HEWLETT PACKARD

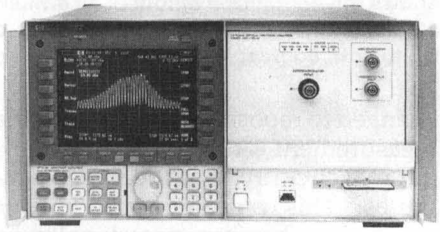
BENCH BRIEFS

SERVICE INFORMATION FROM HEWLETT-PACKARD

1st Quarter 1994

The Optical Spectrum Analyzer - Part 3 Sensitivity

Mike Levernier/Hewlett-Packard



Introduction

In the previous issue of *Bench Briefs* Richard Ogg explained the optical spectrum analyzer in terms of signal processing, various operating modes, noise generation, and the control of noise through filtering schemes. In this issue, Mike Levernier describes OSA sensitivity through Hewlett-Packard's patented way of allowing the user to directly enter the required sensitivity level — what HP calls a "sensitivity function." For more detailed information on optical spectrum analysis basics, order Application Note 1550-4, *Optical Spectrum Analysis*, HP Pub. No. 5091-3054E from your local HP sales/service office.

Sensitivity – Directly Settable by the User

Sensitivity is defined as the minimum detectable signal or, more specifically, six times the rms noise level of the instrument. Sensitivity is not specified as the average noise level, as it is for RF and microwave spectrum analyzers, because the average noise level of optical spectrum analyzers is 0 watts (or minues infinity dBm). (For more information on the differences between electrical and optical spectrum analyzers, see the previous issue of *Bench Briefs*.) Figure 1 shows the display of a signal that has an amplitude equal to the sensitivity setting of the optical spectrum analyzer.

Single monochromators typically have sensitivity about 10 to 15 dB better than that of double monochromators due to the additional loss of the second diffraction grating in double monochromators. The double-pass monochromator has the same high sensitivity of single monochromators even though the light strikes the diffraction grating twice. The high sensitivity is made possible by the half-wave plate and the use of a smaller photodetector that has a lower noise equivalent power (NEP).

Sensitivity can be set directly on Hewlett-Packard optical spectrum analyzers, which then automatically adjust to optimize the sweep time, while maintaining the desired sensitivity. Sensitivity is coupled directly to video bandwidth, as shown in Figure 2. As the sensitivity level is lowered, the video bandwidth is decreased (or the transimpedance amplifier gain is increased), which results in a longer sweep time, since the sweep time is inversely proportional to the video bandwidth. The sweep time can be optimized because the video bandwidth is continuously variable and just enough video filtering can be performed. This avoids the problem of small increases in sensitivity causing large increases in sweep time, which can occur when only a few video bandwidths are available in fairly large steps.

Tuning Speed

Sweep-Time Limits

For fast sweeps, sweep time is limited by the maximum tuning rate of the monochromator. The direct-drive-

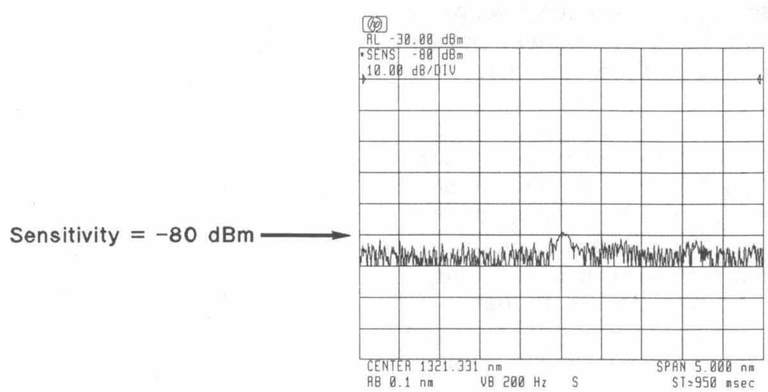


Figure 1. Display of signal with amplitude equal to sensitivity level.

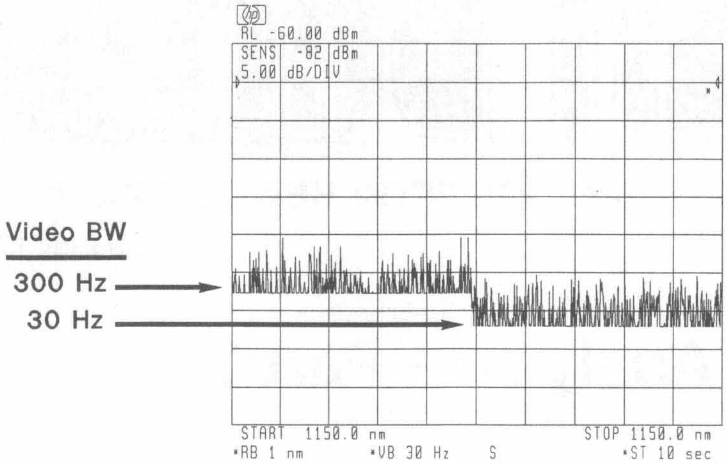


Figure 2. Video bandwidth directly affects sensitivity.

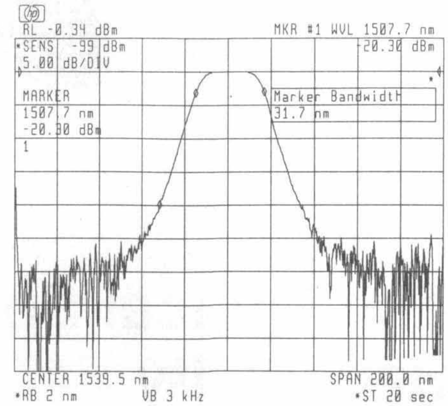


Figure 3. Improved sweep times, even for high sensitivity measurements that traditionally result in slow sweeps. This plot shows the normalized output of an erbium amplifier filter that was stimulated by a white-light source.

motor system allows faster sweep rates when compared with optical spectrum analyzers that use gear-reduction systems to rotate the diffraction grating.

For high-sensitivity sweeps that tend to be slower, the small photodetector and continuously variable digital video bandwidths allow faster sweep times. The small photodetector reduces the sweep time because it has a lower NEP than the large photodetectors used in other optical spectrum analyzers. Lower NEP means that for a given sensitivity level, a wider video bandwidth can be used, which results in a faster sweep. (Sweep time is inversely proportional to the video bandwidth for a given span and resolution bandwidth.)

The continuously variable digital video bandwidths improve the sweep time for high-sensitivity sweeps in two ways. First, the implementation of digital video filtering is faster than the response time required by narrow analog filters during autoranging. Second, since the video bandwidth can be selected with great resolution, just enough video filtering can be used, resulting in no unnecessary sweep-time penalty due to using a narrower video bandwidth than is required. Figure 3 shows a 20 second filter-response measurement. This filter, for an erbium amplifier, was stimulated by a white-light source and the figure shows the normalized response. The purpose of this filter is to attenuate light at the pump wavelength, while passing the amplified laser output of 1550 nm. Due to the low power level of white-light sources, this measurement requires great sensitivity, which traditionally has resulted in long sweep times.

Autoranging Mode

Autoranging mode is activated automatically for sweeps with amplitude ranges greater than about 50 dB. The amplitude range is determined by the top of the screen and the sensitivity level set by the user. With the autoranging mode activated, when the signal amplitude crosses a threshold level, the sweep pauses, the transimpedance amplifier's gain is changed to reposition the signal in the measurement range of the analyzer's internal circuitry, and the sweep continues. This repositioning explains the pause that can occasionally be seen in a sweep with a wide measurement range.

Chopper Mode

The main purpose of the chopper mode is to provide stable sensitivity levels for long sweep times, which could otherwise be affected by drift of the electronic circuitry. The desired stability is achieved by automatically chopping the light to stabilize electronic drift in sweeps of 40 seconds or greater. The effect is to sample the noise and stray light before each trace point and subtract them from the

(See "Optical Spectrum Analyzer," page 8)

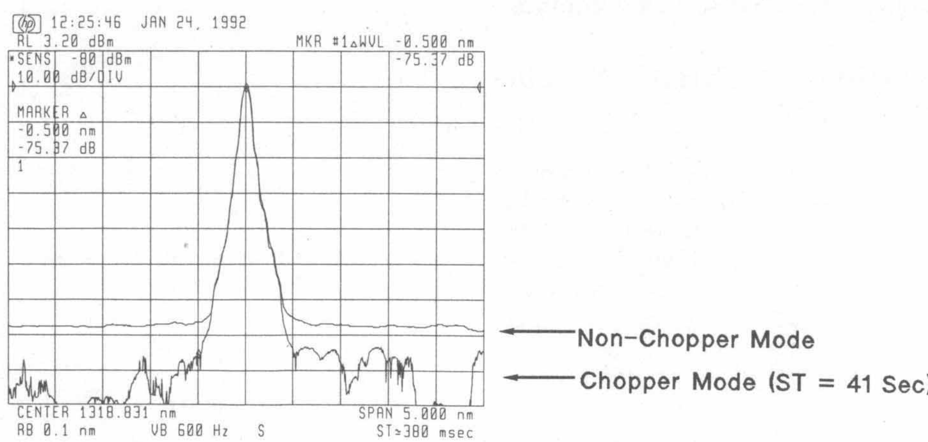
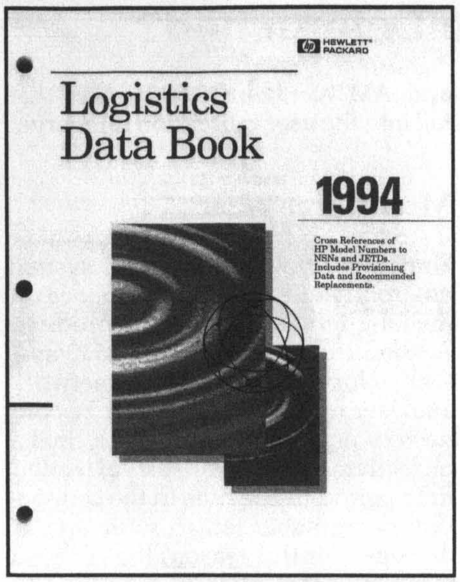


Figure 4. Dynamic range improvement from chopper mode.



1994 Logistics Data Book

John Cloutier/Hewlett-Packard

If your work requires U.S. Government National Stock Numbers (NSNs) for HP products and their components, HP's annual Logistic Data Book and its companion microfiche are must-have resources.

The data book cross references HP product numbers to National Stock Numbers (NSNs) and Joint Electronic Type Designators (JETDs), lists contract numbers for provisioned products, and recommends replacements for discontinued products. The companion microfiche lists NSNs for product components and can be requested with postage-paid cards included in the data books.

To obtain a free copy of the 1994 Logistics Data Book, contact your nearest HP office, or:

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P.O. Box 58059
Santa Clara, CA 95052-8059 □

Safety-Related Service Notes

Service Notes from Hewlett-Packard relating to personal safety and possible equipment damage are of vital importance to our customers. To make you more aware of these important notes, they are printed on paper with a red border, and the service note number as an "-S" suffix. In order to make you immediately aware of any potential safety problems, we are highlighting safety-related service notes here with a brief description of each problem. Also, in order to draw your attention to safety-related service notes in the service note index, each safety-related service note is highlighted with a contrasting color.

HP E1401A VXI C-Size High-Power Mainframe
Serial Numbers Affected
3227A00165 / 3227A00207

Build-up of surface contamination inside the E1401A power supply plus a jumper wire with damaged insulation may cause a shock hazard to exist on an externally-accessible pin on the rear panel of the E1401A.

Check your unit as follows: Connect a voltmeter between chassis ground and pin #23 on the Sub-D connector on the rear of the E1401A Mainframe. If a hazardous AC Voltage is present (greater than 30 VAC RMS, or 42 VAC peak), your unit is hazardous.

A new power supply must be installed. Order Safety Service Note E1401A-02-S (document ID number 5758 on the HP FIRST system) for more information.

E3910A/B PT500 Protocol Tester
Serial Numbers Affected
08-0000 / CA33350292

E3939A/B PT500 Protocol Tester
Serial Numbers Affected
CA32220000 / CA33300023

E4093A/B PT500 Protocol Tester
Serial Numbers Affected
02-0000 / CA33320025

E4095A/B PT500 Protocol Tester
Serial Numbers Affected
03-0000 / CA33330209

E4100B PT500 Protocol Tester
Serial Numbers Affected
CA33130001 / CA33150006

IDAC-M-XPE PT500 Protocol Tester
Serial Numbers Affected
CA32090001 / CA33010010

IDAC-MPT PT500 Protocol Tester
Serial Numbers Affected
01-0000 / 01-9999

High voltage applied to the connector module plane or connector module handle could cause the existing ground path to open, resulting in a possible shock hazard to the user.

Affected units must be retrofitted with grounding wires to rectify the problem. Contact your local HP sales/service office and your unit will be repaired free of charge.

For more information, order the following Product Safety Service Notes using the HP FIRST FAX system.

Product Safety Service Note	HP FIRST Doc. ID No.
E3910A/B-02-S	5961
E3939A/B-02-S	5962
E4093A/B-02-S	5063
E4095A/B-02-S	5064
E4100B-02-S	5065
IDAC-M-XPE-02-S	5066
IDAC-MPT-02-S	5067

□

How is the Recommended Calibration Cycle Determined?

Jim Stead/Hewlett-Packard

Introduction

For T&M products, HP usually indicates in the manual a recommended calibration cycle. For many microwave instruments this is typically a one-year recommendation. With calibration costs rapidly increasing, longer calibration cycles are required to maintain a reasonable cost of ownership. Following is an explanation of some of the steps involved in determining how an extended cycle can be justified.

Past Experiences

Most companies maintain a database on past calibrations and can easily determine what percentage of instruments required adjustments. This data is then used to appropriately change the calibration cycle. HP maintains such a database for instruments used in our microwave instrument production facility. As an example, when the HP 8360 was introduced we looked at the data for a similar product, the HP 8340A. The data indicated that under normal operating conditions the recommended one-year calibration cycle for the HP 8340A was conservative (i.e., 90% did not require any adjustments).

New Circuit Designs

Design improvements are also used to justify extended calibration cycles. Reduced parts count and fewer hardware adjustments mean there is less chance for drift or aging to have an effect on the calibration. In addition, newer circuit designs may provide better stability. When compared to the HP 8340A, the HP 8360 series has about one-third fewer components and about 25% of the HP 8340A hardware adjustments. Long-term ALC stability was also improved through the use of a Planar-Doped-Barrier (PDB) diode as the leveling detector.

User vs. Self Adjustments

Periodic adjustments are sometimes required for optimum performance. To maintain an extended calibration cycle, it is important that these adjustments are either done automatically by the instrument, or set up as user adjustments. Both the HP 8340A/B and HP 8360 series use auto tracking to maintain maximum RF output power. In addition, the HP 8360 series has both frequency span calibration and AM bandwidth calibration that fall into the user calibration category.

Mechanical Wear

Sometimes the instrument or system environment has a large influence on the long-term stability of the product. A good example is the HP 8510 system. Normal usage of a network analyzer requires that devices be connected and disconnected to make measurements. Over an extended time period this results in the connectors being subjected to wear and/or damage. For this reason, the HP 8510 recommended calibration cycle is limited to one year and will probably never be extended.

Conclusions

The recommended calibration cycle is just that; a recommendation. Operating environment and the user's application are variables that cannot be included in the manufacturer's recommendation. The published cycle should be used by the customer to help determine an initial calibration cycle. Then an ongoing data collection process should be initiated to determine the best calibration cycle for the customer's application. □

1994 Bench Briefs' Instrument Service Note Index

HP FIRST (208)344-4809
T & M Section - Press 4
Password Section - Press 3
Password - 76683

SN Type	SN No.	Abstract	HP FIRST Document ID No.
MA	3324A-03	New firmware must be installed with new A6 Signal Source Board	5708
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Service Note Types

IO	Information Only	MA	Modification Available
MR	Modification Recommended	SA	Safety
PS	Priority Safety	SM	Interoffice Service Memo (IOSM)

("Optical Spectrum Analyzer," continued from page 2)

trace point reading. In all modes of operation, Hewlett-Packard optical spectrum analyzers zero the detector circuitry before each sweep.

Improved dynamic range is another benefit of sampling the stray light before each trace point. For measurements requiring the greatest dynamic range possible, some improvement can be obtained with the use of the chopper mode. While this mode does improve dynamic range, it is *not* required for the analyzers to meet their dynamic range specifications.

Figure 4 shows the improved dynamic range obtained by activating the chopper mode.

This concludes the series on optical spectrum analyzers. *Bench Briefs* wants to thank Richard Ogg, Carla McCarter, and Mike Levernier of the Hewlett-Packard Microwave Technology Division/Lightwave Operation for their contributions to this series. □

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