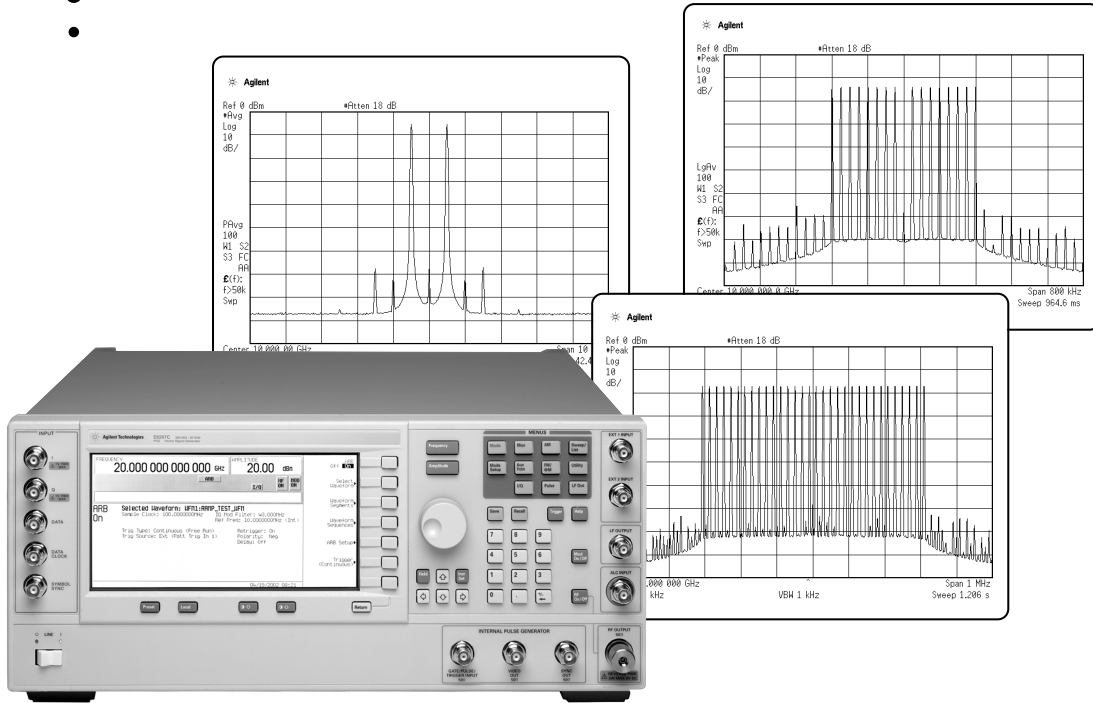# Agilent
Two-tone and Multitone Personalities for the E8267C PSG Vector Signal Generator

Application Note 1410

Generating two-tone and multitone signals at microwave frequencies has never been easier

The E8267C PSG vector signal generator quickly and conveniently produces multi-tone signals from a single signal generator. The PSG is the first microwave signal generator with an integrated I/Q modulator and internal baseband generator. This vector approach facilitates generating complex I/Q modulation previously available only in the RF domain. Plus it improves accuracy and repeatability of the test stimulus while reducing test time and capital equipment costs!

E8267C PSG vector signal generator key features:

- 250 kHz to 20 GHz frequency range
- Up to +18 dBm output power
- Internal baseband generator
- 80 MHz RF modulation bandwidth
- Flexible waveform sequencer
- Variable I/Q offset, amplitude, and phase to optimize signal quality
- 32 Msamples (160 MB) baseband memory for waveform playback
- 1.2 Gsamples (6 GB) memory for waveform storage
- LAN and GPIB connectivity

Two-tone and multitone personalities key features:

- Quickly setup and generate non-linear distortion test signals
- Easily navigate the table editor user interface to configure custom multitone patterns
- Take advantage of the internal baseband generator processing power to calculate I/Q waveforms instantly
- Set relative tone spacing and power
- Set initial phase relationships (fixed or random)
- View peak-to-average statistics
- Store/recall custom configurations and I/Q waveforms

Agilent Technologies

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What is IMD?

Two-tone and multitone signals are used extensively in the communications industry to test for nonlinear distortion at the component, device, sub-system, and system level. Intermodulation distortion (IMD) is a particular type of nonlinear distortion; other types include harmonic distortion and cross modulation. IMD is the primary cause of in-band and out-of-band spectral regrowth (i.e. distortion) and results from unwanted intermodulation between the multiple frequency components that comprise a signal. Intermodulation occurs as a result of the signal traversing components and devices with nonlinear transfer functions. Figure 1 illustrates some of the IMD products generated when two tones at frequencies f_1 and f_2 are presented to the input of a nonlinear device.
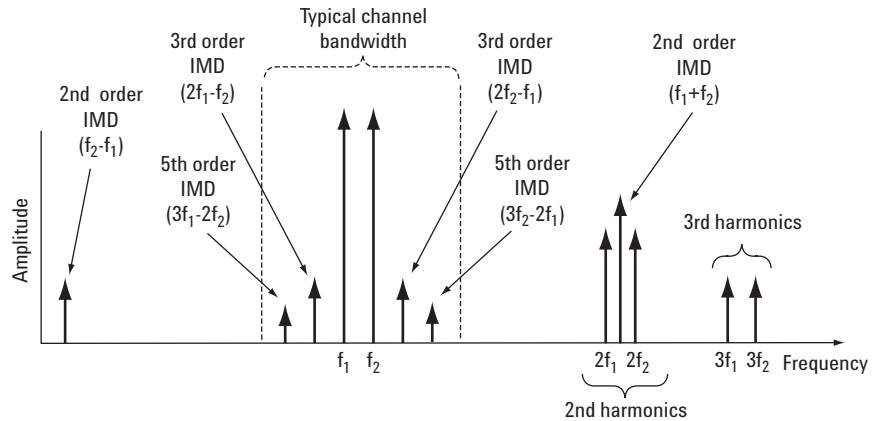

Figure 1. Two-tone IMD products commonly generated by nonlinear devices.

Nonlinear distortion cannot be corrected using equalization techniques (that only works with linear phenomena). As a result, quantitatively characterizing the effect of nonlinear behavior from the component to the system level is an important part of the transmitter/receiver design and verification process. High levels of IMD indicate significant nonlinearities that not only degrade the system performance, but also interfere with neighboring channels. In-band IMD refers to the intermodulation products that fall within the channel bandwidth of the component, device, or system under test. This type of distortion is particularly undesirable since it cannot be filtered and directly interferes with the signal of interest. Although generating out-of-band distortion is also objectionable behavior that must be characterized and addressed (ask your spectral neighbor), simple filtering can typically be applied to correct the problem.

How is IMD Characterized?

Overview

IMD is measured by examining the output of a device under test (DUT) with a spectrum analyzer while the DUT is being stimulated with a multitone test signal, Figure 2. For example, two-tone intermodulation distortion is a common measurement performed when characterizing the nonlinear behavior of an amplifier. Two discrete tones with equal power, that fall within the passband of the DUT, are applied to the input of the DUT. The resultant harmonic and intermodulation distortion products are then measured using a spectrum analyzer. A spectrum analyzer with wide dynamic range is desirable to measure low-level distortion products, like 5th and 7th order IMD and harmonics.[1] Based on these measurements, figures of merit like third order intercept point (TOI) can be determined.

Signal generator #1

f_1

Σ DUT   Spectrum analyzer
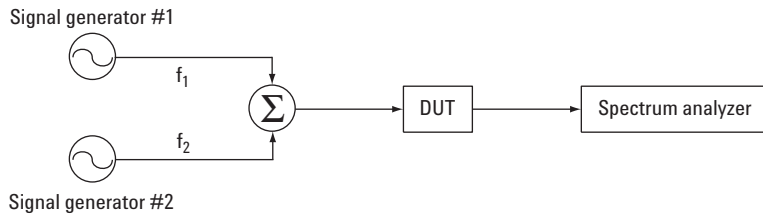
f_2

Signal generator #2

Figure 2. Traditional setup to measure IMD products using a two-tone test stimulus.

As the bandwidths of devices and systems increase, multitone signals are commonly used to characterize nonlinear distortion. Placing multiple tones across the bandwidth of the DUT enables more efficient characterization of the passband and also stresses the DUT with a higher crest factor signal.

Dependence on phase relationships

IMD measured at a specific frequency varies widely depending on the phase relationships of the tones that comprise the test signal. You might expect this when you consider that the phase distribution of the tones determines how they add up at each point in time, Figure 3. The time domain profile of the composite signal has a different peak to average ratio depending on whether the individual tones add constructively or destructively.

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1. The Agilent PSA Performance Spectrum Analyzer Series was used for all measure-ments made in this document. The PSA was chosen because it provides a leading edge combination of dynamic range, speed and accuracy. For more information on the PSA series of spectrum analyzers, including how to optimize the PSA distortion measurement capability, refer to the related literature section at the end of this document.
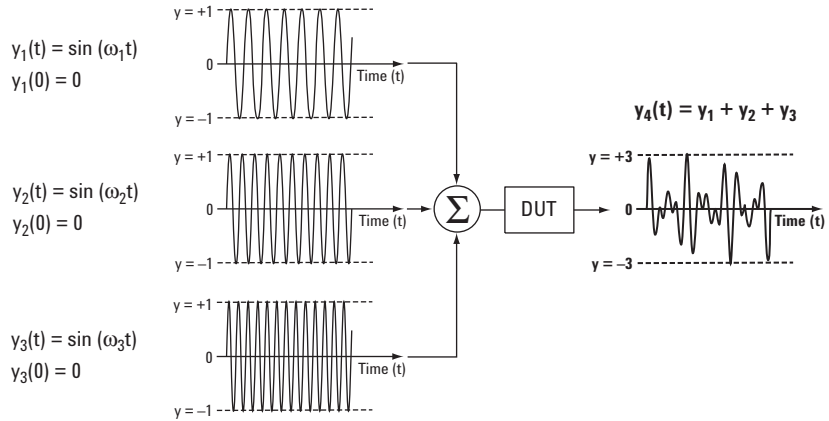
$y_1(t) = \sin(\omega_1 t)$
$y_1(0) = 0$

$y = +1$

0 Time (t)

$y = -1$

$y_4(t) = y_1 + y_2 + y_3$

$y = +3$

0 Time (t)

$y = -3$

$y_2(t) = \sin(\omega_2 t)$
$y_2(0) = 0$

$y = +1$

0 Time (t)

$y = -1$

DUT

$y_3(t) = \sin(\omega_3 t)$
$y_3(0) = 0$

$y = +1$

0 Time (t)

$y = -1$

Σ

Figure 3a.

$y_5(t) = \sin(\omega_1 t + 21°)$
$y_5(0) = -.3584$

$y = +1$

0 Time (t)

$y = -1$

$y_8(t) = y_5 + y_6 + y_7$

$y = +3$

0 Time (t)

$y = -3$

$y_6(t) = \sin(\omega_2 t)$
$y_6(0) = 0$

$y = +1$

0 Time (t)

$y = -1$

Σ DUT

$y_7(t) = \sin(\omega_3 t - 157.5°)$
$y_7(0) = .3827$
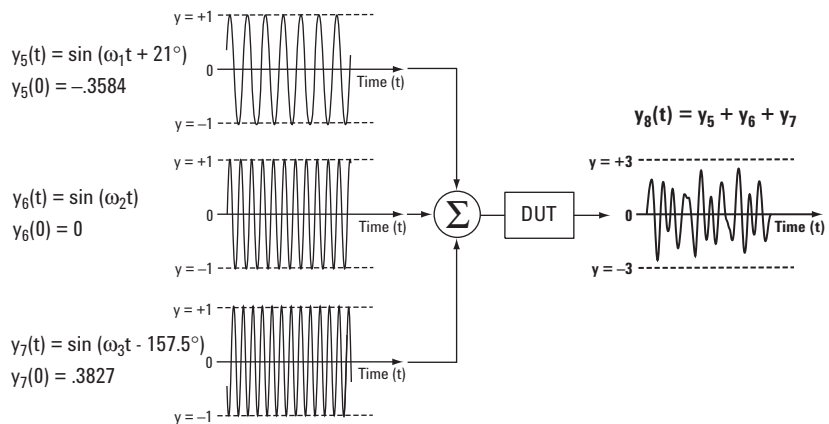
$y = +1$

0 Time (t)

$y = -1$

Figure 3b.

When summing multiple frequencies, the phase relationships of the frequency components affect the time-domain profile and peak-to-average characteristics of the composite signal. Figure 3a shows the composite signal when all the tones have the same initial phase. Figure 3b shows the composite signal when the tones have a random initial phase setting.

Although IMD is noticeably dependent of the phase relationships of the tones, IMD test results from one phase set are not predictive of IMD test results from another phase set based on phase relationships of the tones or peak-to-average ratio of the composite signal; in other words, IMD test results are not strongly correlated to the phase relationships of the tones in a statistical sense. Consequently, as the phase relationships of the spectral components in the passband of the DUT vary over time, the nonlinear distortion characteristics of the DUT vary in an unpredictable manner. As a result, testing with a single phase set does not provide enough information to adequately characterize IMD.

Clearly, attempting to characterize a device's nonlinear distortion performance using all the potential phase relationships that the spectral components in the passband of the DUT may take on under real-world operating conditions (i.e. all the potential phase sets) is impractical at best. So why not test using a phase set that results in a high crest factor composite signal to simulate the worst-case device stress condition?

Generating this signal implies that each discrete tone in the composite test signal is phase aligned so that the individual tone powers add 100% constructively. Consequently, the DUT is subjected to the maximum peak-to-average ratio it will experience when presented with similar loading conditions. Although this test does result in a robust device, it is not representative of the most common operating conditions. In practice, the spectral components in the passband of the DUT are continuously changing over time in a random fashion, particularly when you consider phase-modulated signals.

As more tones are added to the test signal, the probability of all the tones aligning in phase is significantly reduced. As the probability of the peak power occurrence decreases, it becomes increasingly unreasonable to make design tradeoffs based on this event. As a result, the design effort required to accommodate the maximum peak-to-average ratio condition may not be warranted. Even so, if you would like the security of knowing your device can handle the worst-case peak-to-average ratio, the vector stimulus technique discussed later facilitates aligning phase to simulate this event.

More importantly, a high peak-to-average ratio does not imply high levels of IMD at all frequencies. As shown in Figure 4, the IMD levels generated by a device under test vary depending on the phase relationships of the multitone test stimulus. Notice that when the initial phase of the tones are aligned (i.e. worst case peak-to-average ratio) the 3rd order IMD product is –52.89 dBc. However, when the tones have a random initial phase setting, the 3rd order IMD product is –48.65 dBc with random phase set #1 and –60.22 dBc for random phase set #2. This clearly shows that the worst-case peak-to-average ratio (i.e. equal phase set) does not result in the highest 3rd order IMD level. If tests were only performed using phase-aligned tones, the IMD performance issues associated with random phase set #1 would not be revealed.
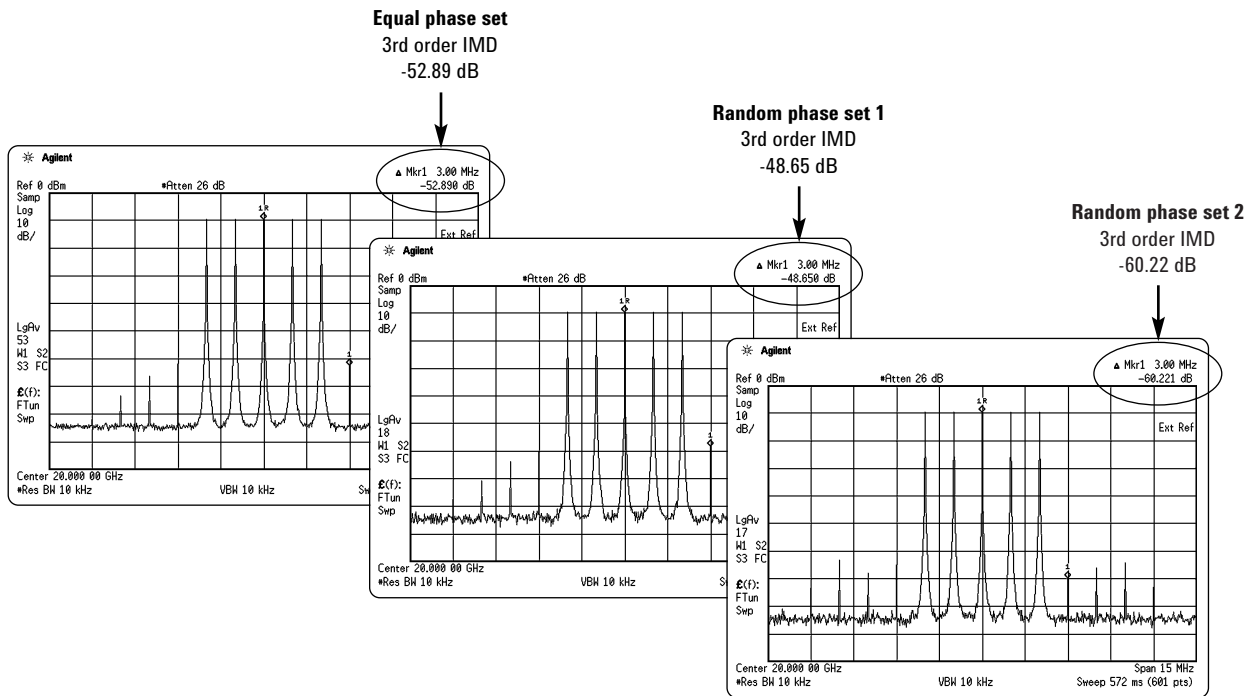
Equal phase set
3rd order IMD
-52.89 dB

Random phase set 1
3rd order IMD
-48.65 dB

Random phase set 2
3rd order IMD
-60.22 dB

Figure 4. Three different IMD measurement results using test signals with different phase sets.

Because worst-case peak-to-average ratio does not imply worst-case IMD levels and IMD varies considerably depending upon the phase relationships of the test stimulus, to truly characterize IMD performance, statistical sampling analysis should be applied to a collection of IMD test results that are gathered using multiple test signals with random phase sets. The central limit theorem can be used to determine how many individual test results from random phase sets need to be averaged to obtain a composite test result that adequately represents realistic operating conditions within some reliable confidence interval. As discussed later, vector stimulus techniques can be used to generate multi-tone signals with random phase sets to facilitate this test approach. For additional information on using statistical techniques to analyze IMD performance, see the paper created by Agilent Technologies in the references section.

Analog Test Stimulus

A traditional test setup to measure IMD is shown in Figure 5. In this setup, two signals from independent continuous wave (CW) signal generators are summed together using a combiner to create a two-tone test stimulus. Multiple isolators are used to ensure that signal generators do not interfere with each other, thus minimizing the IMD contributed by the test equipment. Typical isolators provide 20 dB of isolation in the reverse path at the cost of .5 to 1 dB of loss in the forward path. The amplifier at the output of each signal generator is used to fine-tune the relative tone powers without changing the signal generator level. As a result, the signal source IMD is held constant. The low pass filter is used to minimize the out-of-band spectral components of the test stimulus. The combiner used to sum the signals from the generators should have low loss, sufficient isolation, and add minimal distortion to the test stimulus. The variable attenuator at the output of the combiner is used to change the level of the composite signal at the input of the DUT without manually adjusting each signal generator; again, attempting to hold the source IMD constant.
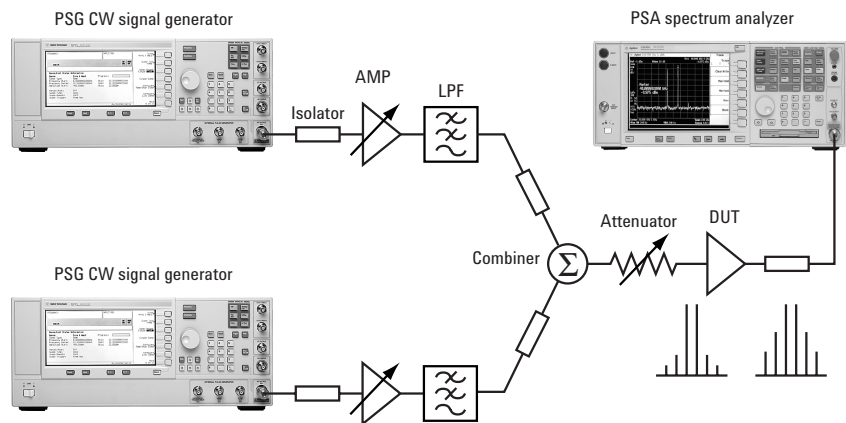

Figure 5. Conventional analog setup to perform a two-tone IMD measurement.

Conventional multitone signal generation methods used to perform IMD measurements are equipment intensive, particularly as the number of tones increases. CW signals (i.e. tones) from multiple signal generators are summed together to create the desired test stimulus. Figure 6 illustrates a multitone IMD measurement setup using CW signal generators.
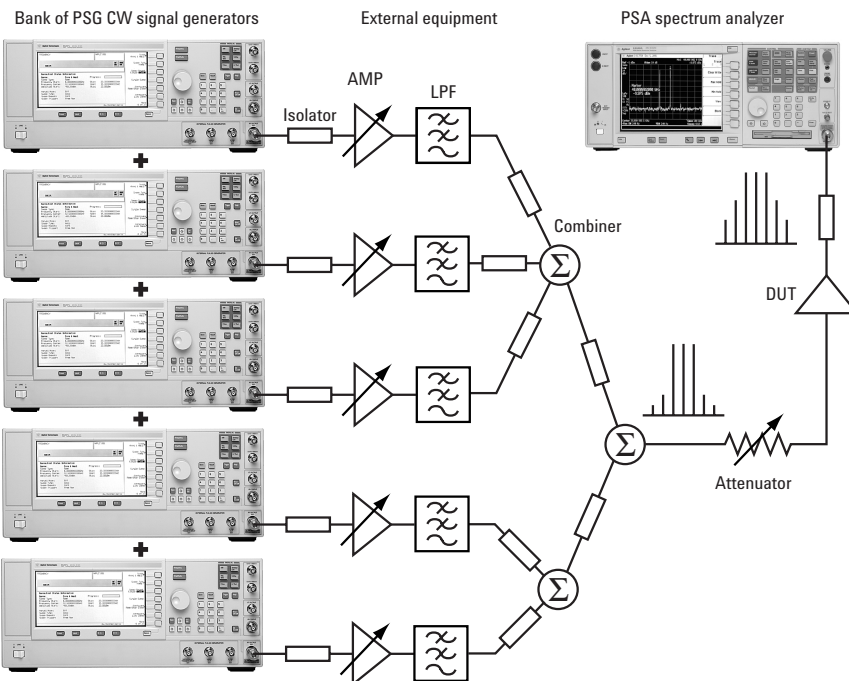
Figure 6. Conventional analog setup to perform a multitone IMD measurement.

Although this approach has been used for many years (primarily due to a lack of reasonable alternatives), this is a relatively complicated test setup with a high overall cost of test. Like with the two-tone test setup, it is important to ensure there is adequate isolation between the individual CW signal generators so that they do not intermodulate with each other prior to the input of the DUT.

The main shortcoming associated with this test setup is the inability to systematically initialize the phase of the CW signal generators. Monitoring the variability in IMD performance on a spectrum analyzer over a period of 5 to 10 minutes reveals that the phase relationships of the CW signal generators do change over time. As previously discussed, this is desirable for gathering IMD results from different phase sets. However, the CW signal generators drift relatively slowly with respect to one another and cannot be systematically initialized. Consequently, the conventional analog approach requires too much time to obtain test results that are statistically representative of real world operating conditions.

Vector Test Stimulus

Rather than summing CW signals from multiple analog signal generators to create multitone signals, an equivalent test stimulus can be achieved from a single signal generator using a vector approach. The PSG vector signal generator takes advantage of its internal baseband generator and integrated I/Q modulator to generate multitone signals with fixed or random initial phase sets. Figure 7 shows the simplified hardware setup to generate multitone test stimulus using the PSG vector signal generator.
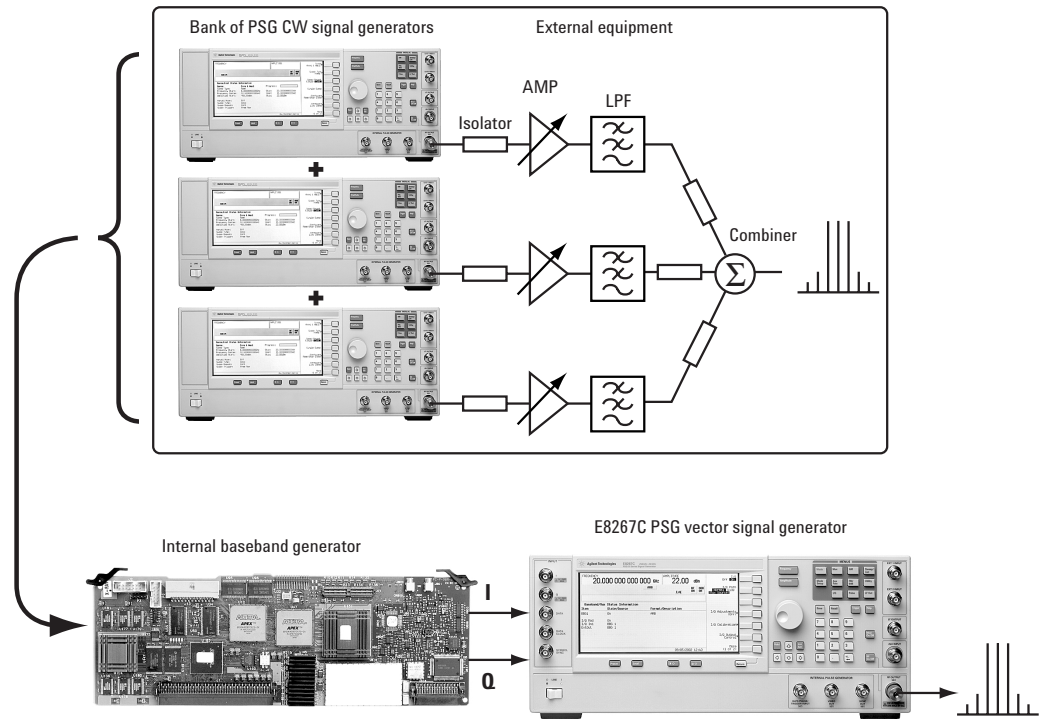
Figure 7. Simplified setup to generate a multitone test stimulus using the vector approach.

This technique employs complex modulation to deliver an accurate and repeatable multitone test signal (with up to 64 tones!) that can easily be configured to perform either in-band or out-of-band distortion measurements by setting the characteristics of each tone independently. Multitone waveforms are created at baseband frequencies and upconverted to the desired carrier frequency using an I/Q modulator. To illustrate this concept, consider the examples in Figure 8.
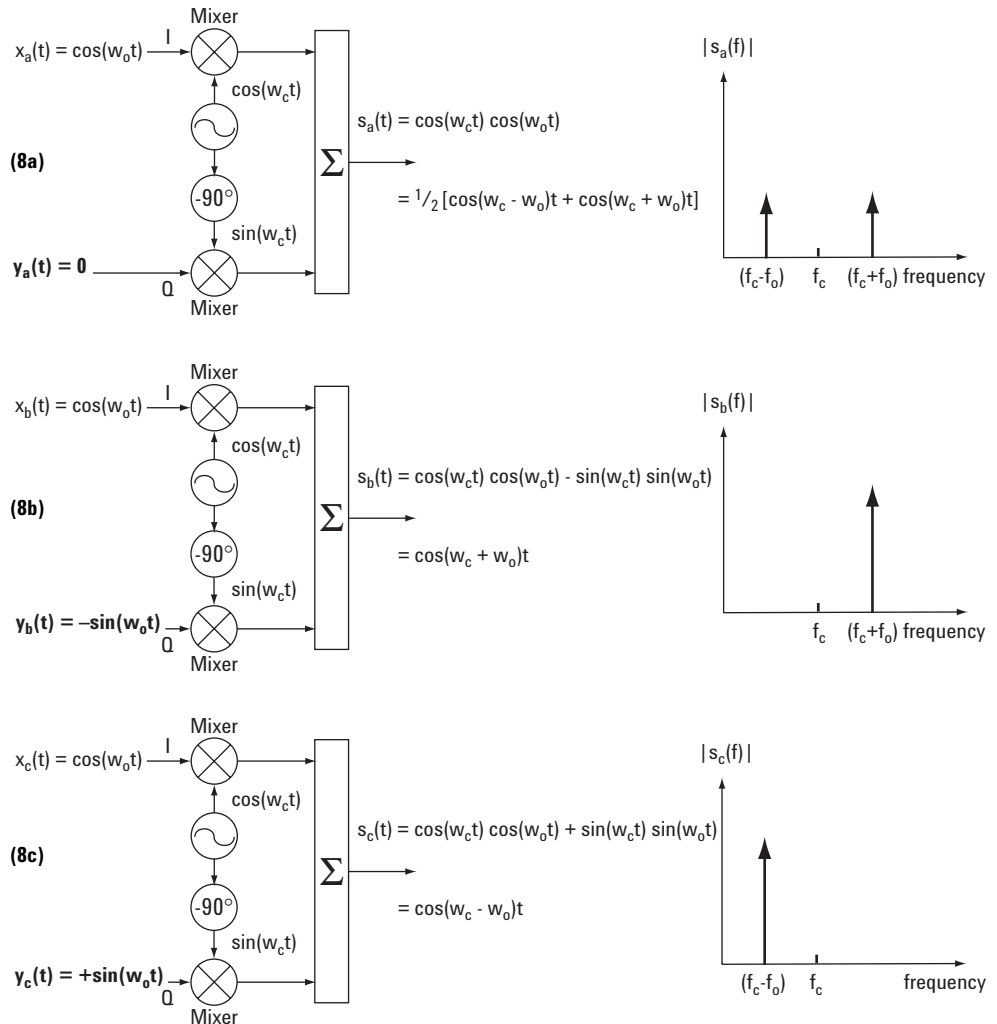
Figure 8. Generating multitone signals using an I/Q modulator[1].

Notice that when a modulating waveform is fed to the in-phase (I) path and zero is fed to the quadrature (Q) path, (Figure 8a), two tones are created symmetrically around the carrier. This is commonly referred to as double sideband suppressed carrier amplitude modulation (DSBSC-AM). Taking this a step further, Figures 8b and 8c show how a single tone can be created. To generate discrete tones with full control over individual tone parameters (i.e. amplitude, phase, and frequency), modulating waveforms are fed to both the I and the Q path. Depending on the sign of the modulating waveform on the Q path, the tone will appear above (Figure 8b) or below (Figure 8c) the carrier frequency. This concept can be extended to generate multitone waveforms if additional frequency components are added to the modulating waveforms on both the I and Q paths.

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1. The following trigonometric identities were used to determine the composite signal s(t): $2\cos(x)\cos(y) = \cos(x-y) + \cos(x+y)$ and $2\sin(x)\sin(y) = \cos(x-y) - \cos(x+y)$.

Because the signals are implemented digitally using the internal baseband generator, relative tone spacing, relative tone power, and initial tone phase can now be controlled with digital precision. Using the Agilent vector solution, these parameters are easily and precisely set from the instrument front panel or remotely using the GPIB or LAN interface. This technique even provides the ability to select fixed or random phase initialization when configuring the test signal. This feature, combined with the internal baseband generator sequencing capability, enables efficient testing with a series of random phase sets. Figure 9 shows the vector test setup to perform a two-tone or multitone IMD measurement.
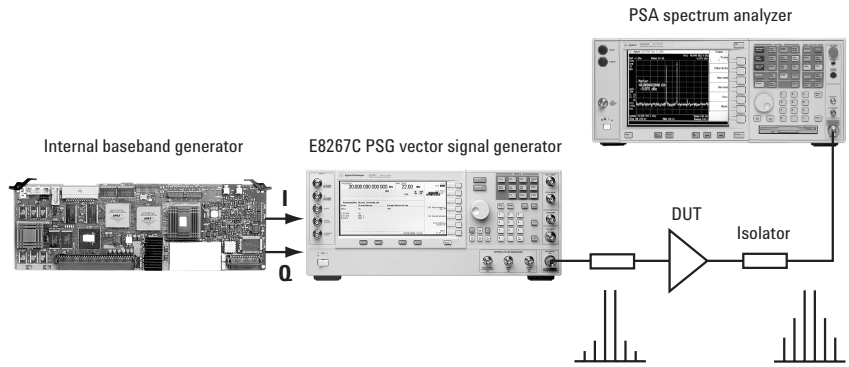
Figure 9. Vector setup to perform a two-tone or multitone IMD measurement.

Analog Test Stimulus Versus Vector Test Stimulus

The following points summarize the main benefits, as well as the drawbacks, associated with employing the conventional analog approach versus the new vector approach to generate a multitone test stimulus. Both methods can be used to generate a multitone signal, however there are many advantages to using a vector approach as discussed below. While there are many advantages, there are also some new measurement challenges introduced when using a vector approach to generate a multitone test stimulus. They are highlighted below and should be kept in mind when performing distortion measurements using the vector approach.

Why use conventional analog stimulus technique?

Well-established test procedure – Summing signals from multiple CW signal generators has traditionally been required to achieve a multitone test stimulus. This is a common test procedure that can be performed using standard off-the-shelf test equipment and accessories.

Issues with analog technique

Complicated test setup – Although the test stimulus is achieved using standard test equipment, the hardware setup is somewhat complicated considering the number of instruments required to generate the test stimulus. Because of the complex instrument configuration, setting up the equipment to perform the nonlinear distortion measurements consumes the majority of the test time.

Signal parameters not easily modified – Because independent signal generators produce each tone, adding or removing tones requires hardware modifications to the test setup. Once setup, manual tuning of frequency and tone power is also required for each signal generator.

Difficult to generate random phase sets – Most CW signal generators do not provide the ability to systematically set the phase of the signal. As a result, it is difficult to generate random phase sets using the traditional analog approach.

High cost of test – Because of the multi-instrument test setup and the time required to perform the measurement, the analog approach has a high overall cost of test. As more tones are added to the test stimulus, the capital equipment cost and time of test increases.

Why use vector stimulus technique?

Simplify test procedure – Now, setting a few basic waveform parameters in the PSG vector signal generator user interface is all that is required to create custom two-tone and multitone IMD test signals.

Control signal parameters – Enable and disable tones at will and easily modify common signal parameters like relative tone spacing and power. Also set fixed or random initial phase distribution with digital accuracy.

Repeatable test setup – The first step to achieving repeatable test results is finding a repeatable test stimulus. With vector techniques, test waveforms can be easily stored and quickly recalled for playback ensuring that the DUT is subjected to an equivalent test signal every time.

Accurate and meaningful test results – A series of multitone signals with random phase sets are required to adequately simulate real world operating conditions. Random phase sets can be generated directly from the instrument front panel or remotely using the GPIB or LAN interface.

Save time – Spend less time setting up the desired test stimulus and more time making measurements. To optimize testing with multiple phase sets, use the waveform sequencing capability of the baseband generator to minimize the waveform switching time.

Reduce cost – Use a single signal generator to produce a multitone test signals that traditionally required multiple analog signal generators and a signal combiner.

Issues with vector technique

Available power – When using a single signal generator to produce a multitone signal, the total power available from the signal generator is divided into each enabled tone based on the relative tone power settings. As a result, there is less power available per tone as compared to the traditional analog approach. Also, as the number of tones increases, the peak-to-average ratio of the composite signal increases. This must be taken into account in both the signal generator and with any amplifiers used to increase the composite signal power. The signal generator output power level should be reduced to account for the peak power of the multitone signal. This will ensure that additional distortion is not introduced by overdriving the signal generator. When using external amplifiers, the same concern applies. In addition, a linear amplifier with a flat passband that is wide enough to accommodate the multitone signal should be used to avoid introducing additional distortion to the signal prior to the input of the DUT.

Carrier feed through – Because an I/Q modulator is employed to create the desired multitone signal, a small amount of carrier feed through is present when an even number of tones are enabled. (With an odd number of tones, there is always a tone placed at the carrier frequency.) A high level of carrier feed through is undesirable since it will result in intermodulation products at one-half the tone spacing interval rather than at intervals equal to the tone spacing. Although carrier feed through cannot be eliminated, it can be minimized through a simple iterative procedure that optimizes the I and Q gain offsets. For additional information on this procedure, refer to I/Q adjustment procedure in the multitone section of the *E8267C PSG User's Guide*.

Images – Images arise when tones are enabled in a non-symmetrical pattern with respect to the carrier frequency. Images occur as a result of the I and Q signals being slightly out of quadrature at the input of the I/Q modulator. When non-symmetrical tone patterns are used, images can be minimized with slight adjustments to the quadrature skew setting in the I/Q adjustments menu.

Relative tone spacing – Tone spacing is limited to the 80 MHz RF modulation bandwidth of the internal baseband generator. The maximum relative tone spacing is calculated by dividing 80 MHz by (N-1), where N equals the number of tones. The maximum relative tone spacing calculation assumes that all tones are enabled. If individual tones are disabled, the increased tone spacing is a multiple of the maximum relative tone spacing. For example, if 5 tones are enabled, the maximum relative tone spacing is 20 MHz. If tone 2 is then disabled, the tone spacing between tones 1 and 3 is then 40 MHz. Relative tone spacing can be set down to 100 Hz, however tone spacing cannot arbitrarily be set on a tone-by-tone basis.

The PSG Vector Signal Generator
Two-tone and Multitone Personalities

Fundamentally, both the two-tone and multitone personalities operate in a similar manner. First the user configures the signal parameters (tone spacing, initial phase, etc.) and activates the application, then the baseband generator calculates the I/Q sample points that represent the baseband multitone signal and loads them into baseband memory for playback. The complex baseband signal is subsequently fed to the I/Q modulator for up-conversion to the desired carrier frequency. The tones are placed symmetrically around the carrier frequency of the PSG and the total power is divided among the tones based on the relative tone power settings, Table 1.

Common multitone configurations

Number of tones	Peak-to-average ratio of composite multitone signal[1]	Maximum average power of composite multitone signal[2]	Maximum average power per tone multitone signal[3]	Maximum relative tone spacing[4]
2	3 dB	15 dBm	12 dBm	80 MHz
8	9 dB	9 dBm	0 dBm	10 MHz
16	12 dB	6 dBm	-6 dBm	5 MHz
32	15 dB	3 dBm	-12 dBm	2.5 MHz
64	18 dB	0 dBm	-18 dBm	1.25 MHz

Table 1. PSG multitone signal generation capability for common multitone configurations.

A key benefit derived from these PSG personalities is reduced test time. Of course, calculation time increases with the number of enabled tones, however waveform build speed is generally negligible. The PSG high-speed microprocessor is capable of calculating waveforms with 64 enabled tones in just a few seconds. Waveform build time can also be reduced to a one-time operation by taking advantage of the PSG waveform storage/recall capability.

The I/Q waveforms created by the application can be stored in the instrument non-volatile memory and quickly recalled for playback. Simply build a library of pre-configured test signals and recall them at will or, to achieve the fastest waveform switching speed, use the baseband generator waveform sequencing capability. This feature allows you to load multiple test waveforms into baseband memory and arbitrarily define when and how long each test waveform plays. Since all the waveforms are pre-loaded into baseband memory, the waveform switching speed is only a few clock cycles during playback.

The signal quality can also be optimized from the instrument user interface or remotely by using the PSG I/Q adjustment capability and fine-tuning the modulator attenuator setting. Refer to the PSG manual set for additional information on optimizing signal quality. All functionality of the two-tone and multitone application(s) is directly accessible from the instrument front panel and can be automated remotely using the LAN or GPIB interface.

1. Assumes initial phase of tones are equal.
2. Assumes PSG maximum power (+18 dBm) is decreased to account for the composite signal peak-to-average signal.
3. Assumes PSG maximum power (+18 dBm) is decreased to account for the composite signal peak-to-average signal and relative tone powers are set to 0 dB.
4. Tones are placed symmetrically around the PSG carrier frequency.

Two-tone personality

Two-tone signals are the most widely used for analyzing nonlinear distortion. The PSG two-tone personality provides a streamlined user interface to quickly generate two tones with equal power and equal phase initialization, Figure 10. The signal parameters that can be adjusted in this application are a subset of those found in the multitone personality. The minimized feature set is intended to simplify the generation of basic two-tone signals so that common measurements can be made efficiently. The wide RF modulation bandwidth of the internal baseband generator allows tone spacing up to 80 MHz.
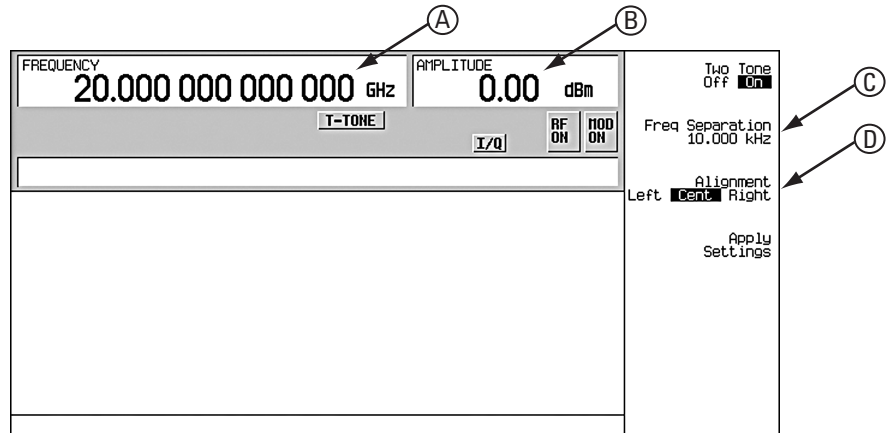
A. Set carrier frequency
   • 250 kHz to 20 GHz
B. Set the amplitude of the PSG signal
   • power is divided equally into each tone
C. Set relative tone spacing
   • 100 Hz to 80 MHz
D. Place tones symmetrically around carrier frequency
   or offset to mask carrier feed through

Figure 10. Two-tone personality user interface.

Multitone personality

The PSG multitone personality provides a full featured, flexible configuration menu for multitone signals ranging from 2 to 64 tones, Figure 11. In-band or out-of band IMD test signals can quickly be configured using the easy to navigate table editor, Figure 12. Enable/disable tones and change relative tone spacing, power, and initial phase conveniently from the instrument front panel or remotely over the GPIB or LAN interface.
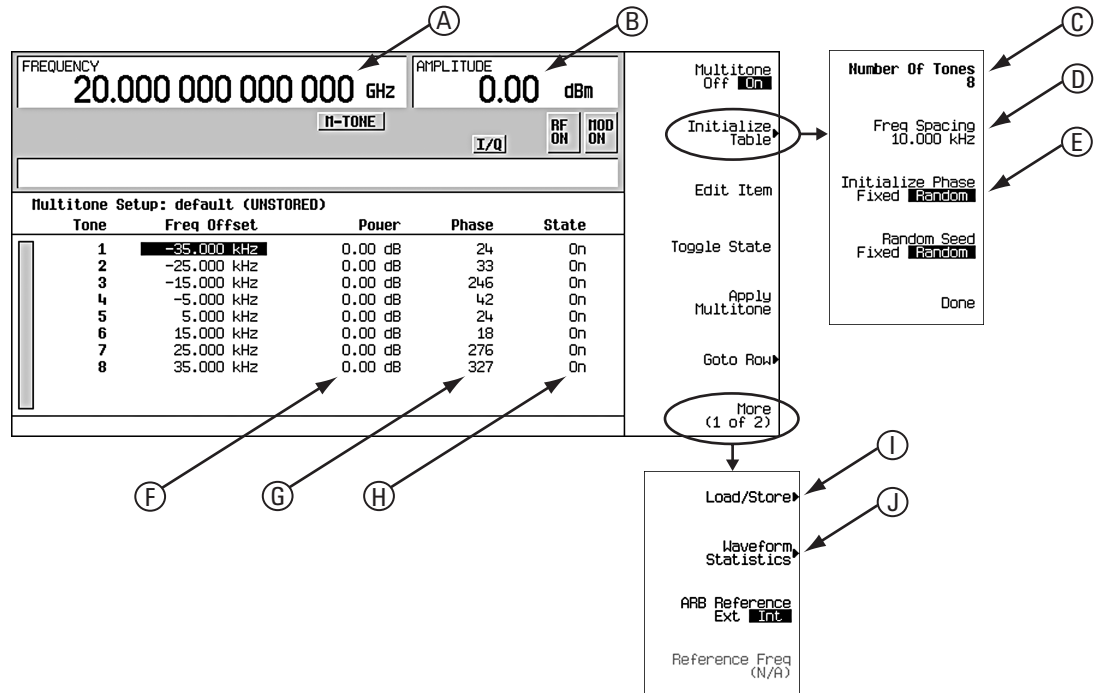
A.   **Set carrier frequency**
· **250 kHz to 20 GHz**
· **tones are placed symmetrically around carrier**
B.   **Set the amplitude of the PSG signal**
C.   **Set the number of tones**
· **2 to 64**
D.   **Set relative tone spacing**
· **100 Hz to 80 MHz**
· **depends on number of active tones**
E.   **Select fixed or random phase initialization**
F.   **Set relative tone power distribution**
· **0 dB to –40 dB**
· **total power is divided among the tones**
G.   **Set and view initial tone phase**
H.   **Quickly enable/disable individual tones**
I.   **Store and Re-load custom multitone setups**
J.   **Plot CCDF characteristics of the multitone signal**

Figure 11. Multitone personality user interface.

Notch   In-band distortion   Out-of-band distortion
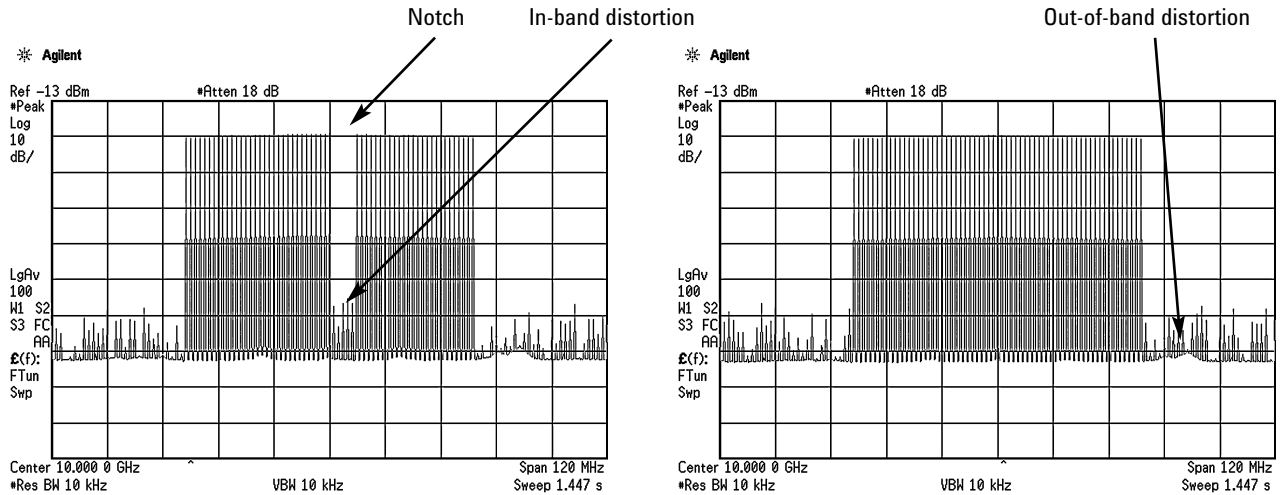
Figure 12. Multitone signals to test for in-band and out-of-band distortion.

The peak to average characteristics of the signal can also quickly be determined by plotting the CCDF (complementary cumulative distribution function) directly on the PSG user interface. This is useful if you need to know the peak power of the signal prior to applying the signal to the DUT and also provides design insight into headroom tradeoff for devices like power amplifiers. The CCDF curve plots the percentage of time the DUT will be subjected to power deviations from the average power, Figure 13. For additional information of CCDF curves, see the references section.

PSG CCDF plot with all tones at initial phase = 0°

Percentage of time that composite signal power is at or above the average power

Peak power deviation from average power
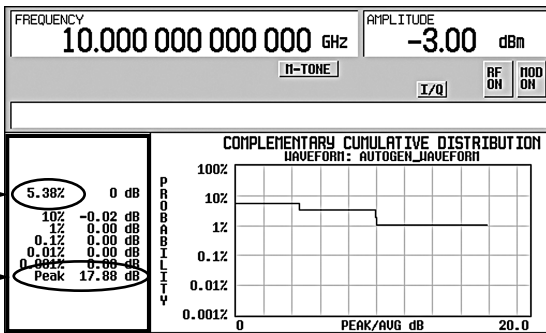
63-tone signal
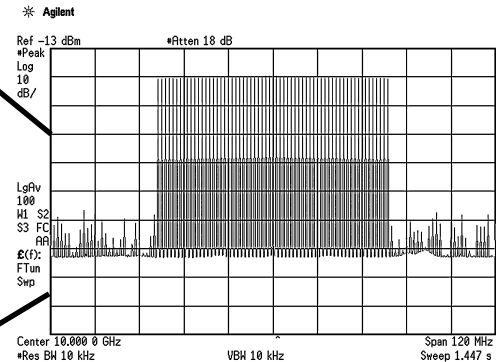
PSG CCDF plot with all tones at initial phase = random

Percentage of time that composite signal power is at or above the average power

Peak power deviation from average power
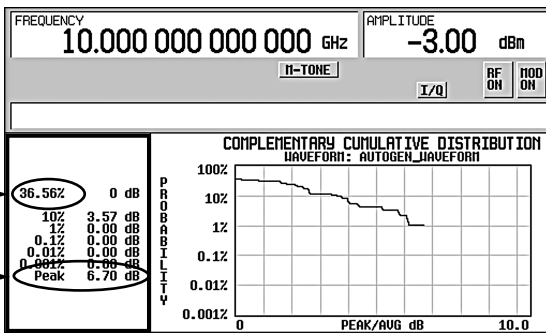
Figure 13. CCDF curves for 63-tone phase aligned signal vs. 63-tone random phase signal.

Specifications

Two-tone

IM distortion

250 kHz to 3.2 GHz	<–45 dBc for RF levels < 0dBm (typical)
>3.2 GHz to 20 GHz	<–55 dBc for RF levels < 0dBm (typical)
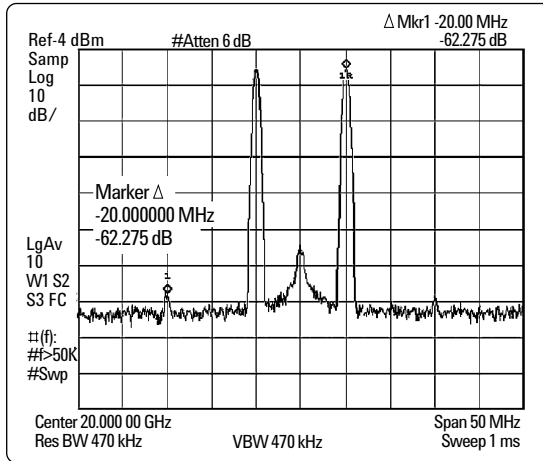
Multitone

Measured multitone
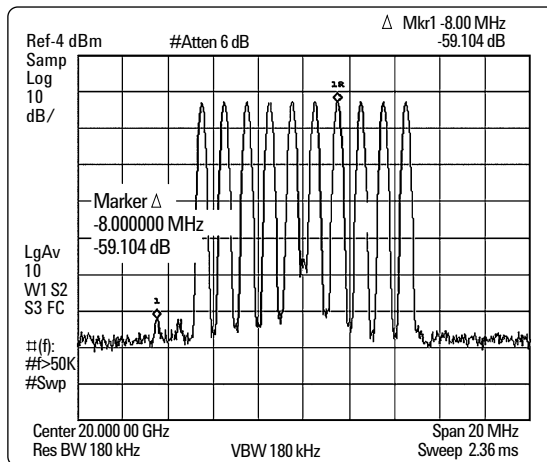
Measured image rejection > 3.2 GHz
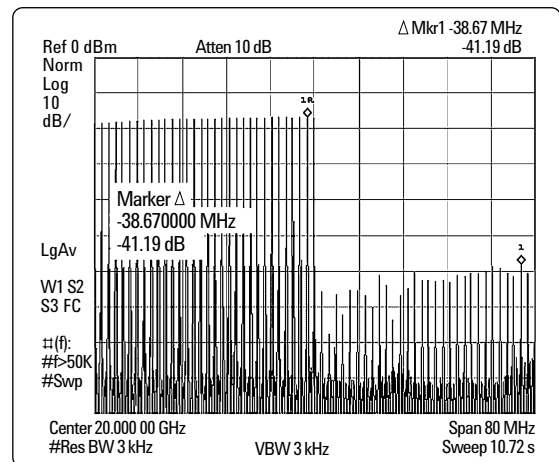
Signal Studio for Enhanced Multitone

There is optional software for the E8267C PSG vector signal generator to improve the signal quality of two-tone and multitone test signals. Signal Studio for enhanced multitone, Option 408 for the E8267C, significantly improves the IMD suppression, RF flatness, image suppression, and carrier feed through performance of multitone test signals generated by the PSG. The improved signal quality is achieved by applying pre-distortion to the I/Q waveform based on an iterative correction algorithm. Refer to the *Signal Studio for Enhanced Multitone Technical Overview* (publication number 5988-5639EN) for additional information on this application.

Connectivity

The E8267C PSG vector signal generator offers a wide array of I/O capabilities to simplify measurement setups. You can perform firmware upgrades, download waveforms to the instrument, or remotely control the instrument with SCPI commands using either 10BaseT LAN or IEEE-488 GPIB. LAN control requires the use of the L version of Agilent I/O libraries, downloadable from the Agilent web site: **www.agilent.com/find/iolib**[1]

Recommended Configuration

E8267C PSG Vector Signal Generator *equipped with the following options:*
E8267C-520 - 250 kHz to 20 GHz frequency range (required)
E8267C-002 - Internal baseband generator with 32 Msample memory (required)
E8267C-UNR - Enhanced phase noise
E8267C-005 - 6 GB internal hard drive
E8267C-408 - Signal Studio for Enhanced Multitone

Other configurations are available. For details regarding the E8267C PSG option structure, see the *PSG Vector Signal Generator Configuration Guide* that is referenced inn the *Related Agilent Literature* section.

Ordering Information

New instruments
The two-tone and multitone personalities are provided free of charge with the purchase of an internal baseband generator. The internal baseband generator may be ordered as Option E8267C-002 for the Agilent E8267C PSG vector signal generator.

To create distortion free multitone I/Q waveforms, the Signal Studio for enhanced multitone software is necessary. It can be ordered as Option E8267C-408 for the Agilent E8267C PSG vector signal generator. The software requires a PC (equipped with either a LAN card or GPIB card and recent version of the Windows operating system) and an Agilent PSA series spectrum analyzer. For additional information, refer to the *Signal Studio for Enhanced Multitone Technical Overview*.

If you need assistance, your Agilent field sales engineer can help you configure your new instrument properly. Contact information can be found at: **www.agilent.com/find/assist**

Upgrade kits
The two-tone and multitone personalities are provided free of charge with the purchase of an internal baseband generator. If you currently own an E8267C PSG vector signal generator and are interested in obtaining an internal baseband generator upgrade kit, order Option E8267CK-002.

If you currently own an E8267C PSG vector signal generator equipped with a baseband generator, and want an upgrade kit (license key) to enable the Signal Studio for enhanced multitone application, order Option E8267CK-408.

PSG Firmware updates

1. If using a non-Agilent GPIB interface card, follow the Agilent I/O libraries side-by-side installation instructions.

Firmware updates can be downloaded from **www.agilent.com/find/upgradeassistant**

Related Literature

Brochures
Agilent PSG Signal Generators
Publication number 5988-7538EN

Data sheets
Agilent E8267C PSG Vector Signal Generator
Publication number 5988-6632EN

Configuration guides
Agilent E8267C PSG Vector Signal Generator
Publication number 5988-7541EN

Technical Overview
Signal Studio Software for Enhanced Multitone
Publication number 5988-5639EN

Manuals
Agilent E8267C PSG User's Guide
Publication number E8251-90253

Application notes
Characterizing Digitally Modulated Signals with CCDF Curves
Publication number 5968-6875E

Related products
Agilent E4440E Performance Spectrum Analyzer
Publication number 5980-1284E

Agilent PSA Performance Spectrum Analyzer Series – Optimizing Dynamic Range for Distortion Measurements
Publication number 5980-3081EN

Spectrum Analysis Basics, Application Note 150
Publication number 5952-0292EN

Web addresses

See **www.agilent.com** for more information
www.agilent.com/find/psg
www.agilent.com/find/signalstudio
www.agilent.com/find/PSA

References

Papers
Evaluating Communications System Performance in Multiple Signal Environments, David R. Koberstein, 1994, Wireless Communications Symposium, Hewlett Packard

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