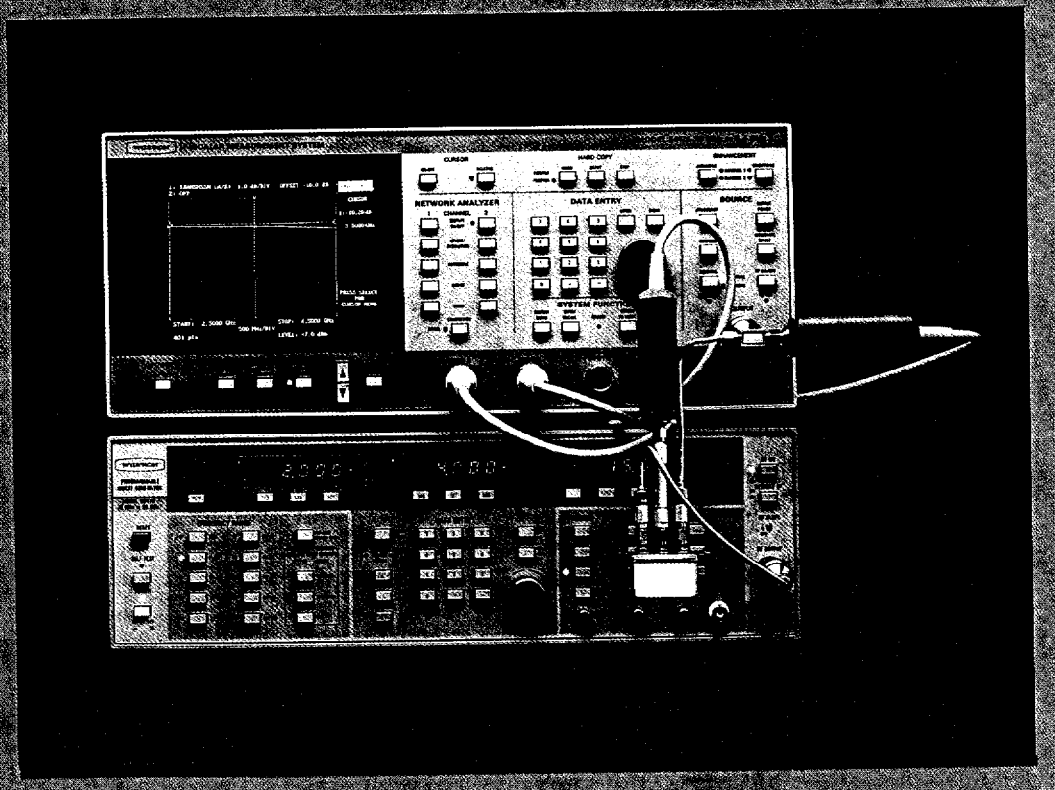
WILTRON

5400A Series Scalar Measurement Systems

Testing Microwave Mixers



Introduction

The Wiltron 5400A Series of Scalar Measurement Systems offer many features for characterizing microwave mixers. This application note describes how these features can be applied to more thoroughly test mixers in less time.

Below is a list of mixer characteristics that are commonly measured with a scalar analyzer:

- LO-to-RF isolation
- LO-to-IF isolation
- RF-to-IF isolation
- SSB conversion loss vs. input frequency (holding IF frequency fixed)
- SSB conversion loss vs. IF frequency (holding RF frequency fixed)
- Conversion loss vs. LO power
- 1 dB conversion compression point

Basic Measurement Setup

Figure 1 shows a basic measurement setup for measuring LO-to-RF isolation. The unmeasured port should be terminated. The attenuators reduce mismatch measurement errors.

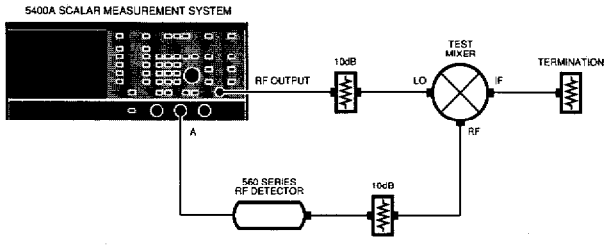
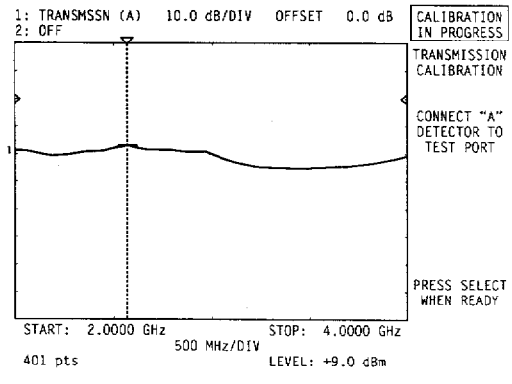


Figure 1
Basic setup for LO-to-RF isolation measurements

FEATURE/BENEFIT NOTE — All 5400A models include a built-in microwave source. This provides unmatched ease-of-use in a compact package. The built-in source offers a complete feature set including start-stop and center-width frequency selection and markers (with amplitude read-out). Optionally, a 70 dB step attenuator allows control of the source power over a range of greater than 80 dB. Low noise mixers may easily be tested at a variety of source powers without the need for reconnecting external attenuators.

Press the [SYSTEM MENU] front panel key, then the [RESET] soft key. The 5400A defaults to Channel 1, Transmission A and Channel 2 Return Loss B. Press the [DISPLAY ON/OFF] key on Channel 2 to turn it off. Select the frequency range to be tested and the desired power from the built-in source.

The measurement of [TRANSMISSION (A)] displays the difference between the input power to the mixer LO port to the output power from the RF port. This requires a calibration sequence to characterize the input power to the mixer. Pressing the [CALIBRATION] front panel key begins this sequence with instructions from the display menu area. Display 1 shows one of the instruction menus.



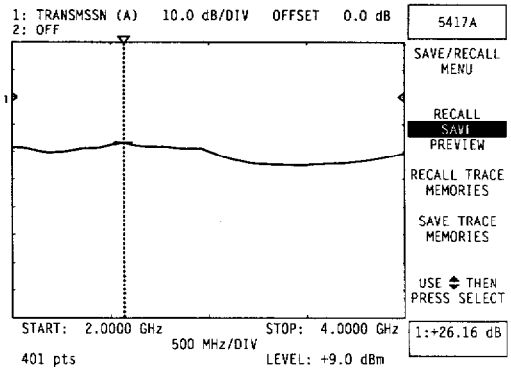
Display 1

Calibration

It's important to include in the calibration as many of the connection components to the mixer under test as possible (such as cables to and from the test mixer) in order for the calibration to compensate for their loss and frequency response. Once calibration is complete, connect the test mixer and adjust the display scaling to view the desired characteristics.

Save/Recall

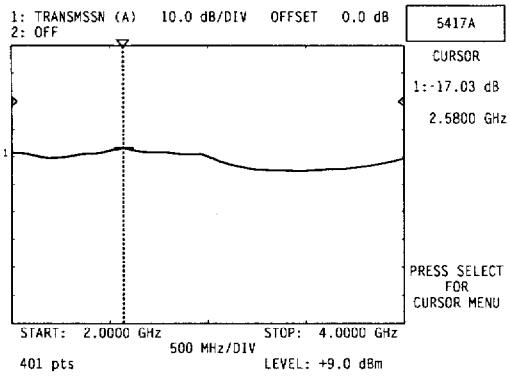
To allow quick movement through different test sequences, this setup and calibration may be stored and recalled using the **SAVE/RECALL** menus. See Display 2.



Display 2

Cursor Functions

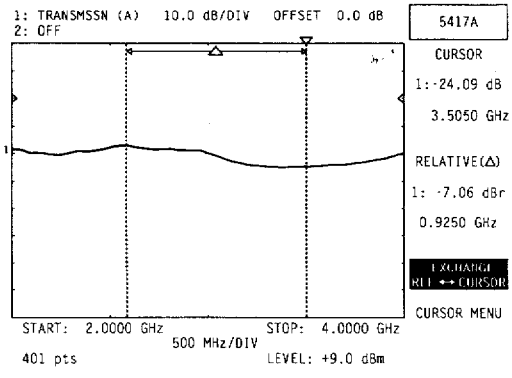
The cursor menus allow quick measurement of the isolation.
For example, the minimum isolation over the frequency range is found by pressing **MOVE CURSOR TO – MAXIMUM**. See Display 3.



Display 3

FEATURE/BENEFIT NOTE —
The 5400A Series offers the most extensive cursor capability available in any microwave network analyzer. Cursors may be set to automatically search for key device characteristics, saving test time and reducing errors from misread displays. Despite its power, ease-of-use is maintained, allowing a new user to quickly make accurate measurements.

Similarly, the maximum isolation can be found by **MOVE CURSOR TO – MINIMUM**. The isolation variation may be found by moving the main cursor to **MAXIMUM** and the relative cursor to **MINIMUM**. See Display 4.



Display 4

Ratio Measurements

One problem with the above setup is that the calibration is maintained only when the power from the source stays constant. This precludes varying the power to the mixer to measure isolation at a specific output power. This problem is readily solved by adding a power divider to the setup and measuring the ratio of the power from and to the test mixer. See Figure 2.

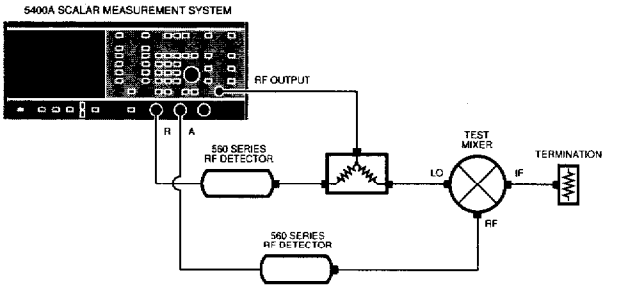
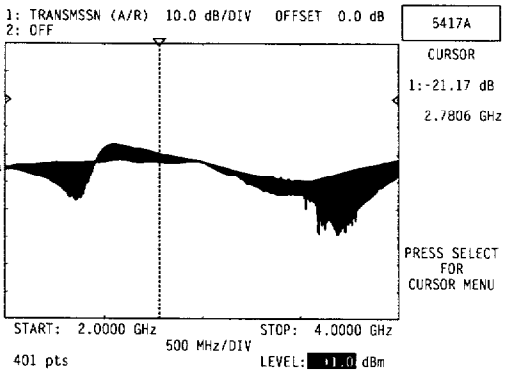


Figure 2
Setup for LO-to-RF isolation measurements using a power divider

FEATURE/BENEFIT NOTE
The optional ratio measurement capability significantly enhances mixer measurement capability and accuracy. The ability to view performance while varying power makes each display more meaningful, saving overall measurement time.

The ratio remains unchanged when the input power is varied. Incidentally, measurement stability is also improved as it is now mainly based on the detector tracking and the stability of the resistors in the power splitter.

To set the 5400A for ratio measurement of transmission (insertion loss), select [A/R] for channel 1. Calibrate as before. Display 5 shows the LO-to-RF isolation after the source power was varied over a 10 dB range.



Display 5

Trace Functions

The [MAX-MIN TRACE] function captures the change in insertion loss due to the increasing power. The vertical width of the display trace indicates the amount of insertion loss variation at that frequency. Notice that the RF-to-LO isolation varies significantly with frequency and power.

The 5400A Series also measures absolute power in dBm. On channel 2, press [POWER] under the [MENU] front panel key and [SELECT INPUT A]. RF-to-LO isolation at a specified output power can be easily measured using the cursor.

Figure 3 shows the setup for measurement of SSB conversion loss when the RF frequency is held fixed. The RF input is set at 4 GHz. The LO is swept from 2 to 4 GHz. The 2 GHz low pass filter prevents the LO and RF power from interfering with the IF power measurement.

To calibrate, first measure the loss of the filter in the passband of 10 MHz to 2 GHz using one of the setups described earlier. Record the average value. The example filter has 1 dB loss. Next, connect the IF detector with attenuator to the cable connecting the LO to the mixer. Be sure to include any attenuators in the LO line. Calibrate as before over the frequency range of the mixer LO port (2 to 4 GHz in this example). Reconnect as per Figure 3.

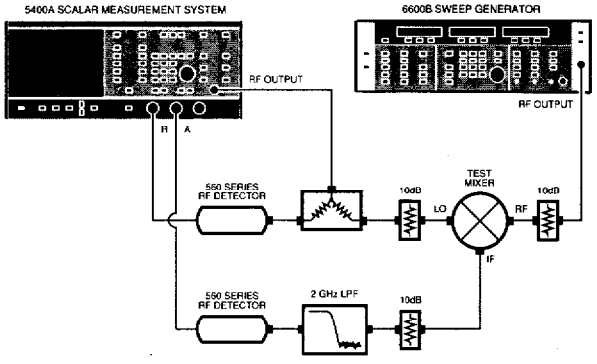


Figure 3
Setup for SSB conversion loss measurements

FEATURE/BENEFIT NOTE —
The 5400A Series offers an extensive set of built-in automation functions such as the MAX-MIN TRACE function to simplify complex measurements and provide more meaningful results.

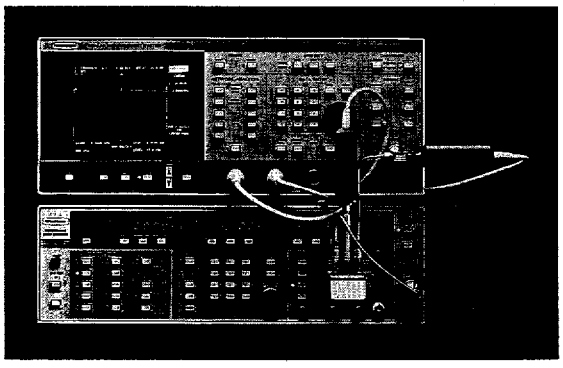
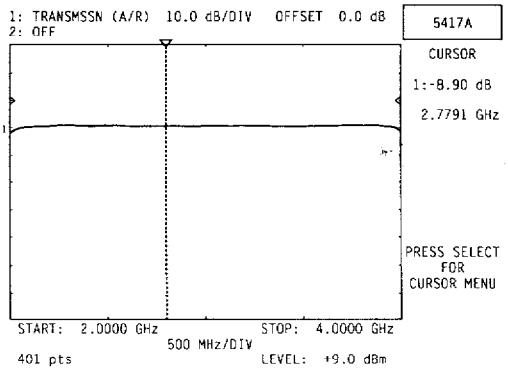


Figure 4

The conversion loss measurement is now the ratio of the R Detector (which is sweeping from 2 to 4 GHz) and the A Detector (which is sweeping between DC and 2 GHz). See Display 6. However, there is still an error from the insertion loss of the passband of the filter.



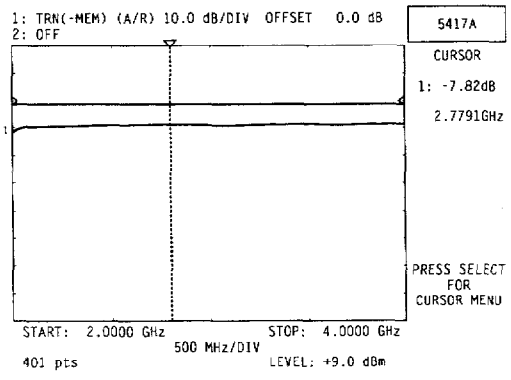
Display 6

Trace Memory

The 5400A Series Trace Memory function can automatically add the loss of the filter to the conversion loss reading. The loss can be measured in Transmission measurement mode and stored into Trace Memory by pressing the [LOAD MEMORY WITH TRACE DATA] under the [TRACE MEMORY STORAGE MENU] and [MENU] front panel key.

The Trace Memory may also be loaded with a Complex Limit line whose value equals the loss of the filter (1 dB). Press [COMPLEX LIMITS] under the [LIMITS] front panel key and [ENTER A HIGH] limit equal to the filter loss. This value may then be stored into Trace Memory. When [VIEW DATA-MEMORY] is chosen, the display indicates the conversion loss of the mixer, corrected for the filter loss. Display 7 shows this measurement.

FEATURE/BENEFIT NOTE — Extensive TRACE MEMORY functions add another level of flexibility not available with any other scalar network analyzer. You can view measurement results in your terms without having to mentally offset readings.



Display 7

Figure 5 shows the setup for measurement of the SSB conversion loss when the IF frequency is held fixed at 500 MHz. The RF input is swept from 2.5 to 4.5 GHz. The LO is simultaneously swept from 2 to 4 GHz. The 2 GHz low pass filter prevents the LO and RF power from interfering with the IF power measurement. The 5400A outputs a 0 to 10 volt sweep ramp, corresponding to the start and stop of sweep, respectively. The 6600B Sweep Generator accepts this ramp and sweeps its own range at the same rate.

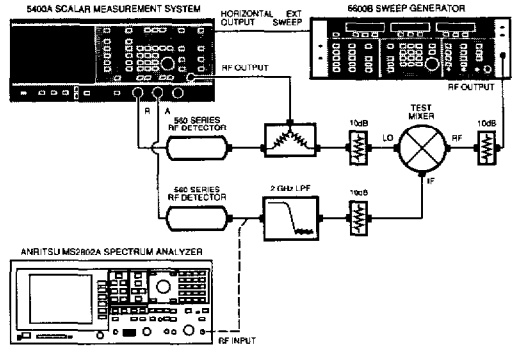
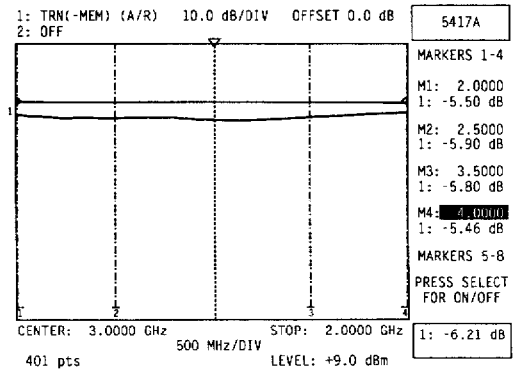


Figure 5
Setup for SSB conversion loss measurements (holding IF frequency at 500 MHz)

Calibrate for insertion loss as in the setup shown in Figure 3. To synchronize the sweep rate of the 5400A with the Sweep Generator, view the IF out of the mixer on the Spectrum Analyzer. Set the 5400A to [CENTER WIDTH SWEEP] by pressing [SELECT] under the [FREQUENCY] front panel menu key and set [CENTER] at 3 GHz and [WIDTH] at 2 GHz.

Similarly, set the 6600B to ΔF CF sweep with CF at 3.5 GHz and ΔF at 2 GHz. Sweep via the EXT SWEEP input by pressing [SHIFT] [EXT SWEEP] on the 6600B front panel. Observe the IF output at 500 MHz on the Spectrum Analyzer. If the IF is not steady at 500 MHz, adjust the ΔF on the 6600B to make the sweep rate equal the 5400A. If needed, slow the 5400A sweep speed down by adding maximum smoothing. Once the sweep rates are synchronized, save the Sweep Generator settings into setup 1 of the 6600B by pressing [SHIFT] [SAVE] [1]. Once synchronized, adjusting the [CF] frequency on the 6600B or [CENTER] frequency on the 5400A adjusts the fixed IF output frequency.

Display 8 shows the conversion loss for this measurement. Markers are used to indicate the conversion loss at 2, 2.5, 3.5, and 4 GHz. The cursor indicates the loss at 3 GHz in the window at the lower right.



Display 8

Cursor and Markers

FEATURE/BENEFIT NOTE — The 5400A offers both markers and cursor readouts to reduce errors and speed measurement time.

The cursor frequency information is based on the number of points of displayed data. The 5400A Series also offers markers, based on the source frequency information, however, they also indicate the trace amplitude at each frequency. Markers can be selected under the [MARKERS] front panel key. A display of both markers and cursors is available by selecting [CONTINUOUS CURSOR READOUT] under the [ANALYZER CONFIGURE] menu, under the [SYSTEM MENU] front panel key.

Fast Sweep for Tuning

For applications where the mixer must be adjusted while monitoring the 5400A display, faster update speeds may be obtained by reducing the number of horizontal data points taken. Selecting [DATA POINTS] under the [SYSTEM MENU] front panel key allows selecting [101], [201], or [401] data points. Best cursor resolution is obtained with 401 points. Fastest update rate is obtained with 101 points.

FEATURE/BENEFIT NOTE — The 5400A Series allows selection of the horizontal display resolution to provide the flexibility to be optimized to a variety of measurement situations.

The 1 dB conversion compression point is easily measured by monitoring the conversion loss while varying power to the mixer RF port. Use the [MIN-MAX TRACE] function under the [SYSTEM MENU] front panel key to show variation of conversion loss as RF power changes. The width of the band is the compression amount.

The 5400A Series Trace Memory function may also be used to store the small signal conversion loss and show "changes in conversion loss" in dB. Store the loss display with a low RF input power into Trace Memory by pressing [LOAD TRACE MEMORY WITH TRACE DATA] under the [MENU] front panel key and [VIEW (DATA–MEM)]. As the power is increased, the conversion loss increases due to compression. Once 1 dB compression is observed, the RF port power can be measured.

System Application

The 5400A Series offers even more automation of the 1 dB conversion compression measurement with a built-in SYSTEM APPLICATIONS function which automates the above sequence. This function can be found under the SYSTEM MENU front panel key.

Automated Setup

FEATURE/BENEFIT NOTE
Full GPIB programmability is an optional feature for the 5400A Series. A color VGA display output is standard. Combined together in a production environment, unparalleled productivity is available. Full automation gives perfect repeatability. The operator views all results on one display, minimizing complexity.

Figure 6 shows an automatic setup for mixer measurements. The Wiltron 360CC MS–DOS® computer automates all of the measurements discussed in this application note. Results, both from the 5400A and the computer, are viewed on the color VGA monitor.

Figure 6

MS–DOS® is a registered trademark of Microsoft Corporation.

WILTRON

Wiltron Company • 490 Jarvis Drive • Morgan Hill, CA 95037-2809
Tel. (408) 778-2000 • Telex 285227 WILTRON MH • FAX (408) 778-0239

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