



**HEWLETT
PACKARD**

Noise and Interference Test Set - MODEL 3708A



TECHNICAL DATA



Evaluate noise and interference effects
in microwave radio systems - **ACCURATELY**

Applying microwave radio systems successfully depends on you being able to quantify transmission impairments caused by the propagation characteristics of the atmosphere and by the effects of interference.

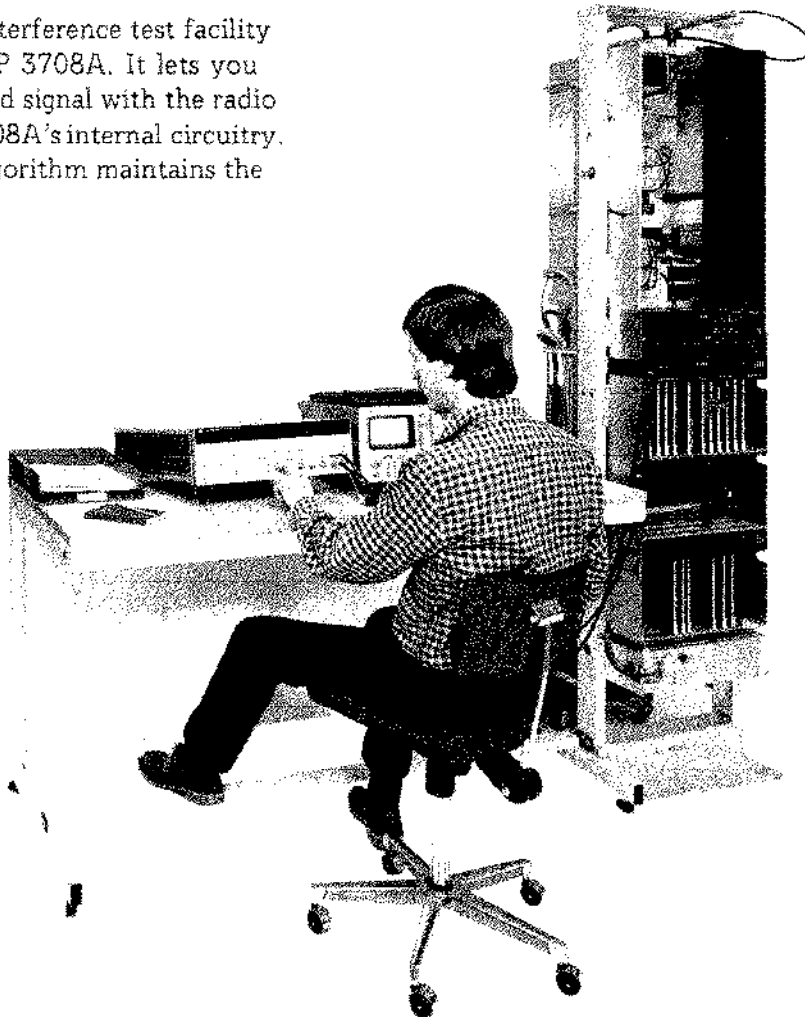
An accurate and simple way of simulating microwave fade conditions is by using the HP 3708A Noise and Interference Test Set. It lets you inject noise of known spectral density into the IF section of a microwave radio link receiver to establish a demanded carrier-to-noise ratio. The radio IF carrier power is sampled by the HP 3708A at the point of noise injection and the noise density adjusted automatically to maintain a constant carrier-to-noise ratio in the presence of receiver carrier level variations.

A simple, yet powerful interference test facility is also provided in the HP 3708A. It lets you mix an external broadband signal with the radio IF carrier using the HP 3708A's internal circuitry. An automatic levelling algorithm maintains the

demanded carrier-to-interference (C/I) ratio, simplifying accurate evaluation of radio performance in the presence of interfering or jamming signals.

Use the HP 3708A to simplify effective performance testing in:

- Digital radio systems
- FDM/FM microwave radio links
- Satellite TDMA ground stations
- Secure communication systems



HP 3708A Noise and Interference Test Set



Auto-calibration for enhanced accuracy.

Carrier/noise mode adds noise and/or interference to the radio IF carrier. Application-dependent units make it easy to use.

Accurate & fast IF power meter.

Noise-only mode to add calibrated levels of white noise where the signal path cannot be interrupted.

st Set



Direct noise bandwidth measurement.

Accurate reference tone output.

Range of internal band-limiting filters.

Zero-loss IF path.

Tracking interferer input.

External band-limiting filter facility.

A cost-effective measurement solution

The highly accurate noise source and power meter of the HP 3708A make the instrument a valuable aid in the development of microwave radio equipment. Repeatable, fast and accurate measurements increase efficiency and reduce costs.

Performance evaluation of microwave radio systems and components is greatly simplified with the HP 3708A. Full programmability via the HP-IB and ease of use reduce test time. Repeatable and accurate results ensure high confidence of systems meeting final customer specifications.

Simulation of microwave radio path fading with the HP 3708A requires less time than the conventional method of adding RF attenuators to the waveguide. Application-dependent units and ease of use simplify operation. A carrier tracking facility guarantees accurate results under field operating conditions.

Accurate simulation of fade conditions with the HP 3708A highlights problems which may not be perceptible under normal conditions. The test time required to restore operation of a failed radio link is reduced as faults can be identified more rapidly, minimizing out-of-service time. A broadband noise source covers all common microwave link IF's, reducing test equipment inventory costs.



HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.

A multi-purpose instrument for improved efficiency.....

General-purpose noise source with high accuracy output

- ☒ Integral power meter and microprocessor closed-loop control maintain the selected noise level.
- ☒ High crest factor gives an accurate Gaussian noise power distribution for realistic fade simulation.

Tracking mode maintains C/N ratio under fading conditions

- ☒ Fast microprocessor control maintains measurement accuracy even under rapid variations in input power level.
- ☒ Radio IF path continuity is maintained at all times, only the noise level is adjusted for constant C/N ratio. Carrier disturbance and impairment are thus negligible.

Interference facility stresses the radio deterministically

- ☒ Broadband inputs for wide range of interference signals.
- ☒ Sophisticated levelling algorithm and circuitry minimizes the effect of variations in carrier power.

Wideband noise source covers all common microwave link IFs

- ☒ Reduce test equipment inventory costs.
- ☒ Use your own external filters for applications where specially-shaped IF filters are required.

True RMS power meter gives accurate indication of receiver IF power

- ☒ Fast sampling rate and software averaging let you select measurement speed and accuracy.
- ☒ Eliminate the need for a separate IF power meter, reducing inventory costs.

High stability reference tone

- ☒ Accurate 0 dBm level.
- ☒ Can be used as single-tone interference source.

Direct measurement of radio IF filter noise bandwidth

- ☒ No additional equipment required.
- ☒ Direct measurement eliminates time-consuming integration techniques.

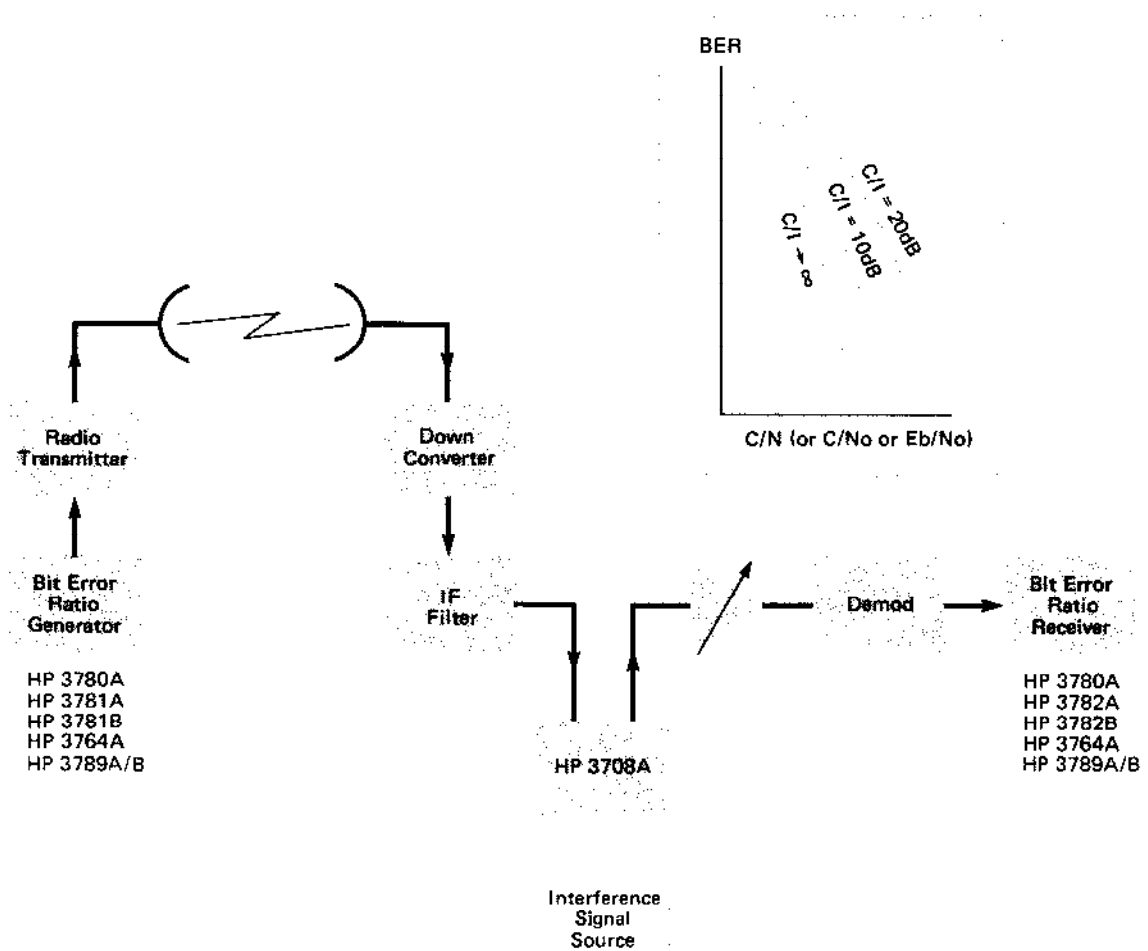
..... in digital microwave radio links.....

Digital transmission system performance is assessed by Bit Error Ratio (BER) measurements. At normal receiver RF levels, however, BER measurements provide only a limited evaluation of system performance. Faded conditions are normally simulated by attenuating the receiver RF signal. This makes the measurement more vulnerable than usual to fading which could postpone routine maintenance and customer acceptance testing, and seriously affect results accuracy.

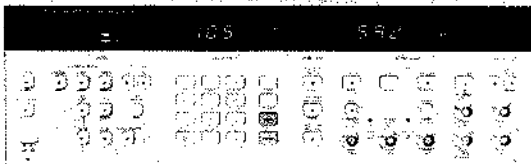
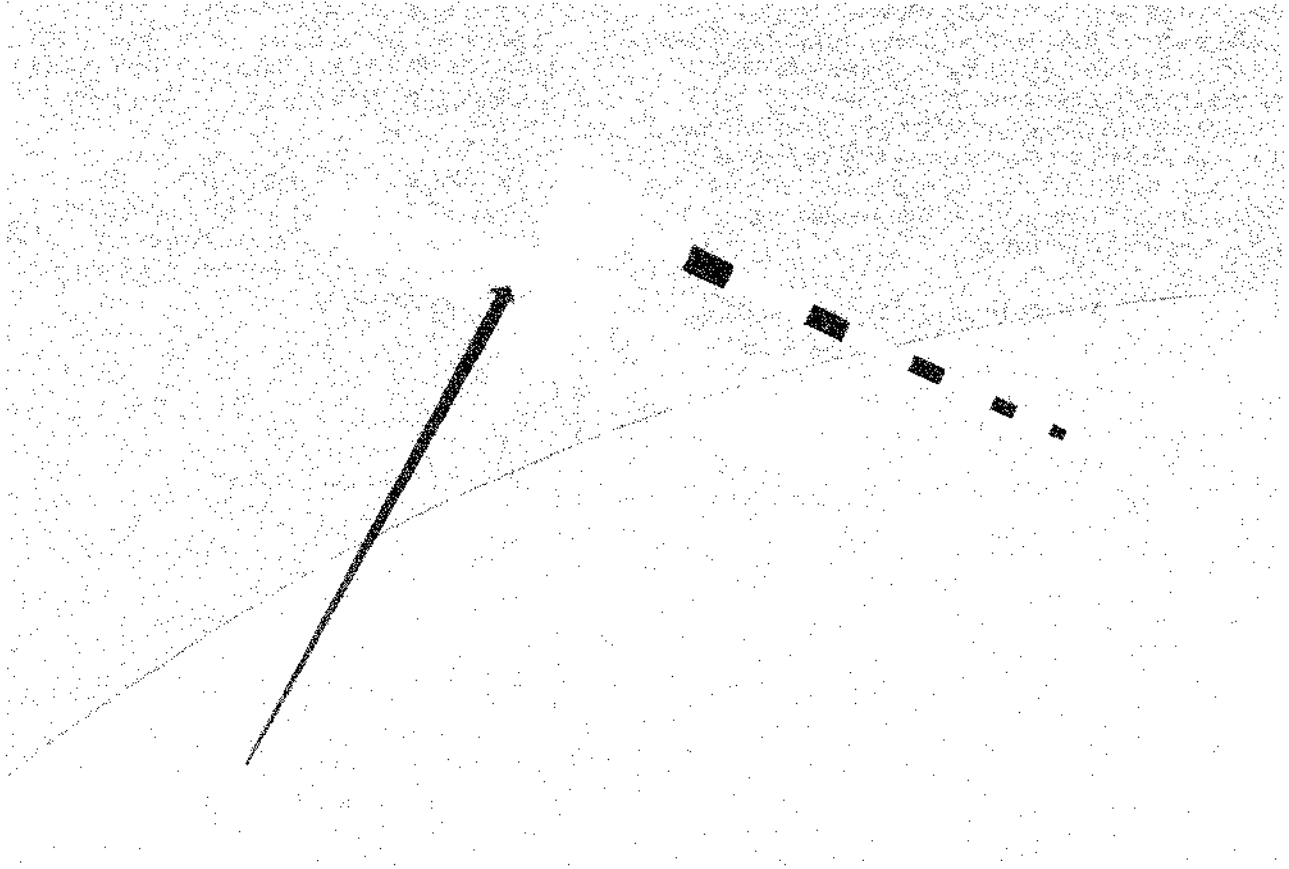
Used together with a bit error ratio test set, the HP 3708A simplifies the measurement of BER as a function of carrier-to-noise ratio (C/N, C/No or Eb/No). Additionally, a range of interference signals can be added to the radio IF to assess the radio performance in the presence of interference signals. BER vs C/I curves can be determined as well as BER vs C/N for several C/I ratios.

Calibrated white noise addition improves the accuracy of bit error ratio threshold tests, clock phase adjustments, diversity switch point setting and eye closure measurements on digital radio receivers.

Determination of radio signature (the ability to handle multi-path) is simplified by the HP 3708A tracking facility which compensates for any carrier power variation introduced by changing the notch depth or frequency.



..... TDMA systems



Enter an
expected
carrier
power



Inhibit
the
automatic
carrier
tracking

The HP 3708A simplifies the evaluation of satellite and point-to-multipoint time division multiple access (TDMA) radio systems where the short carrier bursts would make the carrier power measurement meaningless. The expected carrier power value can be entered via the keyboard rather than measured by the instrument. This mode offers a simple and convenient way of defining the generated noise density as a carrier-dependent ratio.

Intelsat performance requirements for TDMA modems which are greatly simplified by the HP 3708A include:

- BER performance
- Clock and carrier cycle skipping
- Unique word missed detection probability

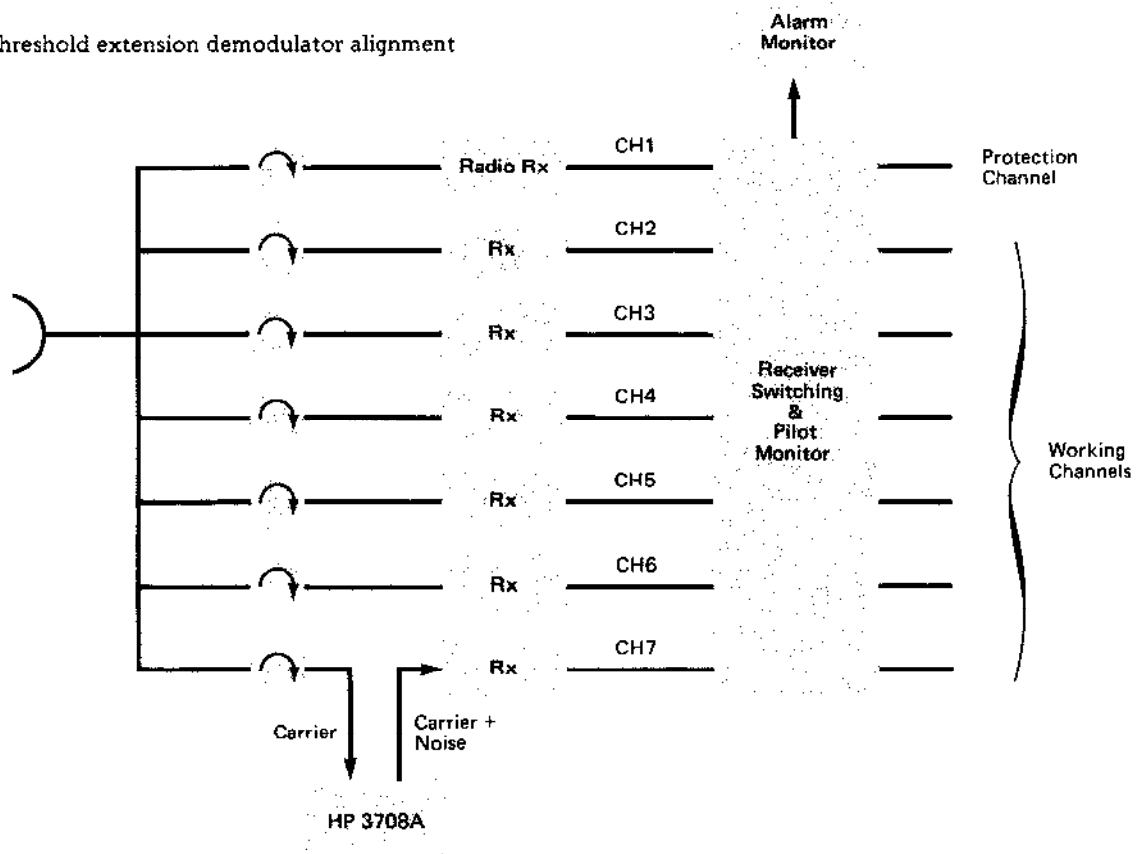
as a function of E_b/N_0 (Energy per bit to Noise Density) ratio.

..... FDM/FM microwave radio systems

Many time-consuming measurements can be simplified and speeded up with the tracking facility and accurate noise source in the HP 3708A. Alarm thresholds and diversity switchover points are easily and accurately set even under carrier fade conditions where conventional methods using RF attenuators would be unusable.

Other uses of the instrument include:

- NPR vs C/N plots
- FM threshold measurements
- Threshold extension demodulator alignment



..... and many other areas

The HP 3708A can be used as a general-purpose noise source wherever accurate thermal noise in the range 10 to 200 MHz is required. Together with the versatile interference facilities offered by the instrument, it finds application in areas such as:

- Anti-jamming equipment in secure communication systems
- Electronic counter measures equipment
- Digital and cable television

Its accurate noise generator.....

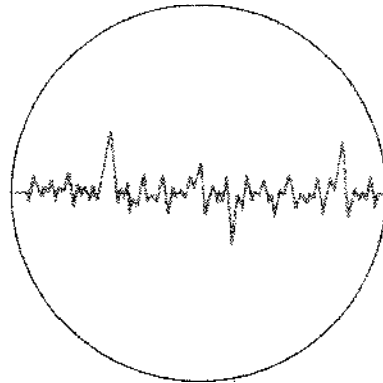
The noise source in the HP 3708A generates thermal noise with a Gaussian distribution. Microprocessor control of all amplifiers and attenuators in the instrument ensures that a high crest factor -- better than 15 dB -- is maintained. This is important as limited amplitude noise does not provide a satisfactory approximation of thermal noise encountered during fading. Output level accuracy is maintained by the instrument using the integral power meter to give closed-loop control.

Temperature variations of the noise source are automatically compensated by the instrument. No operator

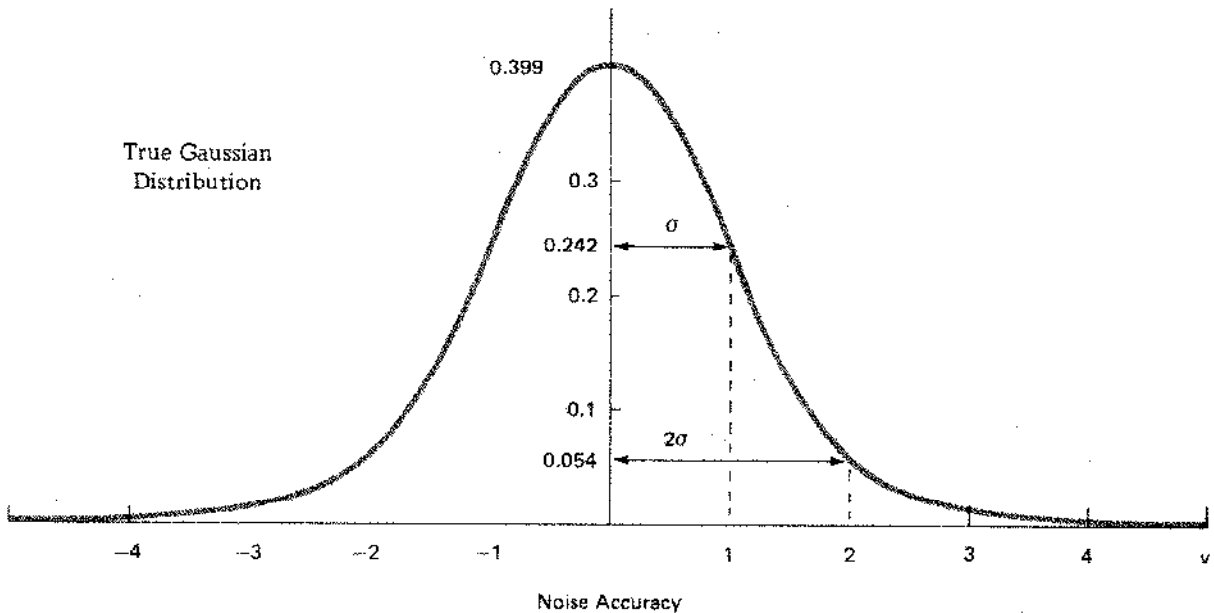
intervention is required to ensure accurate operation. This facility can be inhibited when required, eg for long-term testing.

Where the signal path cannot be physically interrupted, calibrated noise can be added to IF sections using the noise-only output.

Random Noise Output



$$p(v) = \frac{1}{\sqrt{2\pi}} e^{-v^2/2}$$

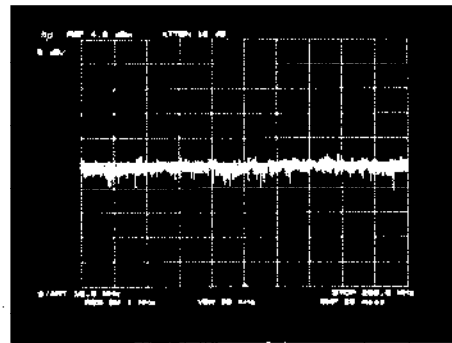
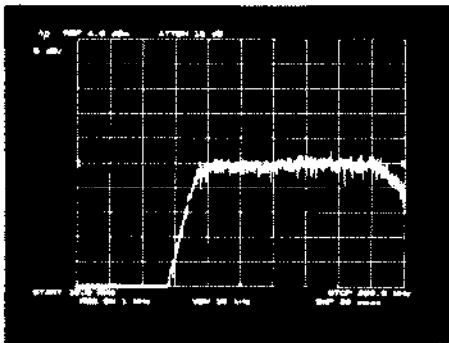
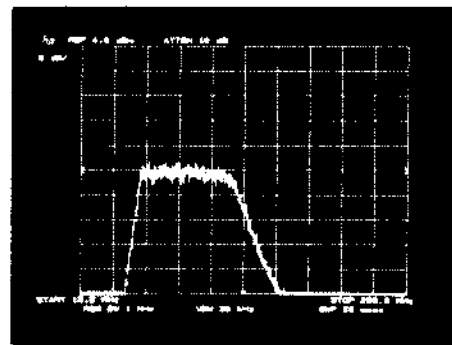
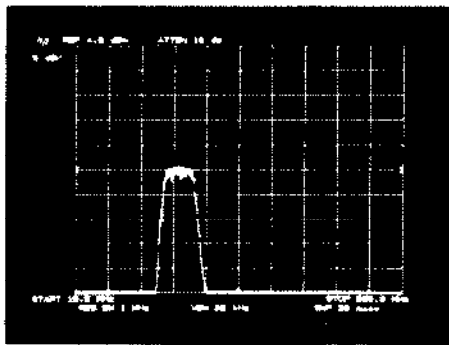


..... with wide frequency range

The HP 3708A noise source generates a band of flat-topped noise in the range 10 to 200 MHz. Four internal band-limiting filters render the noise source applicable to radios using most common IF frequencies. Simple pushbutton selection of the required filter limits the bandwidth of the noise output to the desired range.

operate the HP 3708A in systems where specially shaped IF filters are necessary. The instrument compensates automatically for the insertion loss and noise bandwidth of the external filter, simplifying operation and maintaining measurement accuracy.

For special requirements, you can use your own external filter instead of the standard internal ones. This lets you



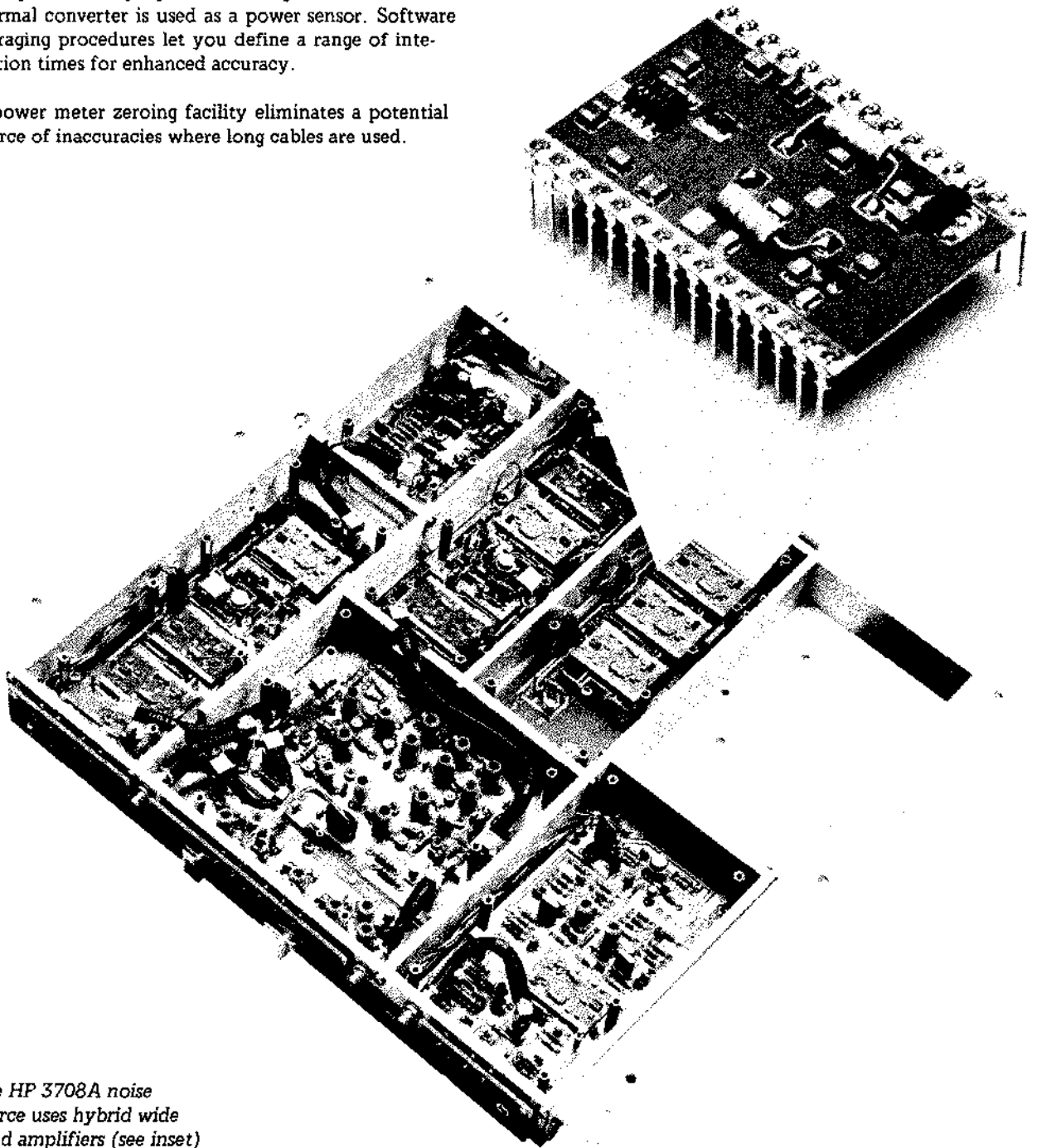
..... gives a single instrument
for every requirement

Accurate IF power meter.....

The HP 3708A's power meter combines speed of response with accuracy. By eliminating the need for a separate IF power meter, inventory costs are reduced.

Simple, single-key operation with an easy-to-read digital display gives an accurate indication of the true RMS power of any signal in the range 10 to 200 MHz. A thermal converter is used as a power sensor. Software averaging procedures let you define a range of integration times for enhanced accuracy.

A power meter zeroing facility eliminates a potential source of inaccuracies where long cables are used.



The HP 3708A noise source uses hybrid wide band amplifiers (see inset)

..... used to track a fast varying carrier

The HP 3708A tracking mode operation generates a value of noise density which corresponds to a user-defined carrier-to-noise ratio and a measured carrier power. This powerful mode combines the accuracy and speed of the HP 3708A power meter with the thermal noise generator to give a tracking noise source.

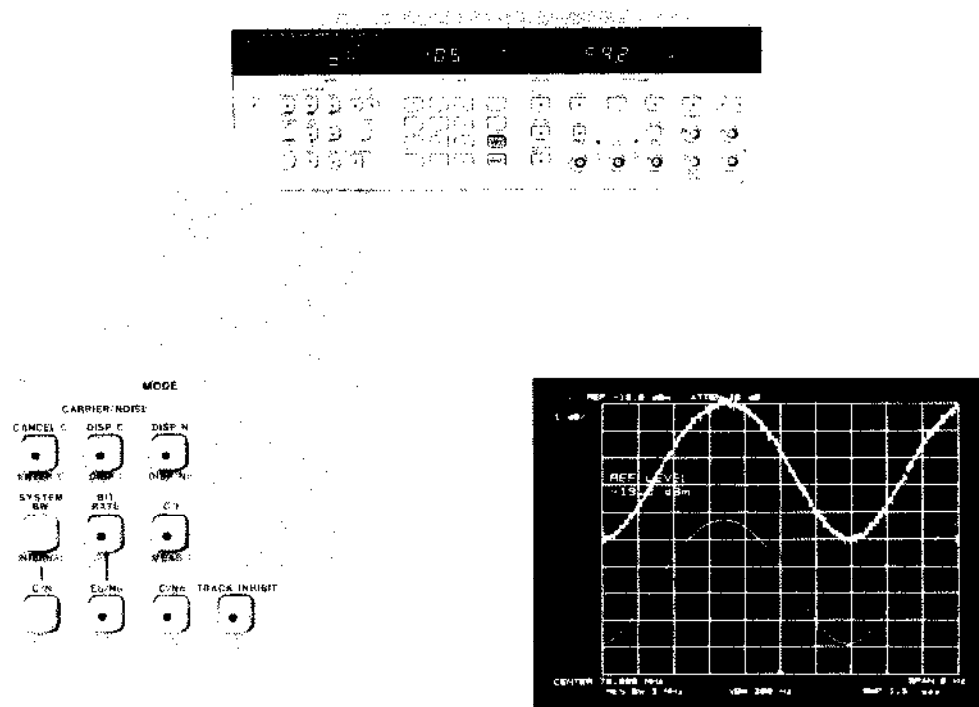
Accuracy is maintained even under fading conditions where small variations in carrier power would cause large changes in the bit error rate.

Only the noise generated is adjusted by the instrument, thus preserving the IF path continuity at all times and

ensuring that no impairments are added to the radio IF carrier.

Simple pushbutton operation gives a precise indication of system conditions by letting you display measured carrier power, generated noise power or noise density.

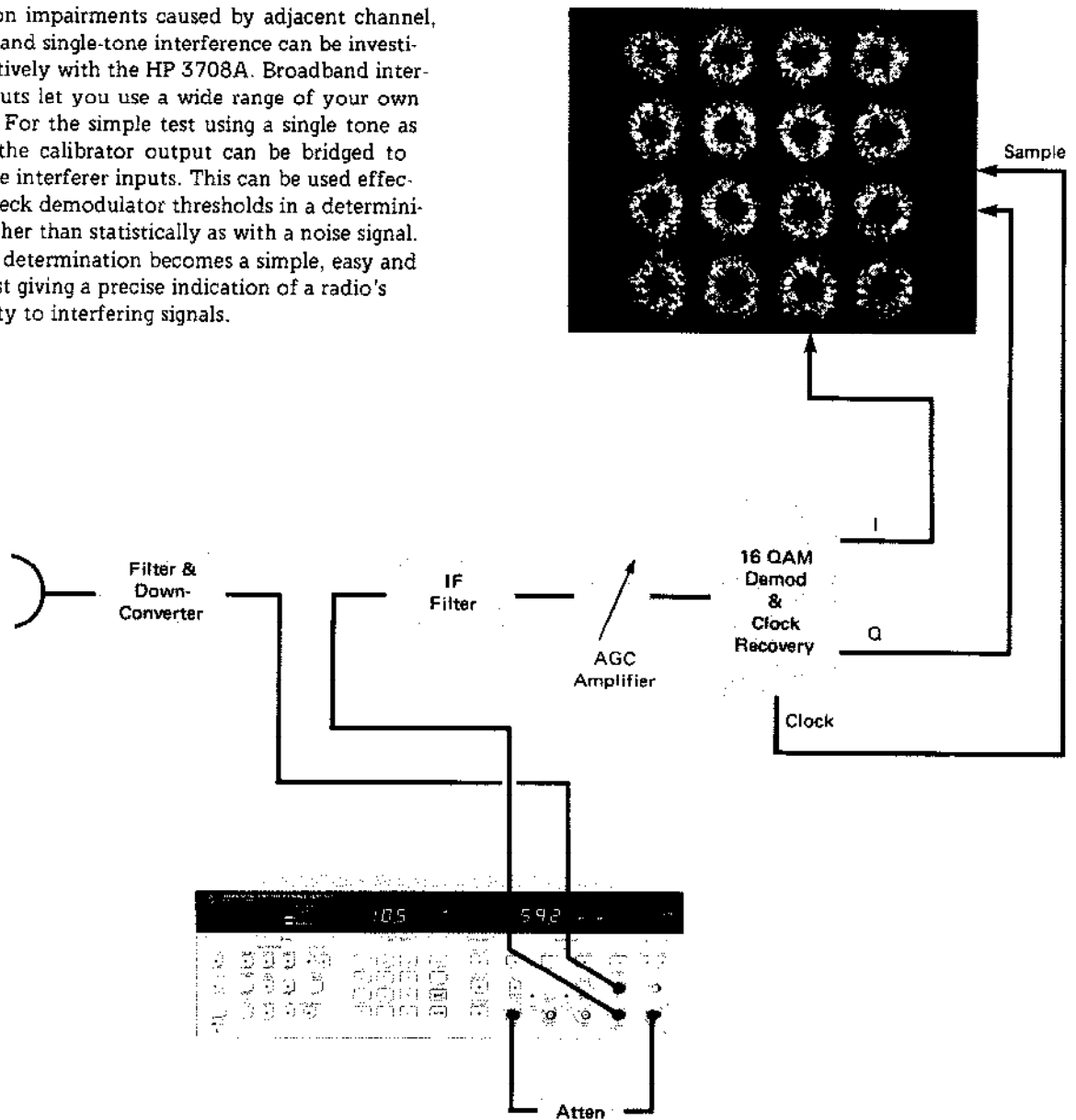
Of course, tracking can be inhibited to let you use the HP 3708A in, for example, TDMA systems where carrier bursts are present. It also permits the C/N ratio to be established for an unmodulated carrier rather than during normal modulated operation.

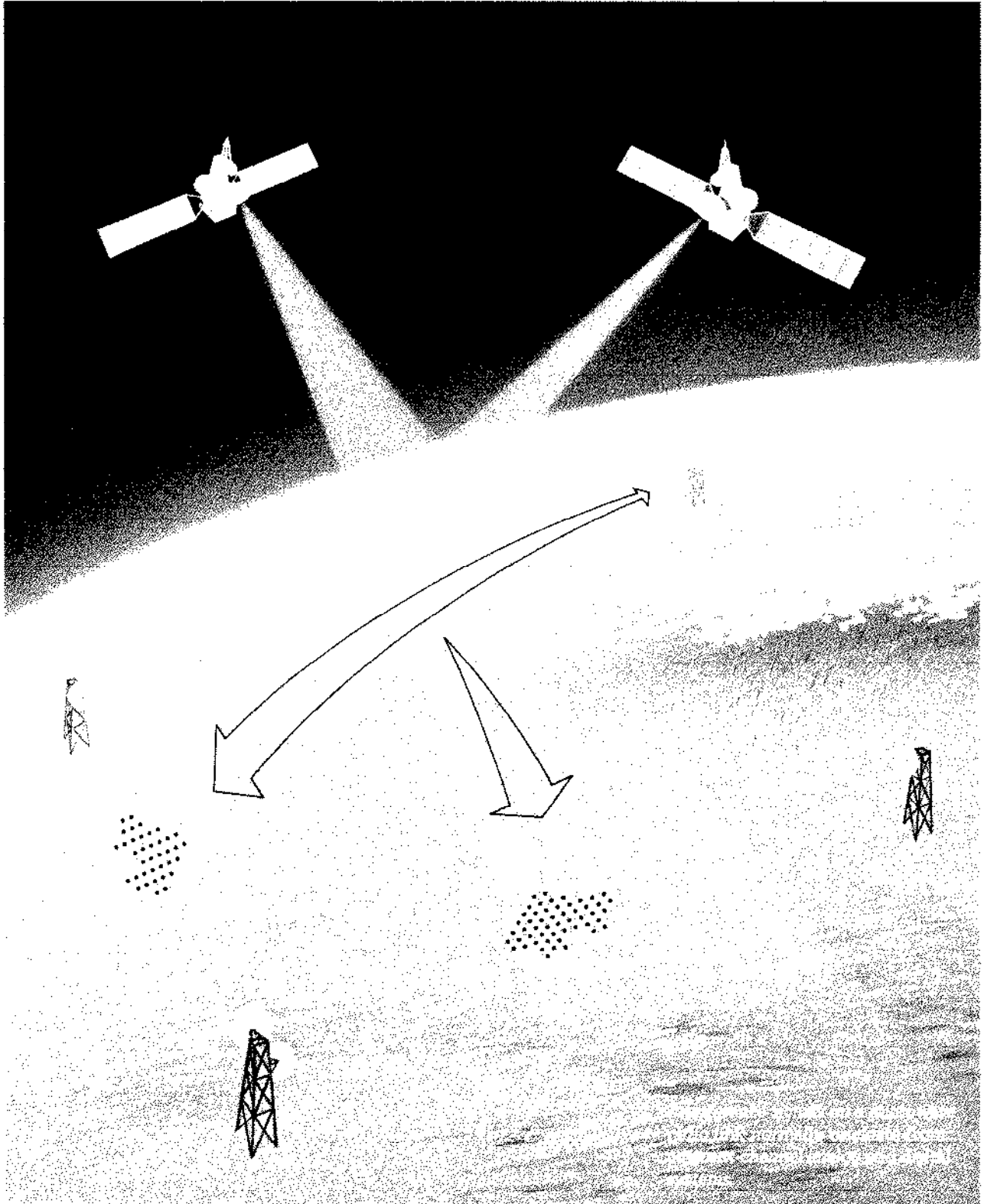


Simple yet powerful interference facility

The main type of interfering signal encountered in a microwave radio system is usually similar to the desired signal. Modulated carriers represent primary sources of interference. Additionally, unmodulated carriers can cause single-tone interference.

Transmission impairments caused by adjacent channel, co-channel and single-tone interference can be investigated effectively with the HP 3708A. Broadband interference inputs let you use a wide range of your own interferers. For the simple test using a single tone as interferer, the calibrator output can be bridged to either of the interferer inputs. This can be used effectively to check demodulator thresholds in a deterministic way rather than statistically as with a noise signal. BER vs C/I determination becomes a simple, easy and accurate test giving a precise indication of a radio's susceptibility to interfering signals.



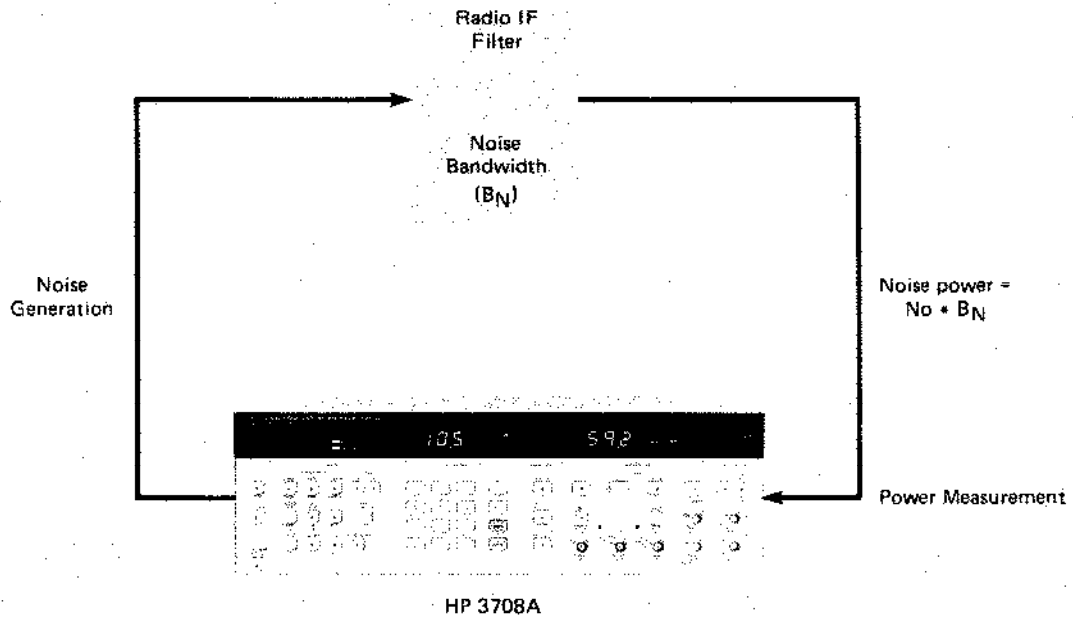
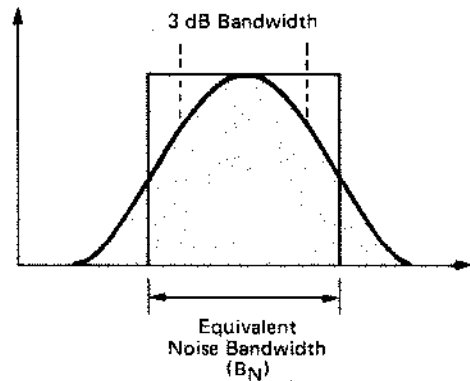
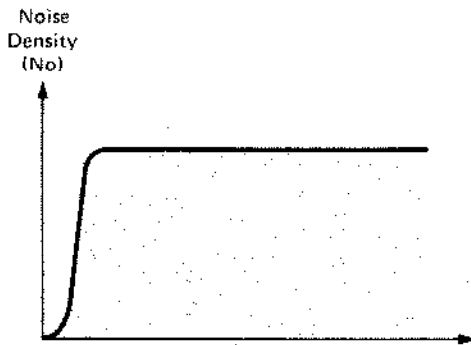


Direct noise bandwidth measurement

To compare different digital microwave radio systems, it is essential to define the noise bandwidth of the radio receiver. The HP 3708A uses its calibrated noise density and power meter to perform a direct, fast and accurate noise bandwidth measurement which compares favourably with the time-consuming and complex numerical integration traditionally performed.

customized ranges of noise, offering all the accuracy and carrier tracking speed features of the standard internal filter ranges. The HP 3708A automatically compensates for the filter noise bandwidth and insertion loss, eliminating long and tedious manual calculations.

Having measured a filter noise bandwidth, this can be used as an external band-limiting filter to generate

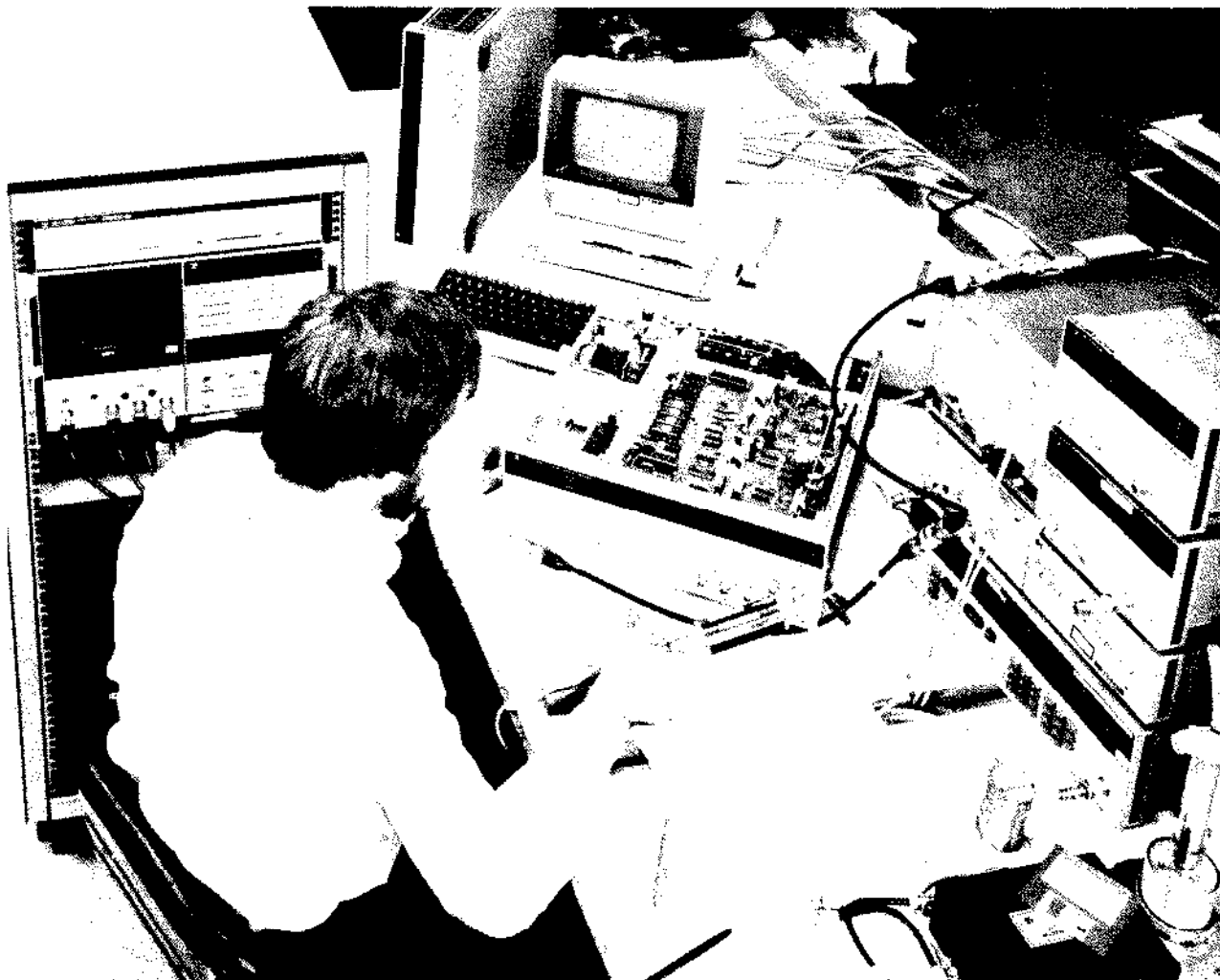


Self-calibration for accurate operation

When measuring the fade margins of a microwave radio system, the accuracy to which the carrier-to-noise ratio can be specified is of vital importance. A typical case is in the generation of BER vs C/N curves where a less than 0.5 dB change in C/N can result in one order of magnitude variation in the BER.

The HP 3708A utilizes a powerful 16-bit microprocessor to implement sophisticated calibration procedures which result in enhanced instrument accuracy:

- Every signal path in the HP 3708A – including the internal filters bandwidth – is characterized by individual software calibration constants. Each instrument is accurately calibrated as part of the manufacturing process and its own "personalized" coefficients are then stored in the instrument's non-volatile memory.
- A temperature sensor ensures that an auto-calibration cycle is initiated during the noise generation mode should the noise source temperature change by a significant amount. The auto-calibration cycle can be initiated on demand and an inhibit facility is also provided for long term testing, when no interruption to the generated noise is desirable.
- The power meter can be calibrated using a 0 dBm reference signal. Subsequent power measurements are referred to this level, giving a convenient means to calibrate a specific cable length. The HP 3708A calibrator output is provided specifically for this purpose and enables the reference signal frequency to be set to 70 or 140 MHz via a front-panel control. Other frequency values are available on a special order basis.

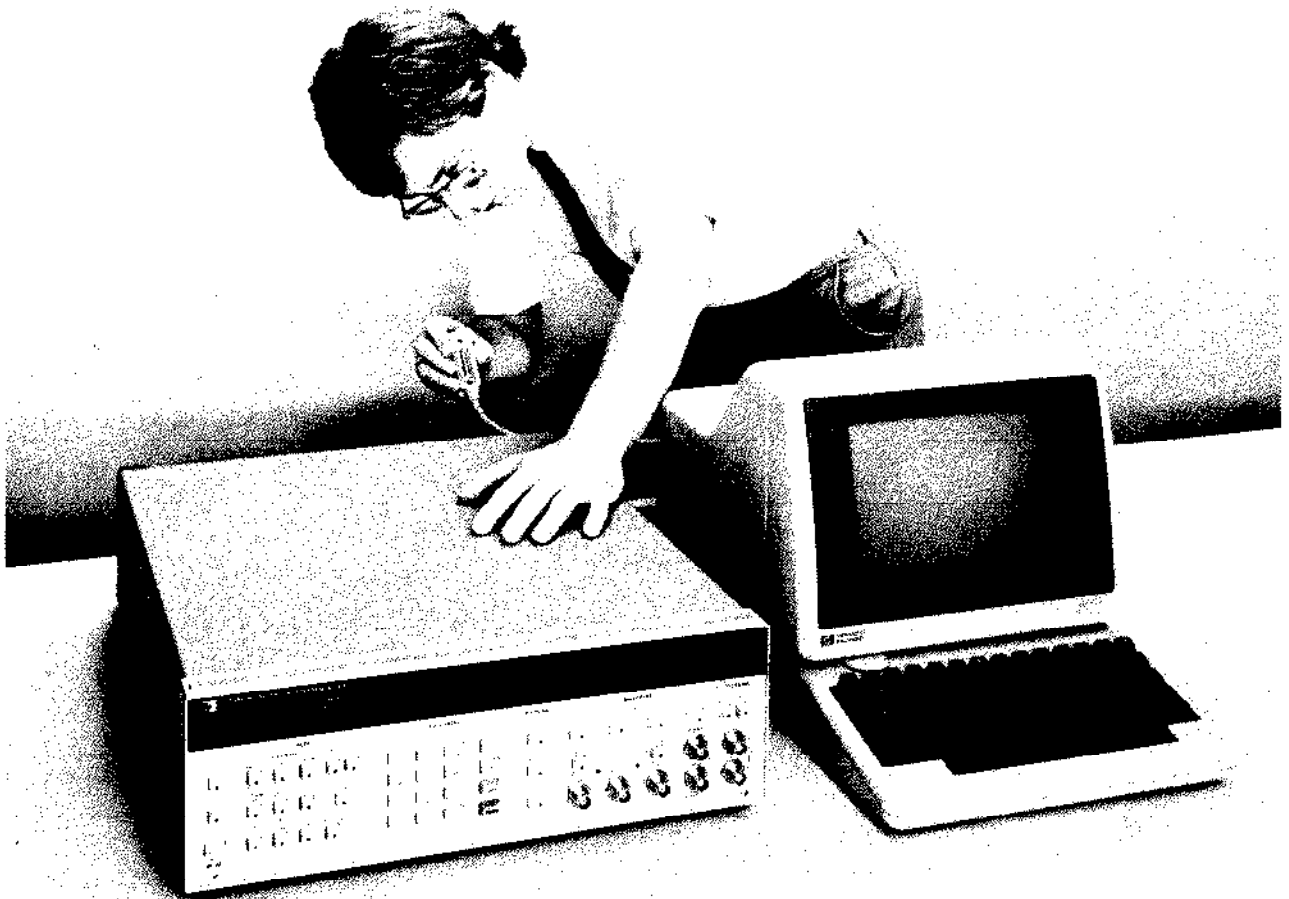
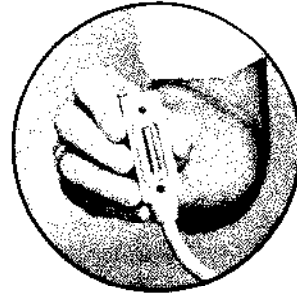


HP-IB operation

To enhance the capabilities of the HP 3708A, the instrument is fully programmable via the Hewlett-Packard Interface Bus (HP-IB). The Noise and Interference Test Set was designed not only as a powerful stand-alone instrument, but also as a systems component.

Add a computer to the HP 3708A and a whole range of measurements are greatly simplified: long-term and unattended tests, automated BER vs C/N plots, results storage and analysis, etc.

Automated measurements can result in substantial improvements in productivity and quality, allowing less-experienced personnel to make repeatable, highly accurate measurements. Presentation and storage of results can be greatly improved, providing higher operator confidence and convenience.



System software

System software has been created for those users of the HP 3708A who wish to take advantage of the productivity gains afforded by computer-aided testing, without requiring expertise in programming or system design.

Ease of use has been designed-in for operator convenience by providing menu-driven operation and descriptive "help" commands. These provide an explanation of system features and commands making it self-explanatory and easy to use, even for the inexperienced user. Extensive use is made of graphics to guide the operator and to present measurement results in a clear and easy to interpret format.

Some of the main features offered by the software include:

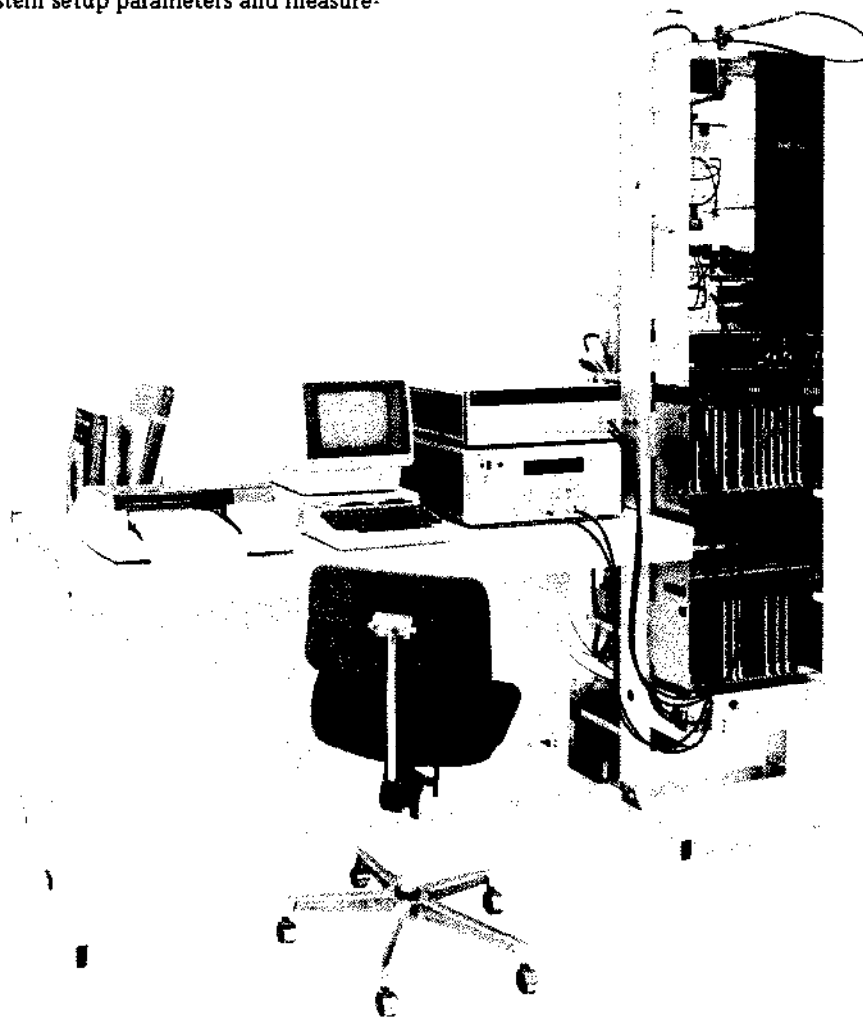
- Data base definition and editing facilities for fast, easy recall of system setup parameters and measurement results.

- Graphic display of measured results with automatic conversion of units, expanded plots etc. Graphs can be measured, entered manually, stored/recalled on disc and plotted on the computer CRT or external plotter.

- Range of bit error ratio test sets supported include the HP 3781A/3782A, 3781B/3782B, 3789A/B and 3764A.

- Accuracy enhancements, including user-defined averaging of a specified number of BER readings.

- Menu-driven, self-documented operation for ease of use.



Except where otherwise stated, the following parameters are warranted performance specifications. Parameters described as "typical" or "nominal" are supplemental characteristics which provide a useful indication of typical, but non-warranted performance characteristics. All specifications are guaranteed over an ambient temperature range of 0° to 55°C except where otherwise stated.

1. C/N & C/I MEASUREMENT MODES

C/N Ratio

Specified at IF Output connector.

Overall range: -10 to 60 dB.

Figure 1 specifies overall accuracy:

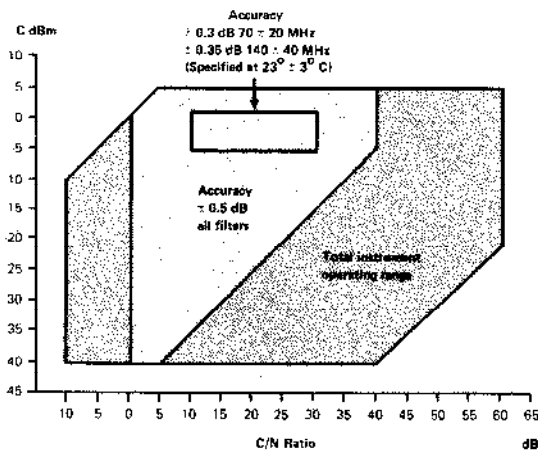


Figure 1

Accuracy typically better than 0.1 dB over 0 to 40 dB C/N range.

The HP 3708A performs easy conversion between C/N, C/No & Eb/No ratio for different applications (eg satellite system testing).

RESPONSE TIME (tracking speed)

Speed with which the noise level responds to carrier level change to maintain constant C/N ratio:

Typically 10 ms for carrier power change $\leq \pm 5$ dB.

C/I Ratio

Specified at IF Output connector.

The HP 3708A offers two facilities for interference testing. Both are broadband inputs, with 10 to 200 MHz frequency range.

Overall range: -10 to 60 dB.

Figure 2 specifies overall accuracy:

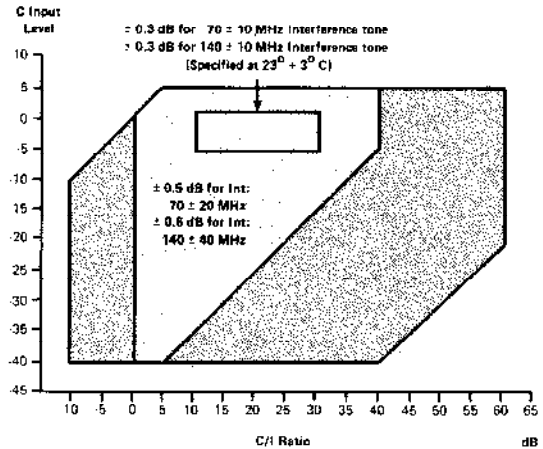


Figure 2

Accuracy typically better than 0.1 dB over 0 to 40 dB C/N range.

INTERFERER (I) INPUT (front panel, same as Ext Filter Input port)

This operation mode provides accurate C/I ratios to simulate interference conditions.

Valid interferer input power: Typically -29 dBm.

AUXILIARY INTERFERER INPUT (rear panel)

Provides a fixed-loss path to the IF Output. This input mixes an interferer with C/N ratios to provide C/(N+I) ratios.

Flatness: 70 \pm 20 MHz: ± 0.2 dB w.r.t. 70 MHz;

140 \pm 40 MHz: ± 0.6 dB w.r.t. 140 MHz.

Path loss - rear panel input to IF Output: Typically 15 dB.

RESPONSE TIME (tracking speed)

Speed with which the interference level responds to carrier level change to maintain constant C/I ratio:

Typically 10 ms for carrier power change $\leq \pm 5$ dB.

I INPUT INTERFERER PATH FLATNESS

70 \pm 5 MHz: ± 0.1 dB w.r.t. 70 MHz.

70 \pm 20 MHz: ± 0.4 dB w.r.t. 70 MHz.

140 \pm 40 MHz: ± 0.4 dB w.r.t. 140 MHz.

10 to 200 MHz: 1 dB pk-pk.

Carrier Path

Specified from IF Input to IF Output.

Gain (at 70 MHz): 0 \pm 0.4 dB (typically 0 \pm 0.1 dB).

Flatness: 70 ± 20 MHz: ± 0.2 dB w.r.t. 70 MHz (typically ± 0.1 dB).
 140 ± 40 MHz: ± 0.3 dB w.r.t. 140 MHz (typically ± 0.1 dB).
Group delay: 0.2 ns for ranges 70 ± 20 MHz, 140 ± 40 MHz.
3rd order intercept point: Typically +29 dBm.

2. NOISE GENERATION

Band-limited white noise available as independent noise source at noise output connector, or as carrier/noise (C/N) ratio at IF Output connector.

NOISE LEVEL RANGE

Specified at Noise Output connector.
N: +6 to -80 dBm (approximate).
No: -70 dBm/Hz (approximate) to -154 dB/Hz.

Both these specifications are filter dependent. See following table.

NOISE POWER ACCURACY

Specified at Noise Output connector, and after power meter calibration with 70/140 MHz 0 dBm reference tone.

± 0.25 dB over the range +6 to -10 dBm output power at 23 ± 3° C.
 ± 0.5 dB over the range +6 to -55 dBm output power.

BAND-LIMITING FILTERS

Each instrument filter noise bandwidth is individually measured and stored in the HP 3708A non-volatile memory. Values given below are typical and individual instruments may show slightly different values on the front panel display.

Noise bandwidth accuracy: ± 0.15 dB.

Frequency Bands (MHz)	Flatness (w.r.t center frequency) (MHz)	Noise Bandwidth* (MHz)	Typical Temp Stability (dB/°C)	Max No* (dBm/Hz)	Min N* (dBm)
70 ± 5	± 0.3	18	0.001	-67	-81
70 ± 20	± 0.1	60	0.001	-72	-75
140 ± 40	± 0.5	125	0.001	-75	-73
10 to 200	± 0.8	215	0.0015	-78	-70

*Nominal values, will vary for individual instruments

CREST FACTOR

Typically ≥ 15 dB for +6 dBm output level. (Typically higher crest factor at lower noise output levels).

3. POWER MEASUREMENT

The true rms power meter can be used separately in addition to standard HP 3708A operation, permitting a wide variety of uses.

Specifications apply to Power Meter input only.

Measurement range: +6 to -55 dBm.

Absolute accuracy:

70 MHz: ± 0.3 dB at 0dBm (0-55°C, no calibration);
 70/140 MHz: ± 0.15 dB at 0 dBm, (23 ± 3°C, after calibration using reference tone - see below).

Flatness: 10 to 180 MHz: ± 0.3 dB w.r.t. 70 MHz.

Resolution: 0.01dB.

Linearity - Measured at 70 MHz:

+5 to -35 dBm: ± 0.1 dB (typically ± 0.05 dB);
 -35 to -45 dBm: ± 0.3 dB.

4. OTHER MEASUREMENTS

User provided, external filter operation provides flexible C/N measurements in many different applications.

REFERENCE TONE OUTPUT

Frequency: 70/140 MHz crystal-controlled oscillator, front panel selectable. Other frequencies available to special order.

Level: 0 dBm ± 0.15 dB. Factory-set to 0 dBm ± 0.05 dB at 23 ± 3°C.

Harmonic content: < -25 dBc.

INSERTION LOSS MEASUREMENT

Accuracy: ± 0.2 dB at 70 or 140 MHz.

Insertion loss range: 35 dB to -5 dB (minus sign represents gain).

NOISE BANDWIDTH MEASUREMENT

Accuracy: ± 0.4 dB (includes insertion loss measurement accuracy of ± 0.2 dB).

Range: Function of insertion loss and filter bandwidth, see Figure 3.

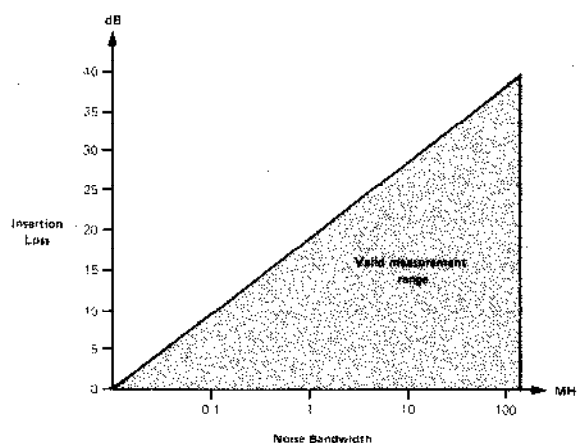


Figure 3

This represents the maximum insertion loss for a given noise bandwidth measurement. Any filter noise bandwidth with insertion loss above the line is outside the HP 3708A measurement range. The minimum insertion loss or upper bound on the range is restricted to +6 dBm maximum power meter input power.

5. HP-IB FACILITIES

MODE

Addressable factory-preset address 8, selected by rear-panel switch.

LOAD

One bus load.

LOCAL SWITCH

Allows switching from remote to local control, except when controller has issued a local lockout command.

INTERFACE FUNCTIONS SUBSET

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.

6. GENERAL

CONNECTORS

All signal connectors in the HP 3708A are BNC type

In the HP 3708A standard instrument, all signal connectors impedances are 75Ω nominal, unbal to gnd. Reference tone oscillator frequency is 70/140 MHz, selectable from the front panel. Reference tone oscillator frequencies other than the standard values are available on a special order basis.

and have a return loss > 26 dB (except the rear panel Aux Interferer input, with a return loss of 18 dB, typically).

POWER SUPPLY

Input voltages: 100/120/220/240V ac.

Tolerance: +5 to -10%.

Frequency: 48 to 66 Hz.

Power consumption: 150 VA max.

DIMENSIONS (including connectors and feet)

145 mm (5.75 in) high; 425 mm (16.75 in) wide;

540 mm (21.2 in) deep.

WEIGHT

16 kg (35 lb), net; 29 kg (63 lb), shipping.

ENVIRONMENT

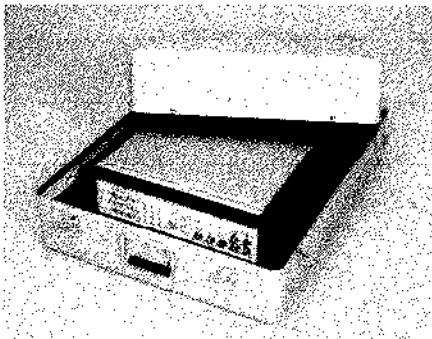
0° to 55°C operating; -40° to 75°C, storage.

001 : CONNECTORS: all signal connectors impedances are 50Ω nominal, unbal to gnd.

908 : RACK FLANGE KIT: enables the HP 3708A to be secured in a 483 mm (19 in) rack.

909 : RACK AND HANDLE KIT: combination of Options 907 and 908.

910 : EXTRA SET OF MANUALS.

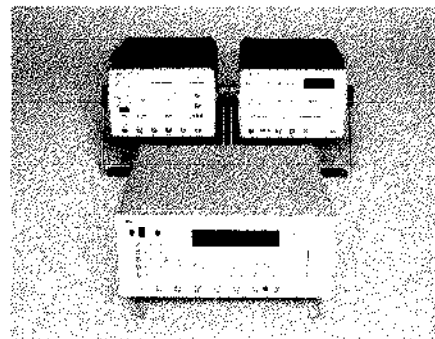


FIBERGLASS TRANSIT CASE

Part No: 9211-2655.

9211-2661 for HP 3708A fitted with Opt 801.

Contains custom-moulded inserts which fit snugly around the instrument for maximum protection during transit.



BIT ERROR RATIO TEST SETS

A wide range of complementary instrumentation is available for use with the HP 3708A for determining bit error ratio as a function of carrier to noise ratio in digital transmission systems.

For more information, contact your local HP Sales Office or -

In US: Call • East (301) 258-2000 • Midwest (321) 255-9800 • South (404) 955-1500 • West (213) 877-1282
Or, write Hewlett-Packard, 3000 Hanover Street, Palo Alto, California 94304.

In Europe: Hewlett-Packard S.A., 150 route du Nant-d'Avril, CH 1217 Meyrin 2 - Geneva, Switzerland.

In Japan: Yokogawa-Hewlett-Packard Ltd., 3-29-21 Takaido-Higashi, Sugunami-ku, Tokyo, 168, Japan.