HEWLETT PACKARD

Choosing the right analyzer for baseband and IF applications

Product Note 3589-1

This product note will explain the feature and performance benefits of low-frequency (or "baseband") spectrum and spectrum/network analyzers. These low-frequency analyzers will be compared to their RF and microwave counterparts which cover a much higher frequency range. The specific subject of these comparisons is the HP 3589A spectrum/network analyzer, though the information contained here concerning spectrum analysis generally applies to the HP 3588A spectrum analyzer as well. With this information it should be easier to choose the right analyzer or analyzers for the job at hand.

LF/Baseband Analyzer Benefits—Major Features

Spectrum Plus Vector Network Measurements

One of the best reasons to choose a low-frequency spectrum analyzer has nothing to do with spectrum analysis—it is the availability of network analysis. A variety of factors enable the combining of swept spectrum and network functions in one instrument for the audio through IF frequency ranges. Network analysis functions such as phase, group delay, impedance and return loss are often needed in the same design environments where spectrum measurements are made. This makes the spectrum/network combination analyzer an outstanding value if its cost is modest and if it can handle spectrum and network tasks equally well.

Full-Performance Special Functions

Low-frequency analyzers such as the HP 3589A can make precision power, frequency, noise and modulation measurements. They can replace other dedicated instruments in a system or on the bench, saving the time and trouble required to "back up" or verify an approximate measurement made by lower-performance RF alternatives.

Baseband spectrum/network analyzers offer benefits for both low frequency and RF/Microwave designers.

Frequency Coverage Including Audio

Audio (about 20 Hz to 20 kHz) or audio frequency information (including low-rate data) is at the heart of many RF and microwave systems. An analyzer with sufficient performance, resolution and frequency range is required to examine the integrity of these signals and the circuits that process them. The HP 3589A can handle circuits, signals and systems from below audio through most IFs where signal processing is performed. Indeed, the unprecedented speed, resolution and accuracy of its narrowband analysis can be as easily used at IF as it is at baseband.

Tracking Generator Standard, Built-In

Most low-frequency HP spectrum analyzers, including the HP 3588A and 3589A include a fully synthesized internal tracking generator as standard equipment. This generator is ideal for scalar (magnitude-only) network analysis.

75Ω And 1MΩ Compatibility
Many low-frequency circuits have impedances other than 50Ω. Video and telecomm/datacomm circuits are often 75Ω, while others, such as audio, require the low loading of a high-impedance input. Some circuit impedances are unknown, ill-defined or badly-behaved. Low-frequency analyzers with multi-impedance inputs handle the broadest variety of these applications, even those where impedance in a device is different at one point than another. Analyzers such as the HP 3589A further broaden this flexibility with their compatibility with active and passive oscilloscopes or other probes.

Autoranging Inputs
Optimum performance demands the appropriate level at the analyzer's inputs. This is more easily achieved in low-frequency analyzers with autoranging input attenuators and amplifiers. In an analyzer such as the HP 3589A the autoranging parameters can be set by the user to optimize distortion or noise performance according to the demands of the measurement. These flexible inputs also provide compatibility with a wider range of input levels without the need for external signal conditioning.

Frequency Counter
Identifying one signal among many others is important in applications such as spur searches and modulation analysis. Where multiple signals are present, however, a traditional counter may not work. A narrowband analyzer with a frequency counter can make these measurements in a definitive way, isolating the desired signal and offering the frequency accuracy of a dedicated counter.

Downconversion to Bring Baseband Benefits To RF/Microwave
Many of the low-frequency analyzer benefits described here also apply to RF and microwave applications. Fast, precision narrowband analysis is useful for examining close-in modulation on high-frequency carrier signals. This modulation may be deliberate (an information-modulated carrier) or the result of phase noise or vibration-induced "microphonics." Low-frequency analyzers can measure these signals by analyzing the downconverted output of receivers or RF/microwave analyzer IF outputs. The HP 3589A incorporates several features to make this easy, including frequency and amplitude corrections and a display "mirror" algorithm to compensate for the frequency reversal of analyzer IF outputs.

Trace Math
Some measurement situations require more extensive manipulation of measurement data than the basic "A-B" capability of many analyzers. Complete trace math capability allows the analyzer to compensate for specific measurement factors such as bandwidth, external gain devices or filtering, and to provide the user with trace data in exactly the desired form.

Programmable Synthesized Source
The built-in tracking generator of low-frequency analyzers like the HP 3589A can be used as a precision wide-amplitude fully-synthesized signal generator. Along with the analyzer's spectrum/network combination and special functions mentioned above, this source can reduce the money and space needed for other equipment on a bench or in a system.

LF/Baseband Analyzer Benefits— Performance Benefits

Low Distortion, High Accuracy
Design optimization and the more-ideal behavior of devices and circuits at low frequencies allow low-frequency analyzers to offer a level of performance that is very expensive or unavailable in instruments with higher frequency range. Examples include distortion products lower than -80 to -100 dB and amplitude accuracy/flatness better than 0.2 dB. This level of performance can be vital in ensuring the integrity of the baseband signals that are the heart of many applications.

High Speed With High Resolution
Measuring closely-spaced signals such as power line, noise or vibration sidebands, or low-rate modulation requires narrow resolution bandwidth in an analyzer. With their all-digital IF circuits and narrowband FFT capability, the HP 3588A and 3589A combine unprecedented narrow resolution capability with measurement speeds 4-400 times faster than traditional swept alternatives.

Frequency Accuracy, Stability
An important factor for close-in measurements is the frequency accuracy and stability of the analyzer's local oscillator. Some low-frequency analyzers have fully-synthesized local oscillators, which ensure that every frequency point in the display is as accurate as the analyzer's reference oscillator. Drift and residual FM are negligible, allowing these analyzers to perform close-in analysis of sidebands on even crystal-controlled sources. Where the

frequency of the signal to be analyzed is known precisely, a fully synthesized analyzer can be set to this frequency directly, without the need for manual tuning.

Faster, Higher Resolution Burst Measurements
Measuring burst or time-varying signals in many applications requires the use of time-gated spectrum analysis. The HP 3589A's fully-synthesized LO can be configured to sweep only when the input signal is valid, providing faster measurements than those in RF and microwave analyzers. Combining this "sweep gating" mode with high-resolution digital filters, the HP 3589A optimizes resolution and speed in these demanding signal measurements.

Price and Value
Some basic performance RF analyzers are available at a low price. However, the price of high-performance RF analyzers is generally 1.5 to 2.5 times higher than baseband analyzers of comparable performance and features. Thus, where all or part of an application fits the frequency range of a baseband analyzer and can benefit from its performance or features, the addition of a baseband analyzer can be a wise choice. The most important feature and performance benefits of baseband analyzers are described on the next page.

Glossary of Analyzer Types and Terms

Over time, different types of spectrum and network analyzers have been developed to meet different needs. In a similar way, some specific terms dealing with these analyzers and their applications have come into general use.

Baseband—The information-carrying part of a signal. This is the voice, data, video or other essential information that for which communication and signal processing systems are created. Baseband information may be used to modulate RF or microwave carriers as a way to transmit the information.

IF(Intermediate Frequency)—A frequency above baseband and below RF, where signal processing is performed.

RF(Radio Frequency)—The frequency range above HF (several tens of MHz) and below microwave (several GHz). Most radio transmission or carrier frequencies are RF.

Low-Frequency Spectrum Analyzer—A spectrum analyzer covering the frequency range from audio (approximately 20 Hz) through HF (high frequency, several tens of MHz). These analyzers have performance comparable to, or better than, the high-performance analyzers mentioned below. Their performance is the result of the more-ideal behavior of circuits at low frequencies and design optimization for the demands of measuring baseband signals.

Basic Performance Spectrum Analyzer—An RF or microwave spectrum analyzer designed for modest price and performance. These analyzers are often portable or ruggedized. They are used to determine the composition of a signal, but not to determine precision frequency or amplitude. They are also not optimized for measuring low levels of distortion, noise or phase noise.

High-Performance Spectrum Analyzer—An RF or microwave spectrum analyzer designed for highest performance in areas such as dynamic range, distortion and frequency accuracy/stability. The local oscillators (LOs) of these analyzers are partially synthesized (start or center frequencies only) for better frequency accuracy and lower phase noise.

Dynamic Signal Analyzer or FFT Spectrum Analyzer—A spectrum or spectrum/network analyzer using analog-to-digital conversion followed by a fast-Fourier-transform (FFT) algorithm for signal processing. These analyzers offer excellent speed and performance for complex or dynamic signals, usually below 100 kHz.

LF/Baseband Applications

The benefits of low-frequency spectrum/network analyzers extend to many applications, from audio through IF. Here are just a few examples:

Video & VCRs
The network/spectrum combination, high performance, frequency range and time-gated spectrum analysis capability of a baseband analyzer like the HP 3589A match the needs of video applications from media test to video amplifier design.

Communications Receiver Design & Test
Communications systems deal with signals and circuits from audio through RF. Except where the RF carrier is above 150 MHz, the HP 3589A can make virtually every frequency domain spectrum and network measurement required.

Magnetic & Optical Disks
Similar to video and VCRs, these data storage applications require high performance narrowband measurements of dynamic signals. Network measurements are also required, to characterize the read/write chain and associated electronics. The full 2-port S-parameter and impedance measurements available with the HP 3589A cover these needs well.

Computers & Peripherals
Low-frequency coverage and narrow resolution bandwidths enable the HP 3589A to measure radiated and conducted EMI and power supply purity. The video-frequency amplifiers and filters, along with the filters used to control EMI found in many peripherals will benefit from a spectrum/network combination.

Sonar, Medical & Industrial Ultrasound, MRI
These applications often involve narrowband burst signals, along with the sources, amplifiers and filters necessary to produce them. High performance spectrum, network and impedance measurements are all vital to successful designs.

Narrowband RF & Microwave
As noted above, many low-frequency phenomena must be investigated after they have been translated to microwave frequencies. This task is easier with the special features available for downconversion in the HP 3589A. See the document in this series entitled *High Resolution, High Speed Measurements at RF and Microwave Frequencies Using the HP 3589A Spectrum/Network Analyzer*.

Conclusion

In many applications low-frequency spectrum and spectrum/network analyzers offer important benefits and excellent overall value. For applications involving higher frequencies they are a valuable complement to dedicated RF and microwave analyzers.

United States:
Hewlett-Packard Company
Test and Measurement Organization
5301 Stevens Creek Blvd.
Bldg. 51L-SC
Santa Clara, CA 95052-8059
1 800 452 4844

Canada:
Hewlett-Packard Canada Ltd.
5150 Spectrum Way
Mississauga, Ontario 5G1
(905) 206 4725

Europe:
Hewlett-Packard
European Marketing Centre
P.O. Box 999
1180 AZ Amstelveen
The Netherlands

Japan:
Yokogawa-Hewlett-Packard Ltd.
Measurement Assistance Center
9-1, Takakura-Cho, Hachioji-Shi,
Tokyo 192, Japan
(81) 426 48 0722

Latin America:
Hewlett-Packard
Latin American Region Headquarters
5200 Blue Lagoon Drive
9th Floor
Miami, Florida 33126
U.S.A.
(305) 267 4245/4220

Australia/New Zealand:
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130
Australia
Melbourne Caller 272 2555
(008) 13 1347

Asia Pacific:
Hewlett-Packard Asia Pacific Ltd.
17-21/F Shell Tower, Time Square,
1 Matherson Street, Causeway Bay,
Hong Kong
(852) 599 7070

Printed in U.S.A. 11/94
5091-2318E