HP 85672A Spurious Response Measurements Utility

Product Overview

09:58 05/01/96

INTERMODULATION MEASUREMENT RESULTS

LOWER SIGNAL:	500.0 MHz	0 dBm
UPPER SIGNAL:	500.0 MHz	0 dBm

SIGNAL SPACING: 29.92 kHz

IMD (LOWER PRODUCT):	-79.5 dBc
IMD (UPPER PRODUCT):	-79.3 dBc

TOI/IP3 (LOWER PRODUCT):	39.8 dBm
TOI/IP3 (UPPER PRODUCT):	39.7 dBm

One button testing for common spectrum analyzer measurements

The five most commonly made spectrum analyzer measurements are now automated with the HP 85672A. Set-up and execution of each measurement is reduced to a few keystrokes--saving time, eliminating errors and optimizing the instrument to produce the best possible measurement results.

The HP 85672A provides automated tests for:

- Third-order intermodulation product and Third-Order Intercept (TOI/IP3)
- Harmonics and Total-Harmonic Distortion (THD)
- Discrete sideband spurs
- General spur search
- Mixing products

No tinkering with markers and no extra calculations are required. With the HP 85672A, output information is automatically summarized in a concise tabular format on the screen of your HP 8560 E-series or other high-performance portable HP spectrum analyzer[1].

Intermodulation Distortion (IMD) and the Third-Order Intercept (TOI)

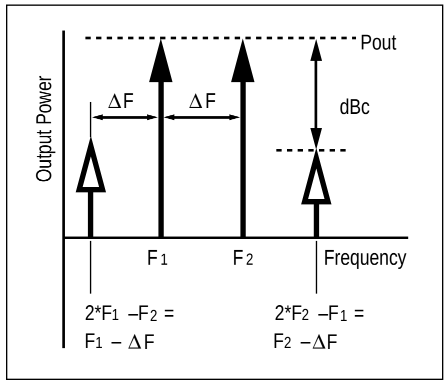
In the past, the trick to obtaining valid intermodulation distortion (IMD) measurements was to configure the spectrum analyzer to measure the IMD of the device and not the IMD of the instrument. With the HP 85672A, results are obtained quickly and with confidence without having to worry about these details. All information required to interpret test results is summarized in tabular form on the analyzer screen: the test signal output power, the upper and lower IMD products, and the calculated TOI from the upper and lower products.

1. The HP 85672A is primarily designed for use with the HP 8560 E-series family of spectrum analyzers, but it will also operate on other HP high-performance spectrum analyzers. See ordering information.

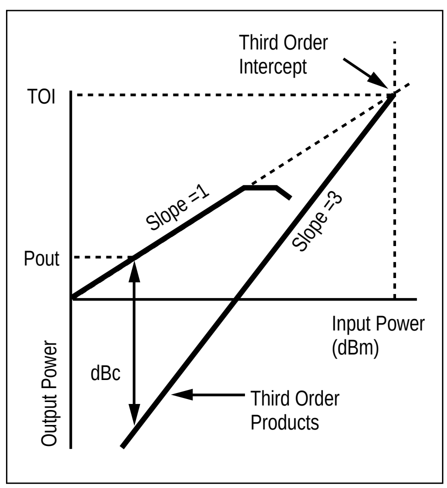
IMD Testing

Intermodulation distortion is a very important parameter for evaluating the non-linear performance of devices. While IMD is usually at a much lower initial amplitude compared to harmonic distortion, it increases much faster (x3 vs x2) as a function of an increasing input signal.

The figure below depicts the typical test method for measuring two tone, third order intermodulation products (IMD). Two signals of equal power, separated by ΔF are injected into the amplifier under test. The intermodulation products at $F_1 - \Delta F$ and $F_2 + \Delta F$ are measured in dBc relative to the output signal levels. IMD measurement results depend on input signal levels.



TOI was developed to describe device performance independent of operating conditions. The TOI of an amplifier is defined as the theoretical operating point where the third-order intermodulation products are equal in amplitude to the two test signals. While this operating point is not achievable, the TOI (in dBm) is a single number which characterizes IMD performance for all operating conditions.

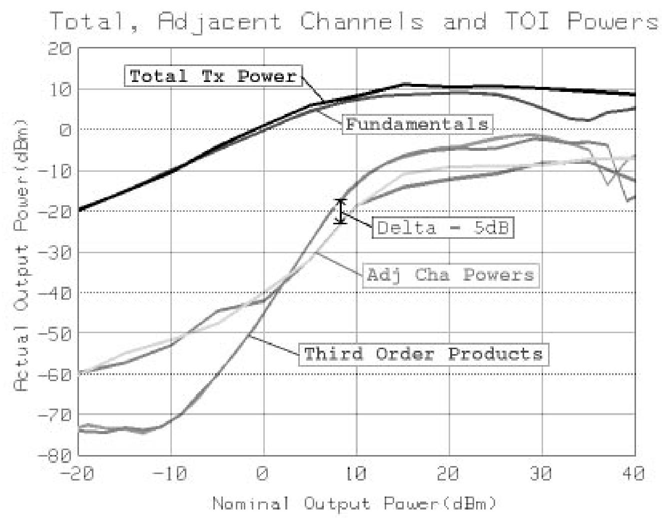


The HP 85672A automatically adjusts the value of the spectrum analyzer input attenuator to ensure that no internal intermodulation products interfere with IMD and TOI measurements.

Adjacent Channel Power Measurements and IMD

Intermodulation distortion measurements are an effective alternative to measuring adjacent channel power[2] (ACP) in channelized communications systems. Results from IMD measurements correlate well with ACP tests because the power measured in adjacent channels is caused by spectral regrowth (i.e., intermodulation products). While ACP measurements clearly indicate spectral regrowth values, they require time to sweep both the adjacent and main channels. Traditional two-tone intermodulation distortion measurements require only a fast narrow bandwidth sweep around the frequency of interest. Single point (i.e., output frequency) intermodulation measurements are virtually always faster than swept adjacent channel power tests.

Correlating ACP and IMD Measurement



Adjacent channel power measured with a PI/4DQPSK signal and IMD for the same device are compared in the graph above. Note the high degree of correlation in the region between an output power of +5 dBm to +35 dBm. Nearly identical curves appear to be offset by approximately 5 dB. This 5 dB offset results from the wedge shaped distribution of spectral regrowth within adjacent channels. Below an output power of +5 dBm, ACP appears much higher. In reality, the ACP of the generator is being measured.

2. Standard on HP 8560 E-series spectrum analyzers

Harmonics and Total Harmonic Distortion (THD)

Up to ten harmonics and the resulting THD are automatically measured and reported with the HP 85672A. The output summary table includes the power in dBc of the requested harmonics, an estimate of total harmonic distortion (THD) based on the harmonics measured, and the fundamental frequency and amplitude in dBm.

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10:30  05/01/96
   HARMONIC MEASUREMENT RESULTS

  FUNDAMENTAL SIGNAL:   500.0 MHz
                         10.2 dBm

  HARMONIC   LEVEL dBc   FREQUENCY
         2      -49.3     1.000 GHz
         3      -29.8     1.500 GHz
         4      -46.5     2.000 GHz
         5      -53.0     2.500 GHz
         6      -60.2     3.000 GHz

TOTAL HARMONIC DISTORTION =     3.3 %
  (OF HARMONICS MEASURED)
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Measuring Harmonics and Total Harmonic Distortion (THD)
All components and systems generate harmonics as a result of their non-linear performance. Generally, harmonics vary directly with the input level, at least until the signal level changes the distortion mechanism. Since harmonics are simple multiples of the fundamental, their locations are easy to predict for a sinusoidal input signal.

In the HP 85672A, THD is defined as:

$\sum [V^2(Fn)]^{(0.5)}/V(F)$ for n=2 to 10 (max)

Discrete Sideband Spurs

Oscillator and synthesizer designers can now measure discrete sidebands in addition to measuring noise sidebands on the HP 8560 E-series spectrum analyzers. The discrete sideband search capability of the HP 85672A complements the HP 85671A Phase Noise Utility to provide a comprehensive set of measurements that characterize signal sources.

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DISCRETE SIDEBAND SEARCH RESULTS
12:38  05/01/96

CARRIER FREQ:     500.0 MHz
CARRIER POWER:      .5 dBm

OFFSET FREQ  - OFFSET   + OFFSET
                  dBc        dBc
-----------  --------   --------

1.001 kHz       -10.0      -10.2
2.002 kHz       -26.2      -26.5
3.003 kHz       -47.2      -49.0
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General Spur Search

The most troublesome spurious responses are often the ones that cannot be predicted. The only way to locate these signals is to set up a search range and look for them--a tedious and time consuming task that begs for automation. The HP 85672A has a general spurious response search routine to meet this need. The search window is specified by inputting the frequency range and the maximum and minimum power levels of the search. The analyzer returns the frequency and power level of each spurious response in absolute units (dBm) or relative to a user-specified reference signal (dBc).

GENERAL SPUR SEARCH RESULTS
12:06 05/01/96

REFERENCE FREQ: 65.00 MHz
REFERENCE POWER: -.3 dBm

MHz	dBc
115	-31
165	-28
180	-30
195	-27
245	-20
295	-14
310	-32
325	-36
345	-46

TOTAL OF 9 SPURS FOUND

Measuring Spurious Responses
The difficulty in measuring spurious responses (spurs) is finding them. To the extent spurs are predictable, that information can be used to direct the search. For example, finding an upper discrete spur on an oscillator is trivial once the lower spur has been found. By definition, general spur searches cannot be directed. Very simply, the search algorithm must direct the analyzer to look everywhere within the search range. Good algorithms find significant spurs quickly while poor algorithms take a long time or miss the spurs completely.

Spur search algorithms trade-off search speed and measurement accuracy. Since the difficult part of measuring spurs is to find them, the search algorithm in the HP 85672A is optimized for speed. Once located, spurious responses can be measured manually with more precision, if necessary. An estimate of the search time is provided to facilitate optimization of the range, resolution, and measurement speed.

Spurious Mixer Products

All mixers give you the upconverted or downconverted signal you want... and a host of unwanted mixing products. Characterizing these unwanted products manually is time consuming. Now, the HP 85672A can simply and quickly quantify all mixing products based on how many mixing products you want to measure (to a maximum of 100). Results are displayed relative to a specified reference signal (dBc). The HP 85672A utility will perform this characterization on up to N=10, M=10 spurious mixer products.

MIXING PRODUCTS

12 49 05/01/96

¦N*LO - M*RF¦

LO: 480.0 MHz -16.0 dBm

RF: 500.0 MHz -13.8 dBm

REFERENCE: ¦LO - RF¦

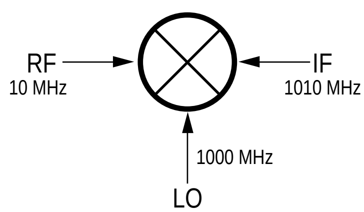
REFERENCE: 20.00 MHz -4.0 dBm

M (*RF) \ N (*LO)	1	2	3	4
1	-1	24	30	50
2	34	35	42	51
3	45	44	34	44
4	57	63	49	51

VALUES IN dB BELOW REFERENCE

Measuring Mixer Products

A typical mixer, acting as an upconverter, is shown below. In this example, the desired IF product is an output signal at 1.01 GHz; however, additional higher order mixing products are also generated. These spurious products are a potential source of interference and need to be characterized relative to the desired mixer product.



Fortunately, the frequencies of mixer products are very predictable. The fundamental and the harmonics of the LO (N) will mix with the fundamental and harmonics of the RF signal (M). Important products are N*LO+M*RF and N*LO-M*RF. Since the frequencies of mixer products are very sensitive to slight variations in the frequency of the input signals, the HP 85672A verifies the fundamental frequencies before performing a search.

Remote Operation of the HP 85672A Spurious Response Measurements Utility

The HP 85672A is easily incorporated into a custom test automation program. A command language, similar to the language used to remotely control spectrum analyzers, provides remote setting of all test parameters and remote transfer of test results to a computer. Compete information on remote operation of the HP 85672A is described in the User's Manual.

Specifications

Specifications shown are based on use with a host HP 8560 E-series spectrum analyzer.

Measurement modes:
TOI / IMD
Harmonics and THD
Discrete sideband spurious
Mixer products
General spur search

Frequency range:
Dependent on host analyzer
Minimum frequency of input signals:
100 kHz
Maximum frequency of input signals:
Specified stop frequency of spectrum analyzer used

TOI / IMD measurement mode:

Both fundamental CW signals must be on-screen before the measurement is executed.

Signal level:	≥–40 dBm
Signal separation:	≥100 Hz

Harmonics and THD measurement mode:

The fundamental CW signal must be on-screen before the measurement is executed.

Signal level:	≥–50 dBm

Discrete sideband spurious measurement mode:

The fundamental CW signal must be on-screen before the measurement is executed.

Signal level:	≥–50 dBm
Measured offset frequency range:	50 Hz to maximum user specified

Mixer products measurement mode:

The fundamental CW signals must be on-screen before the measurement is executed.

Fundamental frequency range:	≥100 kHz
LO signal level:	≥–50 dBm
RF signal level:	≥–60 dBm

General spur search measurement mode:

The reference CW signal must be on-screen before the measurement is executed if measuring relative spurious responses.

Minimum frequency:	100 kHz
Minimum measurement range:	100 kHz
Signal level range:	–130 dBm to +50 dBm
Relative amplitude accuracy (typical):	±0.5 dB

Ordering Information

The HP 85672A Spurious Response Measurements Utility is compatible with HP 8560 E-series spectrum analyzers equipped with a Mass Memory Module (Rev. C firmware, date code 910116 or later). The fastest measurement speed is obtained with HP 8560 E-series spectrum analyzers with firmware equivalent to or newer than the firmware cited below. Firmware upgrade kits are available to improve the measurement speed of the HP 85672A with older HP 8560 E-series spectrum analyzers.

Compatible Spectrum Analyzers

HP 8560A (50 Hz to 2.9 GHz, firmware 890720 and later)
HP 8560E (30 Hz to 2.9 GHz, all revisions of firmware)
HP 8561A (1 kHz to 6.5 GHz, all revisions of firmware)
HP 8561B (50 Hz to 6.5 GHz, firmware 890720 and later)
HP 8561E (30 Hz to 6.5 GHz, all revisions of firmware)
HP 8562A (1 kHz to 22 GHz, firmware 890728 and later)
HP 8562B (1 kHz to 22 GHz, firmware 890728 and later)
HP 8562E (30 Hz to 13.2 GHz, all revisions of firmware)
HP 8563A (9 kHz to 22 GHz, all revisions of firmware)
HP 8563E (30 Hz to 26.5 GHz, all revisions of firmware)
HP 8564E (30 Hz to 40 GHz, all revisions of firmware)
HP 8565E (30 Hz to 50 GHz, all revisions of firmware)

Firmware Retrofit Kits: Improves Measurement Speed of HP 85672A in Older HP 8560 E-series spectrum analyzers

HP Part Number: 08560-60079, Firmware Upgrade Kit. This kit upgrades the firmware on all HP 8560 E-series spectrum analyzers and will substantially improve the speed of the HP 85671/72A utilities. Some HP 8560 E-series analyzers may additionally require hardware changes. See Firmware Note 5963-2937 for more information.

Other Accessories for HP 8560 E-series Spectrum Analyzers

HP 85671A, Phase Noise Utility
HP 85620A, Mass Memory Module (standard on HP 8560 E-series spectrum analyzers)

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