Agilent AN 355-1

Tools for Digital Microwave Radio Installation and Maintenance

Application Note

A description of the wide range of test solutions available from Agilent for Digital Radio Test

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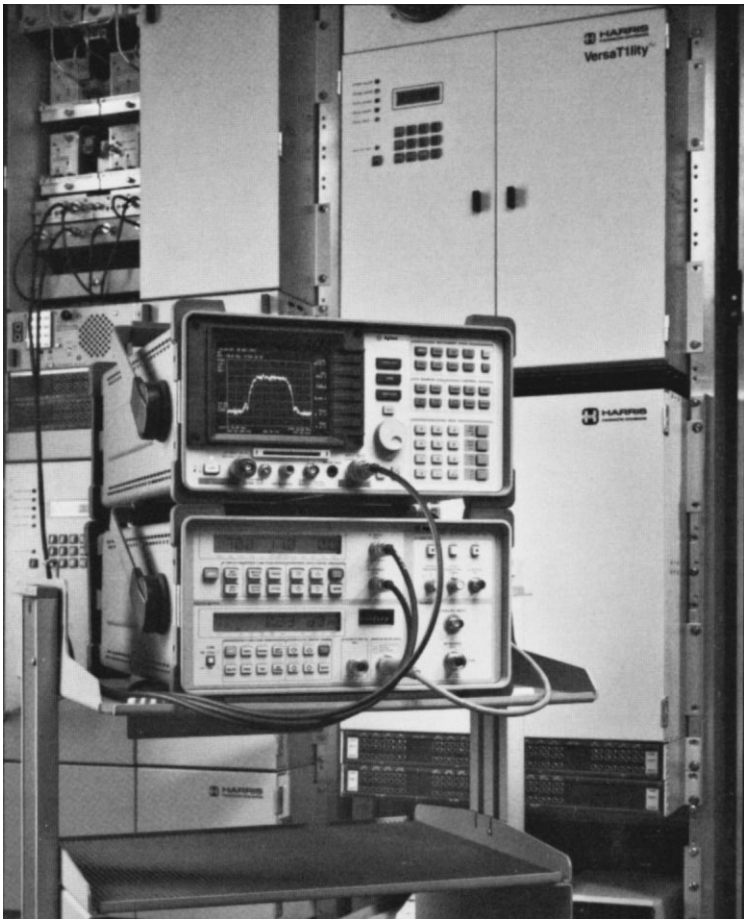
Agilent Technologies
Innovating the HP Way

Agilent Technologies is dedicated to providing the best solutions for your test needs during Digital Microwave Radio installation and maintenance. Agilent has a wide range of measurement options so that you can choose the right tools for your job. We design into each instrument the performance you need while still providing a familiar, easy-to-use, and reliable test solution.

At Agilent, we have worked with Digital Radio professionals for many years, so we understand the unique problems involved in testing radios "in the field." We track the latest technical standards that affect the way you must do your job and design our measurement solutions to have all the capabilities and features you need to do your job quickly and efficiently.

Our objective is to improve your efficiency so that you can quickly get your radios working and keep them working at peak performance. Agilent test equipment provides the best value for your money and allows you to maximize long-term profit obtainable from your radio network.

Agilent Product **Test**	**37721A**	**3708A**	**11757B**	**11758V**	**5347A/48A**	**8593E**	**8970B**	**437B**	**Page**
Bit Error Rate Ratio	●								10
C/N vs. BER		●							9
Multipath Testing			●	●					6
Spectral Occupancy				●		●			3
Power				●	●			●	7
Frequency				●	●				7
Group Delay				●		●			5
Flatness/Scalar Analysis				●		●			4
Return Loss				●					7
Intermodulation				●					7
Noise Figure						●	●		4



Spectrum Analyzers

Portable Spectrum Analyzers Agilent 8590E Series

Spectrum analysis is one of the most important measurement needs in digital radio testing. A few of the many uses of a spectrum analyzer include:

- Spectral occupancy testing
- Checking for interference
- Identification of major system failures and misalignment

Agilent has a wide range of portable spectrum analyzers which will meet your performance requirements. Our analyzers set the standard for usability and are designed to be rugged and portable. The 8590E Series Portable Spectrum Analyzers are especially well suited to microwave radio testing.

What really sets the 8590E Series apart is the ability to help you do your job by providing a complete measurement solution for your Digital Radio test needs. In addition to many important built-in measurement functions, "Measurement Personalities" are available that transform the analyzer into an ***application-specific measurement tool.***

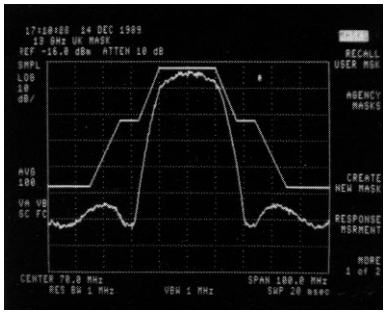
These measurement personalities automate and simplify complex measurement tasks so that you can quickly attain accurate and clear measurement results.

Here are a few examples of the measurement personalities available for the Agilent 8590E Series Portable Spectrum Analyzers.

Digital Radio Measurements
The Agilent 85713A Digital Radio Measurements Personality adds mask comparison with mean power level, frequency response, and transient analysis capabilities.

The "compare to mask" function measures the mean power level and compares the radio's spectrum to the spectral occupancy mask.

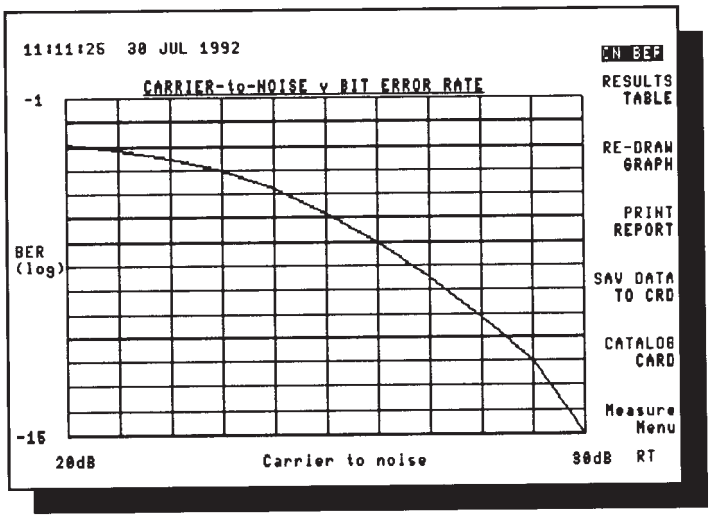
C/N versus BER Measurements Personality
This personality uses the spectrum analyzer as an instrument controller and display. It allows the spectrum analyzer to control an Agilent 3708A Noise and Interference Test Set and bit error ratio (BER) tester to automatically measure the Carrier-to-Noise (C/N) vs. BER response of your radio. ***The synergy among the various Agilent products increases your productivity.***

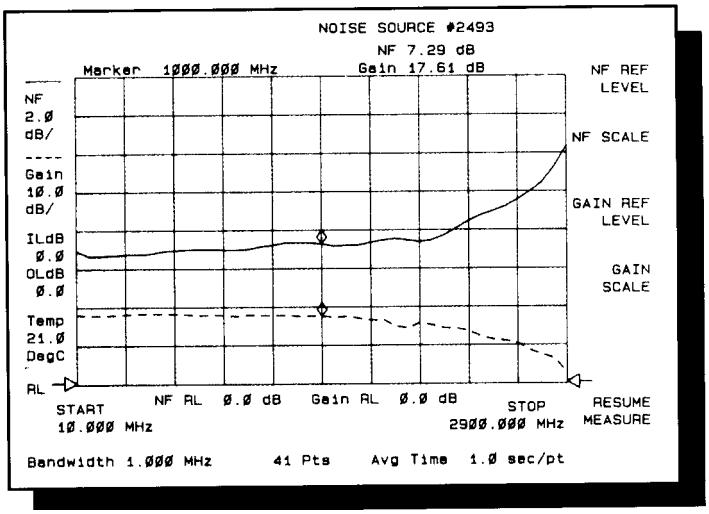


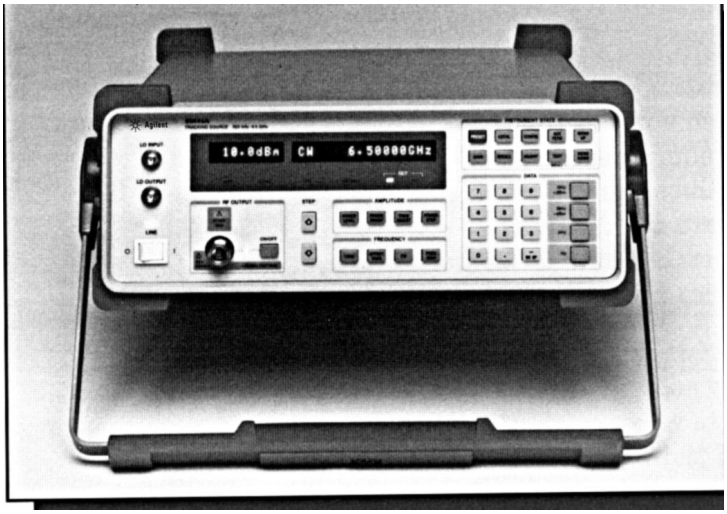
Noise Figure and Gain Measurements
The Agilent 85719A Noise Figure Measurements Personality offers a unique, dedicated solution for swept noise-figure and gain measurements up to 2.9 GHz. You can simultaneously display noise figure and gain on the screen; and by positioning the markers at any frequency point on the trace, you can read specific gain/noise figure values.

Scalar Analysis Measurements
For transmission and reflection measurements, such as antenna return loss, you can configure an Agilent 85714A Scalar Measurements Personality, 85630A Scalar Transmission/Reflection Test Set, and 8590E Series Spectrum Analyzer with built-in tracking generator to perform scalar measurements up to 2.9 GHz.

The system allows high dynamic range measurements and limit lines for fast and accurate pass/fail testing. For your scalar measurement needs up to 6.5 and 26.5 GHz, Agilent offers the 85644A and 85645A Tracking Sources.



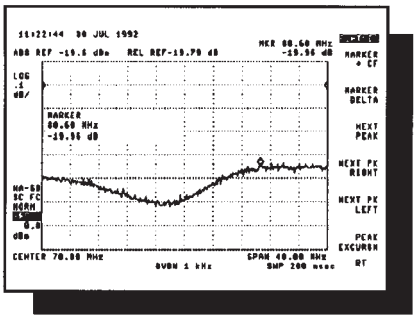




Link Analysis

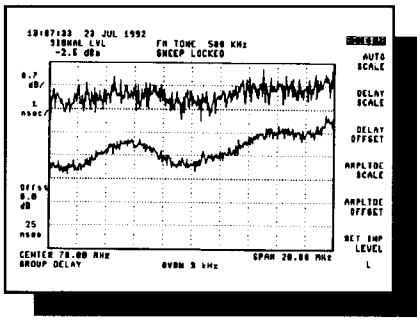
Agilent 11770A Link Measurements Personality

The 11770A Link Measurements Personality adds end-to-end group delay and amplitude flatness measuring capability to an Agilent 8593/4/5/6E Spectrum Analyzer configured with a tracking generator and group delay card. This gives you important link analysis capability with a minimum of test equipment. The portability advantage is obvious. In one instrument you have multi-instrument capability. This integration gives you substantial cost savings compared to the traditional approach of rack and stack instruments.

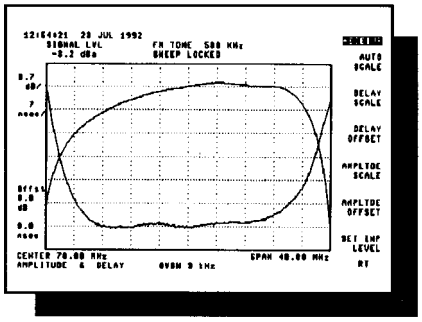


Measure IF Return Loss using the Agilent 11769A Return Loss Bridge.

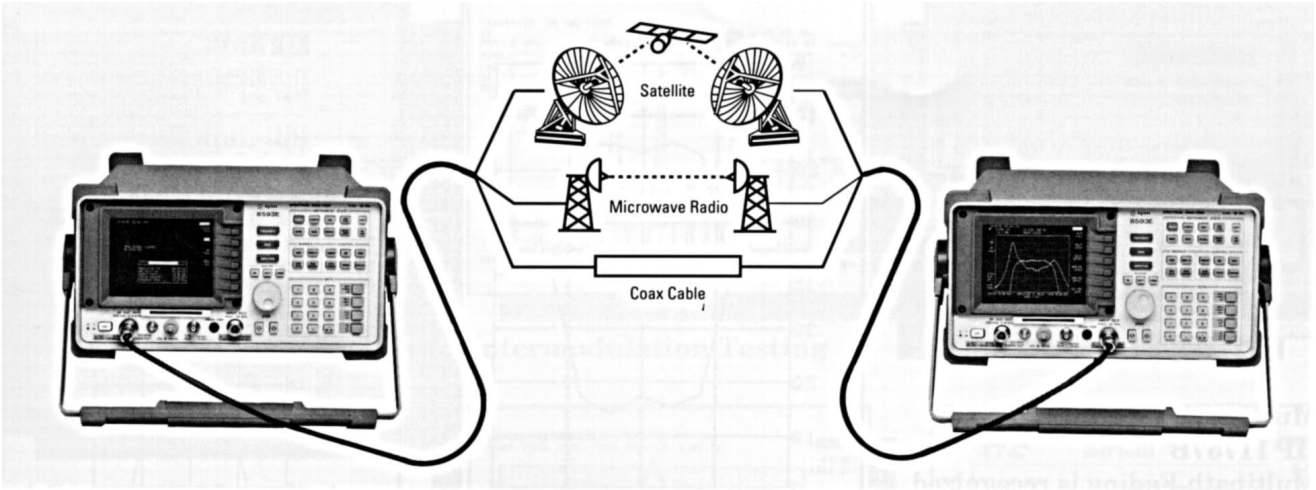
The spectrum analyzer's tracking generator provides the group delay test signal output and has a frequency range from 300 kHz to 2.9 GHz. This frequency range more than covers the common intermediate frequencies (IF's) of 70 and 140 MHz used in microwave radio and satellite systems. Using the 8593E receiver, you have a maximum input frequency of 22 GHz (standard), and with high frequency extension Options 026 and 027, the maximum frequency is 26.5 GHz. Therefore, using two spectrum analyzers, you can perform IF to RF (up converter) measurements of group delay and amplitude flatness, in a choice of frequency ranges depending on the Agilent spectrum analyzers used, up to a maximum of 26.5 GHz.



Measure the delay difference between two diversity antennas using the Agilent 11770A Link Measurement Personality and 11766A DADE Switch.



Measure End-to-End or Loop-back group delay and amplitude flatness to adjust link equalizers and verify proper system alignment.



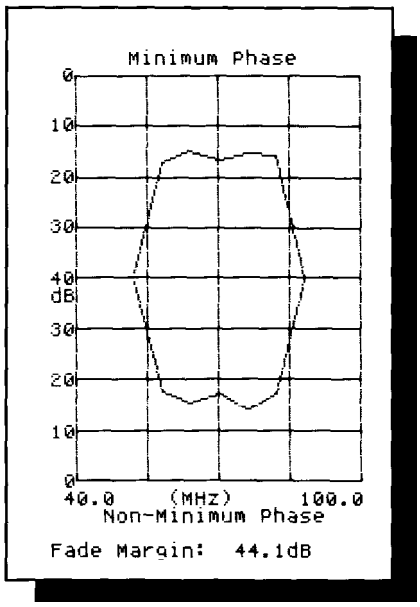
Multipath Signature Analysis

Multipath Fading Analysis with the Agilent 11757B

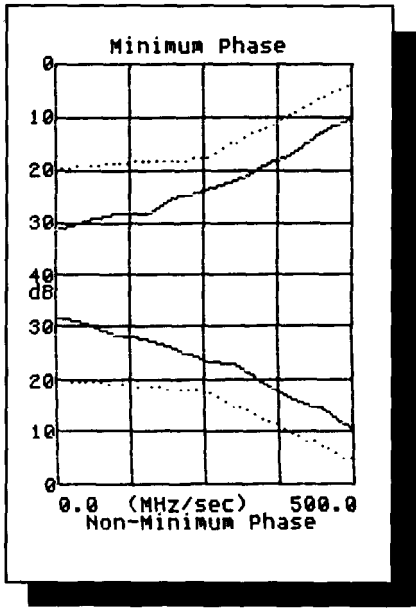
Multipath Fading is recognized as one of the leading causes of link outages. As digital radios continue to operate at higher data rates and with more complex modulation, the need for multipath fade testing during installation and routine maintenance increases. The 11757B Multipath Fading Simulator/Signature Test Set simplifies the task of making these multipath tests in the field.

The 11757B automatically makes a range of common multipath measurements by stressing the radio's equalizers with controlled amounts of multipath fading. Measurements can be printed out for comparison to specified performance documentation during radio line up or for comparison between different radios. The possible measurements include:

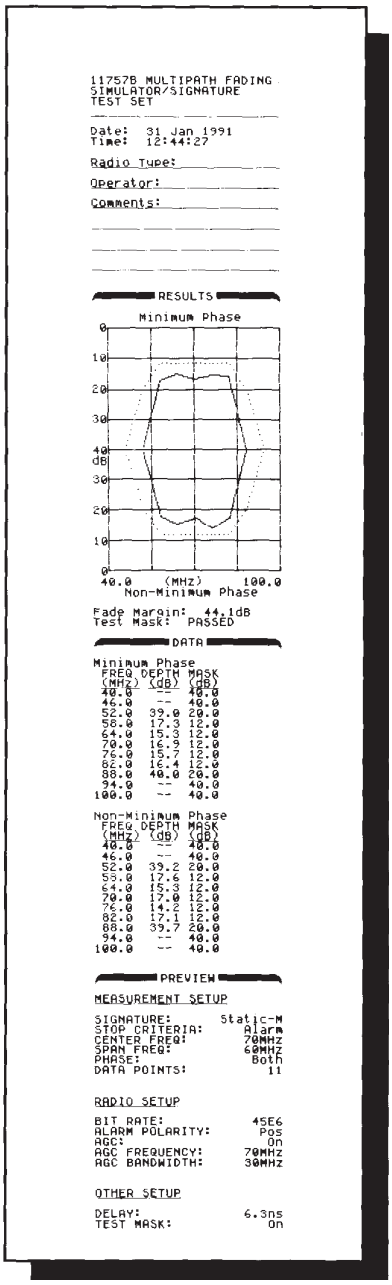
- Static Signature (M-Curve)
- Dynamic S-Curve
- Dynamic M-Curve
- Hysteresis M-Curve
- Recovery Time
- Dispersive Fade Margin



Traditional manual signature techniques and even computer-automated methods can take as long as 30 minutes. With the Agilent 11757B, measurements are fast and simple. A hardcopy result can be in your hands in under a minute.



The S-Curve clearly shows the relationship between the notch sweep speed and the equalizer performance for a notch sweeping across the channel band.



Save time by using the 11757B's pass/fail masks to compare measured results with the manufacturer's specifications.

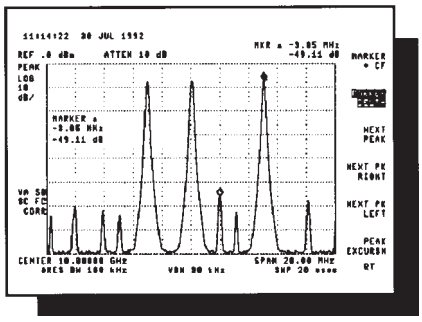
It's easy to log data and see radio degradation over time because the built-in printer provides hard copy results of both the signature plot and tabular data. All of the important measurement parameters and a time/date stamp are printed out.

Digital Radio Test System

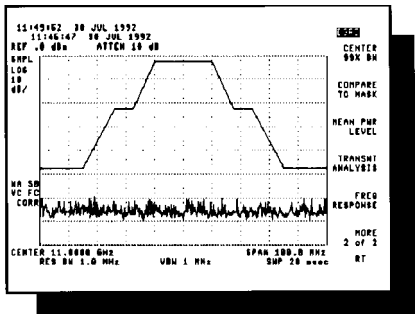
- **A Complete and Integrated Solution for Installation and Maintenance Measurements**
- **Portable and Rugged Construction**
- **Easy to Use**
- **New Options—Group Delay and Amplitude Flatness; delete Multipath Fading Simulator**

Agilent has designed the 11758V Digital Radio Test System to meet your unique needs when testing digital microwave radios in the field. It is easy to transport, set up, and use. It is designed to perform all of your most important measurements during installation and maintenance. Its capabilities include:

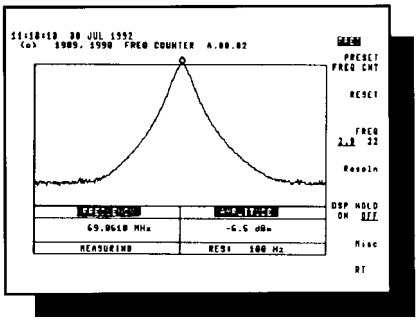
- Spectral Analysis at IF and RF
- Group Delay and Amplitude Flatness
- IF and RF Power Measurement
- IF and RF Frequency Measurement
- IF and RF swept signals
- Scalar Analysis
- IF and RF Return Loss
- Diversity Antenna Delay Equalization
- Upconverter Flatness Measurement
- Intermodulation Distortion Measurement
- Multipath Fading Analysis
- CIN Measurement Control and Display



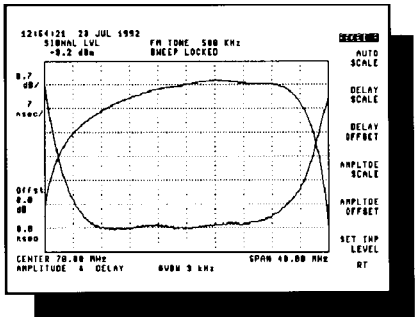
Intermodulation Testing



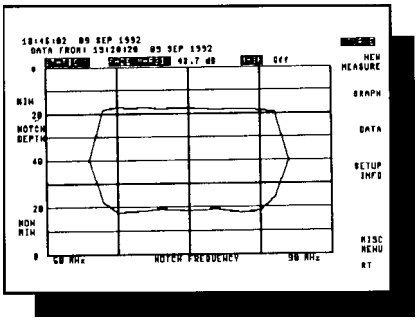
Group Delay and Amplitude Flatness



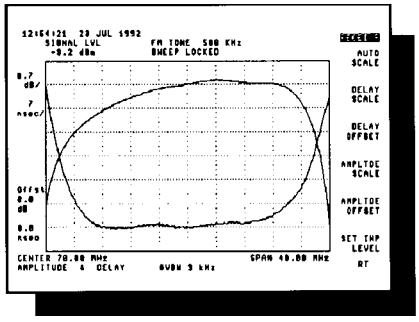
Spectral Occupancy



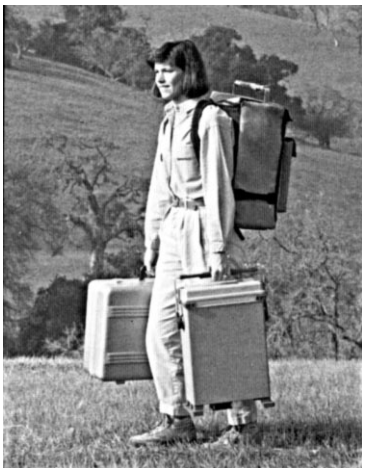
Multipath Signature



Frequency



Return Loss



In the microwave radio installation and maintenance market, the portability of test equipment is an essential requirement. Base and repeater stations can be in remote locations and are usually at the highest point in the area. This is where the 11758V is in its element weighing only approximately 38 kg (84 lbs). You will spend less time and effort in transporting test equipment, so improving the efficiency of your radio link maintenance.

Agilent 11758V Options H60 and H61

The 11758V Options H60 and H61 offers a new maintenance test solution for low and medium capacity microwave radio systems.

Basic radio measurements at an affordable price

Options H60 and H61 provide POWER, FREQUENCY, and SPECTRAL OCCUPANCY. Plus, with Option H61, add the GROUP DELAY and AMPLITUDE FLATNESS measurement capability and the CIN versus BER measurement program, already mentioned in this application note.

A rugged, portable package

Microwave radio stations are commonly located in remote and inaccessible locations, which can make the transportation of test equipment a real problem. However, using this test system, radio maintenance engineers will appreciate the combination of its measurement capability and portability. Option H61 weighs approximately 23 kg (50 lbs) including the carrying case and accessories which, for user convenience, are stored in pouches within the case.

A future proof measurement system

Options H60 and H61 are upgradable. As your microwave radio network expands and gets more advanced, using higher bit rate communications with complex modulation schemes, you have the ability to upgrade to a full 11758V system.

Power and Frequency

In most microwave radio systems, non-intrusive monitor points are available for the measurement of RF output power and transmit and receive Local Oscillator (LO) frequencies. Therefore, the measurements of transmitter power along with LO frequencies and power are logged on a routine maintenance basis. For power measurements, Options H60 and H61 provide an Agilent 437B Power Meter, 8481A Power Sensor, and a calibrated 20 dB attenuator. This combination allows accurate power measurements to be performed within the range –30 to +40 dBm.

Spectral Occupancy

The spectral occupancy test is a measure of how well unwanted sidebands and spurious signals have been suppressed by successive filters in the transmitter. Digital microwave radios operate with well-defined and controlled spectral occupancy, therefore it is routine practice to measure the occupancy of the radio against predefined limits or masks. Options H60 and H61 make this measurement automatically and quickly.

Carrier-to-Noise (C/N) Testing

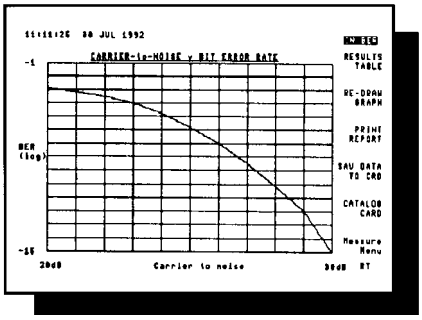
Agilent 3708A Noise and Interference Test Set

- Generate C/N vs. BER curves
- Accurate and repeatable
- Accuracy independent of varying carrier level in field applications
- Easy to automate

The 3708A Noise and Interference Test Set is used with a BERT to make one of the most common and important measurements on a digital microwave radio: **the C/N curve.**

This measurement is made at virtually every stage of a radio's development, production and use. The 3708A helps make the measurement quickly and easily during initial alignment. Later measurements can be made to identify faults or gradual degradation in performance. Measurements can be automated using either an Agilent 8590E series spectrum analyzer or a computer.

For radios where access to the IF is possible, simulation of the microwave path fading with the 3708A is more accurate and requires less time than the conventional method of adding attenuators in the waveguide path. The carrier tracking facility guarantees accurate results even under varying received signal level conditions often experienced during field operations.



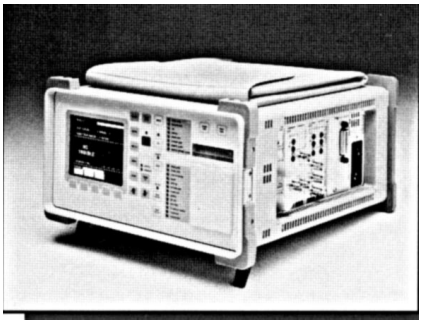
C/N vs. BER Curves show a radio's sensitivity to flat fading and points out possible problems.

The C/N vs. BER Measurement Personality allows an Agilent 8590 Series spectrum analyzer to control the 3708A to make automatic measurements.

Bit Error Analysis

BERTS

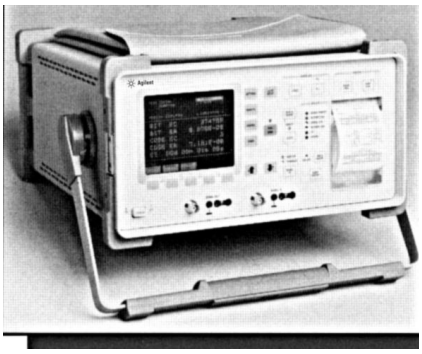
Agilent manufactures a wide range of error performance analyzers designed for your needs in the installation and maintenance of digital microwave radios operating under the North American or European hierarchies. The latest products incorporate comprehensive error-performance analysis and data logging. This has a substantial benefit in reducing the amount of equipment required for complete radio test. Shown here are just a few of the error analysis instruments available from Agilent.



Adaptable and versatile PDH/SDH transmission tester family

The 37714A/16A/17A/18A family of transmission testers provides you with a modular, upgradable solution for installation, commission, and field maintenance of PDH and SDH networks.

The 37714A is a single-unit solution for PDH and SDH testing. It gives you PDH rates of 704 kb/s, and 2, 8, 34, and 140 Mb/s and you can upgrade it to include SDH rates of 155 Mb/s (STM-1) and 622 Mb/s (STM-4). A LAN interface provides for remote-control, test-system applications.



Combined 140 Mb/s BER and frame analysis

The 37721 digital transmission analyzer simplifies test setup, and provides superior results display and analysis. It covers all your in-service and out-of-service test needs at 704 kb/s, and 2, 8, 34 and 140 Mb/s.

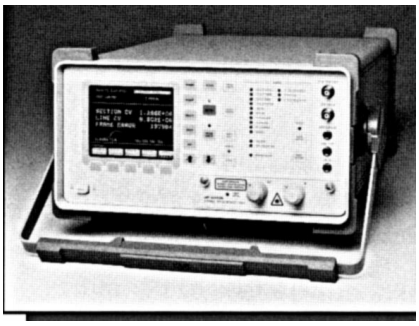
With auto setup, the analyzer rapidly self aligns to the incoming signal level and code; also to the bit rate, test pattern, and interface. Alternatively, choose any one of nine user-defined sets of test parameters.

Comprehensive SDH testing in single, portable unit

The 37724A SDH/PDH test set provides a single-unit solution for testing the installation, commission and maintenance of SDH equipment operating at 155 Mb/s (STM-1) and 622 Mb/s (STM-4). It offers you comprehensive functional testing of your SDH/PDH network equipment in a field-portable test set. A range of plug-in modules can be connected to optical and electrical interfaces at rates up to 622 Mb/s (STM-4).

Field-portable test set for SONET and T-carrier testing

The portable, lightweight Cerjac 156MTS SONET maintenance test set combines digital transmission testing capabilities with SONET-specific tests to meet your SONET and T-carrier applications in the field. You can use the base unit for STS-1 testing with full receive/transmit function and you can drop and insert DS3 payloads. OC-1, OC-3, and OC-12 interfaces, or DS3, DS1, and EI ports, can be added as required.



Comprehensive SONET testing in single, portable unit

The 37704A SONET test set provides a single-unit solution for testing the installation, commissioning, and maintenance of SONET equipment. It offers comprehensive, functional testing of your SONET network equipment in a field-portable test set.

A range of plug-in modules can be connected to optical and electrical interfaces at rates up to 622 Mb/s (STS-12). The test set check the transmission of DS1 and DS3 services in SONET and verifies the operation of network alarms, error monitors, automatic protection switching, pointer processing, and desynchronizer circuits.

Ordering Information

(Data Sheet Literature Number given in brackets)

8593E AM Spectrum Analyzer (9 kHz to 22 GHz) [5091-3271E]
8594E RF Spectrum Analyzer (9 kHz to 2.9 GHz) [5091-3271E]
8595E RF Spectrum Analyzer (9 kHz to 6.5 GHz) [5091-3271E]
8596E MW Spectrum Analyzer (9 kHz to 12.8 GHz) [5091-3271E]

Options
- **004** Precision Frequency Reference
- **010** Tracking Generator 300 kHz to 2.9 GHz
- **021** GPIB Interface
- **026** Frequency Extension to 26.5 GHz, Type APC 3.5 mm (8593E only)
- **027** Frequency Extension to 26.5 GHz, Type-N (8593E only)
- **11.1** Group Delay Measurement Card
- **119** Noise Figure and Gain
- **E04** DRTS Compatible Spectrum Analyzer

Measurement Personalities
11770A Link Measurements Personality [5091-4652E]
85713A Digital Radio Measurements Personality [5952-1452E]
85719A Noise Figure Measurements Personality [5091-4800E]
85714A Scalar Measurements Personality [5091-1338E]

Applications Accessories
85630A Scalar Transmission/Reflection Test Set
85644A Tracking Source (6.5 GHz) [5091-1230E]
85645A Tracking Source (26.5 GHz) [5091-1230E]
85032B Calibration Kit (50 ohm)
11766A DADE Switch [5091-4652E]
11767A IF Amplifier [5091-4652E]
11769A Return Loss Bridge [5091-4652E]

11758V Digital Radio Test System [5091-4651E]
Options
- **147** 70 and 140 MHz Multipath Fading Simulator (70 MHz) and Three Tone Source
- **201** Group Delay and Amplitude Flatness Measurements
- **270** Frequency Extension to 26.5 GHz, Type-N
- **301** Accessory Kit
- **H04** Fader Higher Input/Output Power
- **007** 3.5 to 6.5 GHz Source
- **H07** 6 to 8 GHz Source (requires Opt. 007)
- **H08** 7 to 10 GHz Source (requires Opt. 007)
- **H10** 9.5 to 13 GHz Source (requires Opt. 007)
- **011** 10.7 to 11.7 GHz Source (requires Opt. 007)
- **H13** 6 to 13 GHz Source (requires Opt. 007)
- **H19** 3.5 to 19 GHz Source
- **H24** 3.75 to 23.6 GHz Source
- **H66** Delete Multipath Fading Simulator
- **H60** Low cost DRTS for low/medium capacity digital microwave radios (power, frequency, and spectral occupancy)
- **H61** Low cost DRTS for low/medium capacity digital microwave radios (power, frequency, spectral occupancy, group delay/amplitude flatness, and C/N versus BER)

11757B Multipath Fading Simulator/Signature Test Set [5091-1052]
Options
- **147** Both 70 and 140 MHz coverage
- **H02** Higher input/output power capability (+4 dBm)

3708A Noise and Interference Test Set [5953-5433]
Option
- **001** 50-ohm unbalanced connectors

Bit Error Ratio Testers
37741A DS1 Tester [5962-9221E]
37742A Wit Test Set [5091-2038E]
37701B T1 Datacom Tester [5091-8851E]
37702A Digital Data Test Set [5091-8850E]
37721A Digital Transmission Analyzer [5091-5074E]
37722A Digital Telecom Analyzer [5091-8438E]
37724A SDH/PDH Test Set [5091-8844E]
37714A/ 37717A PDH/SDH BER and Jitter Test Sets [5091-8371E]
37716A/ 37718A PDIVSDH Structured BER and Jitter Test Sets [5091-8370E]
Cerjac 156MTS SONET Maintenance Test Set [930407-01]

Literature
- AN 355A Digital Radio Theory and Measurement [5091-4777E]
- AN 355-1 Tools for Digital Microwave Radio Installation and Maintenance [5091-4653E]
- AN 379-1 Measuring Digital Microwave Radio M-Curves/ Signatures [5959-7859]
- AN 379-2 Measuring Microwave Radio Antenna return Loss [5959-8749]
- AN 343-1 Measurement Applications in Digital Microwave Radio [5954-6365]
- AN 364-1 Quality Gains in Telecom Australia's Digital Microwave Network [5954-9572]
- AN 364-2 Digital Radio Testing with British Telecom [5952-1959]
- AN 387 High Productivity Measurements in Digital Transmission [5959-7898]

Agilent Technologies' Test and Measurement Support, Services, and Assistance
Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise
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