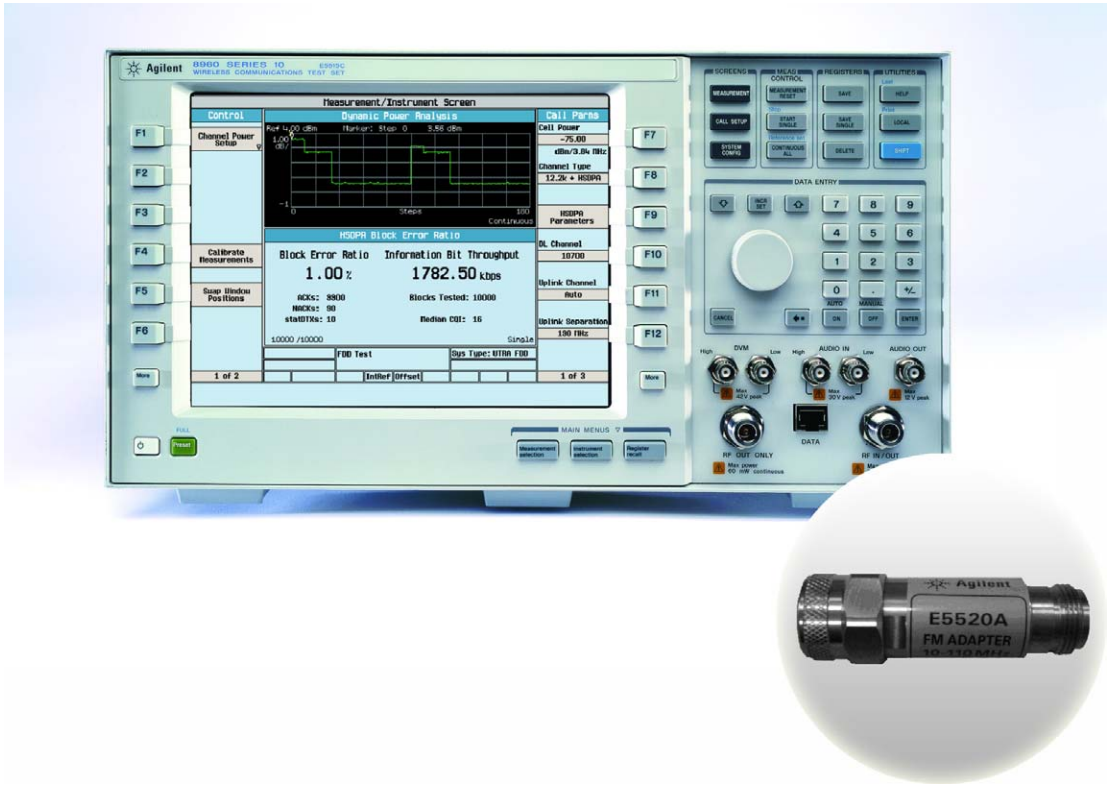
Testing FM Receivers with the Agilent 8960 Wireless Communications Test Set and E5520A FM Adapter

Application Note



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Introduction

Agilent's 8960 wireless test set and Agilent's E5520A FM Adapter can be used together in manufacturing to fully verify your device's FM receiver. The test system (E5520A connected to the 8960) generates a stable and accurate mono FM signal to enable FM receiver testing over your device's full operational range.

This application note discusses the accurate and reliable testing of FM receivers in mobile phones, MP3 players or portable radios, with the 8960 and the FM adapter (E5520A) connected to create an FM test system. Included in the discussion are hardware and software requirements, instructions for performing FM receiver tests and how to analyze the results, and the typical specifications that can be expected when performing FM receiver tests.

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FM Receiver Testing Overview

A device's full range of received FM broadcast signals can be reliably tested by using Agilent's 8960 Series 10 Wireless Communications Test Set in combination with the E5520A FM Adapter to create an FM test system. The 8960 and E5520A generate a mono FM broadcast signal. The device being tested demodulates the FM signal into audio and the audio is analyzed using 8960 audio measurements.

When the test set is in FM broadcast mode, one of the test set's RF sources is fixed at 1 GHz and the other source provides an FM signal from 890 MHz to 990 MHz. The FM Adapter mixes the 1 GHz Local Oscillator signal with the FM signal and then filters the mixer output to provide a stable and accurate resultant signal at the user specified FM broadcast frequency. This process is illustrated in the block diagram below.

While in FM Broadcast mode, the test set also allows you to set parameters such as frequency modulation, deviation, and rate and RF signal level. RF level accuracy can also be optimized by adjusting the amplitude offset factor.

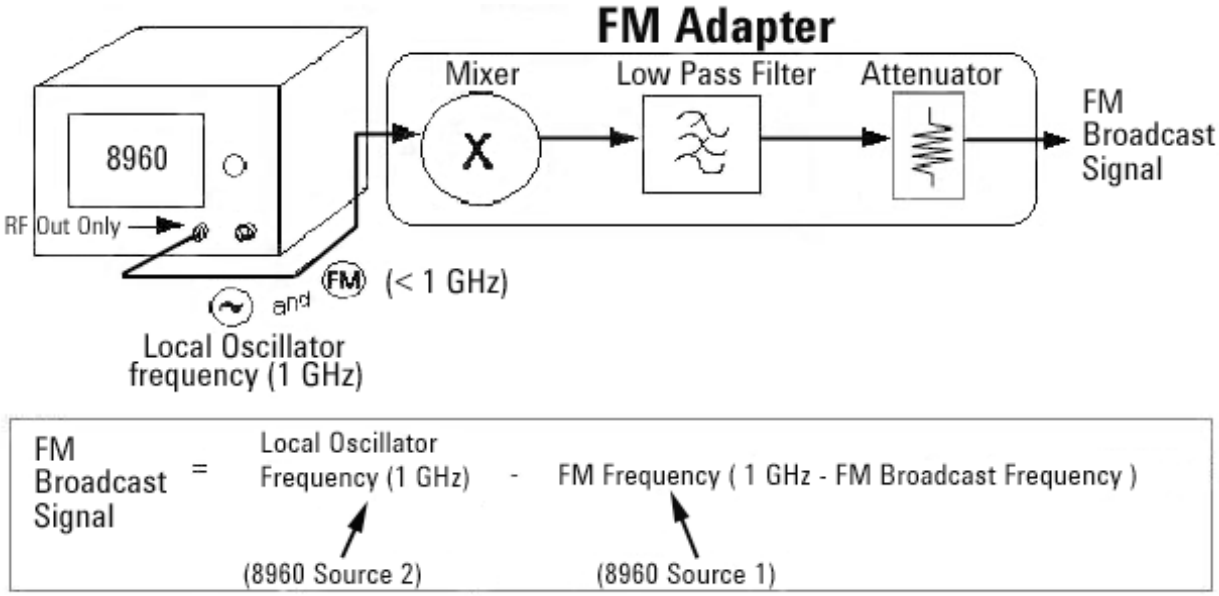

Figure 1. Simplified block diagram of how the system generates the FM Broadcast Signal.

Test set requirements

- Hardware E5515B/C with optional 2nd source, and the RF Out Only port.
- Software: A special revision of 8960 Test Application (TA) is required. Please contact your Agilent sales representative to get an early release of a TA with FM test capability.

Other hardware requirements

- E5520A FM Adapter

The E5520A FM Adapter is shown in the figure below. It as an N-type connector casing with an internal printed circuit board that provides the mixing and filtering described above. The E5520A FM Adapter is ordered separately from the test set.

Figure 2. E5520A FM Adapter

FM Receiver Testing

Connection setup

To set up an FM receiver test, first connect the FM Adapter directly to the RF OUT ONLY port of the test set. Do not use a cable between the 8960 and FM Adapter. Next, connect the device's antenna to the output of the FM adapter. Then, to make measurements on the received audio signal, connect the device's demodulated FM output to the test set's High AUDIO IN connector. Figure 3 illustrates a typical hardware configuration. The audio input level specifications for the test set's audio analyzer are listed in the Technical Specifications at the end of this paper.

Note: The test set's AUDIO IN connectors (High and Low) are differential inputs, therefore unless a differential measurement is needed, it is recommended that the Low connector be grounded and the audio signal be connected to the High connector.

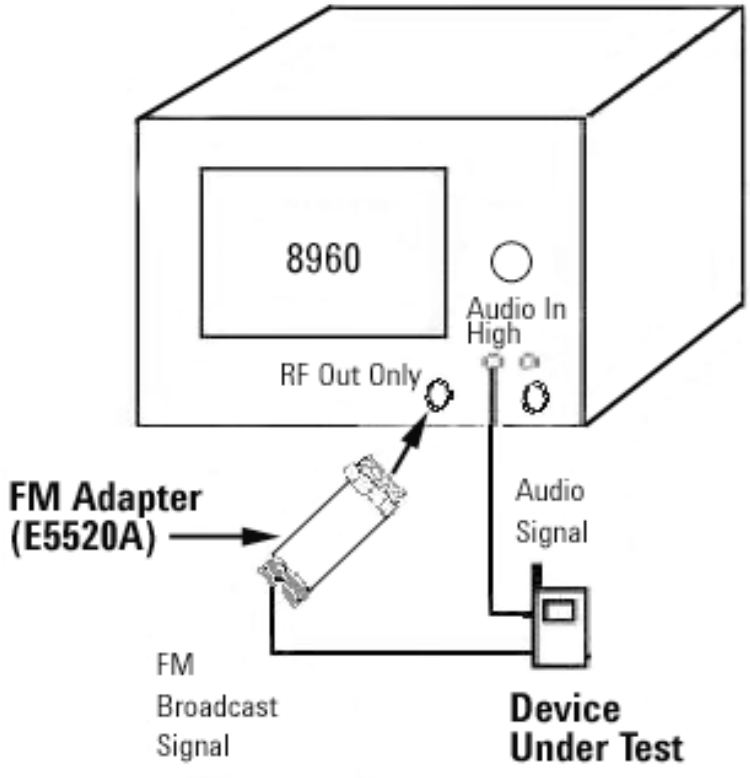

Figure 3. 8960 Series 10 Wireless Communications Test Set, FM Adapter, and DUT setup for FM receiver testing

Parameter Setup

To perform FM receiver testing, the operating mode of the test set must first be set to CW and then RF generator mode must be set to FM Broadcast. These initial conditions are set in steps 1 and 2 of the steps below. The third step allows access to the test set's FM Broadcast parameters.

1. Turn off RF IN/OUT Amplitude Offsets:
   - Press the SYSTEM CONFIG hardkey
   - Press RF IN/OUT Amptd Offset (**F5**)
   - Press RF IN/OUT Amptd Offset Setup (**F2**)
   - Change the RF IN/OUT Amplitude Offset State to Off

2. Set the Operating Mode to CW:
   - Press the CALL SETUP hardkey
   - Press Operating Mode (**F1**) and select CW

3. Configure the FM Broadcast Mode Parameters:
   - Press RF Gen Configure (**F10**) and select FM Broadcast. All the FM Broadcast parameters are now visible in the Control Parms menu (right side of the test set's front panel).
   - Configure the FM Broadcast parameters as needed. The available parameters include (refer to the Control Parms menu in figure 4):

     - FM Broadcast Power
     - FM Broadcast Frequency
     - FM Broadcast Amplitude Offset (non-volatile settings):
       - FM Adapter Gain and State
     - Amplitude Offset
     - Internal FM Deviation
     - Internal FM Frequency

The test set is now ready to perform FM receiver testing.

Analyzing FM receiver test results

Once the test set is generating the FM signal and is properly connected to the device, the device's FM receiver performance is ready to be analyzed.

To analyze the audio signal that has been demodulated by the device, connect the demodulated FM output to the test set's High AUDIO IN connector and run the appropriate Audio Analyzer measurements based on the Test Application format that is active in the test set.

- GSM/GPRS and EGPRS format:
  1. Press **Measurement Selection**
  2. Select GSM Analog Audio
  3. Select Analog Audio Setup (**F1**) to configure the GSM Analog Audio measurements. For example, to view the measurement results for the SINAD Distortion Rate State, the state must be on.

Figure 4 shows the results that the GSM Analog Audio measurement displays.

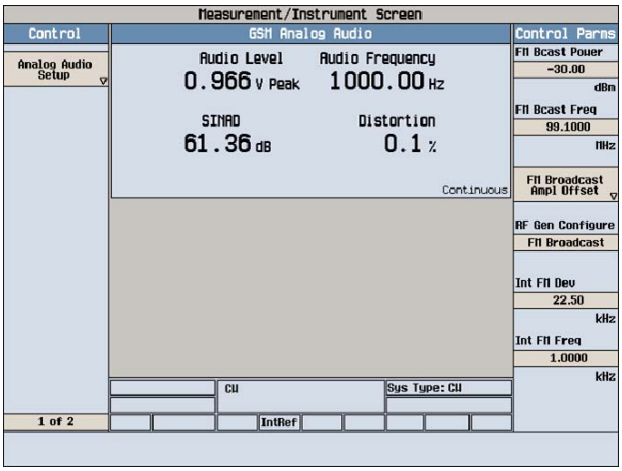

Figure 4. Example 8960 FM receiver results (GSM/GPRS and EGPRS format)

- W-CDMA, cdma2000, and 1xEV-DO formats:
  1. Press **Instrument Selection**
  2. Select Audio Analyzer
  3. Select Analog Audio Setup (**F1**) to configure the Audio Analyzer parameters. For example, to view the measurement results for the SINAD and Distortion, the SINAD/Distortion State setting must be turned on. The results for the Audio Analyzer setup are the same as those reported in the GSM Analog measurement (refer to Figure 2).

In general, at the output of the FM test system, you can expect the typical output level accuracy to be ±1 dB at 76 to 108 MHz (that is, the full range of the FM Broadcast Bands) and -30 to -110 dBm, and the deviation accuracy to be ± 5% + residual FM at 1 kHz rate. See the typical specifications for 8960 with the E5520A FM Adapter connected to the RF Out Only port listed at the end of this paper for more details. See the Technical Specifications section at the end of this paper for technical performance data.

Conclusion

Creating a FM test system for testing your device's FM receiver is as simple as connecting the Agilent E5520A FM Adapter to the 8960. When the device's demodulated audio signal is connected to the 8960's audio port, audio measurements can be used to measure audio level, frequency and distortion - providing a complete solution for FM receiver testing needs.

Technical Specifications

These specifications apply to an 8960 test set (E5515B or C) when used with an E5520A FM adapter and a test application with FM measurement capability. Output signal amplitude and distortion specifications for FM testing with the E5515B/C and E5520A are supplemental. Supplemental characteristics are intended to provide typical, but non-warranted, performance parameters that may be useful when using the test set with the FM adapter. All units shipped from the factory meet supplemental characteristics at +25 °C ambient temperature without including measurement uncertainty. The Audio Measurement specifications are listed for your convenience. Please refer to the appropriate TA audio specifications for warranted audio measurement performance. TA specifications can be found on the 8960 product website at **www.agilent.com/find/8960**

Typical Output Signal Specifications:

Amplitude

Conversion gain through E5520A: -20.00 dB
Output level range: *-20 to -140 dBm*
Output level accuracy: *+/-1 dB at 76 to 108 MHz and -30 to -110 dBm*
VSWR at output: *< 1.2 at 76 to 108 MHz*
Reverse power: *250 mW*
Output level setting resolution: *0.1 dB*
Output level switching time: *< 50 ms to be within 0.1 dB of final level*

Frequency Modulation

Rate range: *50 Hz to 20 kHz*
Deviation range: *0 to 75 kHz*
Deviation accuracy: *+/- 5% + residual FM at 1 kHz rate*
Residual FM: *< 30 Hz at 50 Hz to 20 kHz*
Harmonic distortion: *< 0.5% at 1 kHz rate and 20 kHz deviation*
Deviation resolution: *1 Hz*
Rate resolution: *1 Hz*

Audio Measurement Specifications

Audio analyzer specifications

All specifications for the audio analyzer apply to signals present at test set's AUDIO IN ports.

Audio analyzer de-emphasis: 750 µs, de-emphasis settable as off or on

Audio analyzer expandor: settable as off or on with reference level setting of 10 mV to 10 V

Audio analyzer filters: settable choices of none, C-message, 50 Hz to 15 kHz band pass, 300 Hz to 15 kHz band pass, or 100 Hz bandwidth tunable band pass tunable over 300 Hz to 15 kHz

Audio level measurement

Types of signals measured: sinusoidal audio signals
Measurement frequency range: 100 Hz to 15 kHz
AUDIO IN level range: 7.1 mV to 20 V peak (5 mV to 14.1 V rms)
Measurement accuracy: < ±(2% of reading + resolution) for 100 Hz to 8 kHz, < ±(3% of reading + resolution) for > 8 to 15 kHz GSM/GPRS/EGPRS)
Measurement THD plus noise: < 200 µV rms
Measurement detector: selectable choices of rms and peak
Measurement trigger source: immediate
Available result: audio level
Multi-measurement capabilities: 1 to 999 measurements, average, minimum, maximum, and standard deviation results

External input impedance: *typically 100 kOhms in parallel with 105 pF*
Measurement resolution: *typically 0.3% of expected level setting or 0.2 mV, whichever is greater*

SINAD measurement

Types of signals measured: sinusoidal audio signals
Measurement frequency range: 100 Hz to 10 kHz
AUDIO IN level range: 42.4 mV to 20 V peak, (30 mV to 14.1 V rms)
Measurement accuracy: < ±1.0 dB for SINAD < 44 dB
Residual THD plus noise: < –60 dB or 200 µV rms, whichever is greater
Measurement trigger source: immediate
Available result: SINAD ratio
Multi-measurement capabilities: 1 to 999 measurements, minimum, maximum, average, and standard deviation results

Distortion measurement

Types of signals measured: sinusoidal audio signals
Measurement frequency range: 100 Hz to 10 kHz
AUDIO IN level range: 42.4 mV to 20 V peak (30 mV to 14.1 V rms)
Measurement accuracy: < ±12% of reading (±1.0 dB) for distortion > 0.67%
Residual THD plus noise: < –60 dB or 200 µV rms, whichever is greater
Measurement trigger source: immediate
Available result: audio distortion
Multi-measurement capabilities: 1 to 999 measurements, minimum, maximum, average, and standard deviation results
Measurement resolution: *typically 0.1%*

Audio frequency measurement

Types of signals measured: sinusoidal audio signals
Measurement frequency range: 100 Hz to 15 kHz
AUDIO IN level range: 7.1 mV to 20 V peak (5 mV to 14.1 V rms)
AUDIO IN signal conditions: signal at test set's AUDIO IN must have signal-to-noise ratio > 30 dB
Measurement accuracy: < 0.1 Hz averaged over 10 measurements, < 1.0 Hz for a single measurement
Measurement THD plus noise: < 200 µV rms
Measurement trigger source: immediate
Available result: audio frequency
Multi-measurement capabilities: 1 to 999 measurements, minimum, maximum, average, and standard deviation results
Measurement resolution: *typically 0.1 Hz*

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