

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

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.