

# Signal Analyzers

**2309** 100 MHz to 2.4 GHz FFT Analyzer

**AEROFLEX**  
A passion for performance.



Unparalleled speed accuracy and dynamic range. A revolution in measurement accuracy

- Automated Intermodulation measurement on amplifiers and frequency converters
- Accurate spurious measurement on transmitters
- RF attenuator calibration and switch repeatability testing
- Accurate true RMS power measurement to 40 W
- Conversion of RF signals to digital IF data for external processing on a PC
- Excellent linearity and high intermodulation free dynamic range
- Fine level resolution of 0.0001 dB
- Frequency resolution to 0.04 Hz
- Low phase noise -121 dBc/Hz
- Input sensitivity to -167 dBm
- <math>< -130\text{ dBc}</math> IF spurious<sup>(1)</sup> free dynamic range

## A new architecture for signal analysis

The 2309 is a new concept in frequency selective level measurement offering broadband frequency coverage between 100 MHz and 2.4 GHz.

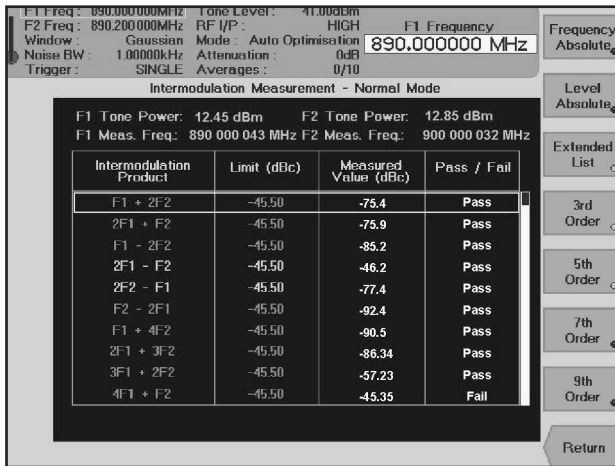
The 2309 has many advantages over conventional swept tuned spectrum analyzers particularly in terms of speed, accuracy, dynamic range and detector linearity that together add up to a revolutionary improvement in measurement capability for applications including amplifier intermodulation testing, attenuator calibration and VCO noise measurements.

The instrument uses a direct frequency conversion system followed by a highly linear patented 1 bit bandpass sigma delta converter operating at an IF of 10.71 MHz. In this way it is possible to make faster, more repeatable and precise absolute or relative signal and noise power measurements.

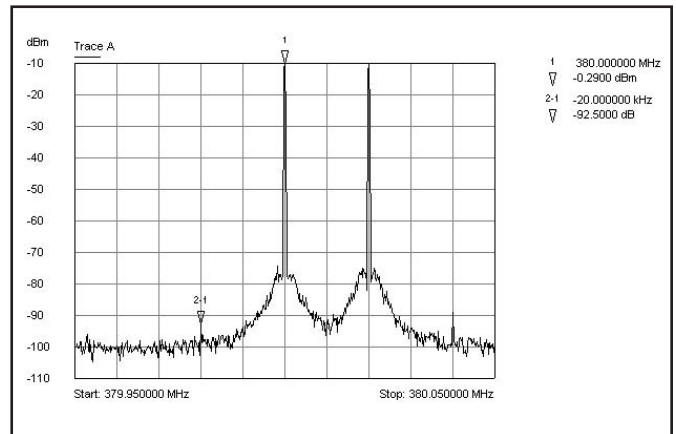
## Automated Intermodulation measurement

The 2309 includes an applications mode featuring automated intermodulation measurement functions ideal for both amplifiers and frequency converting devices. This mode provides either user defined or automatic measurement of a selected range of intermodulation products. This simple to use mode is both fast and very accurate. All hardware set-ups are automatically calculated which ensures that the intermodulation products measured are always a function of the device under test and not the test instrument. The user is no longer required to make careful calculations in order to find the optimum operating point for the instrument thus ensuring valid results are obtained every time. The results can be displayed as a table of values or as a spectral trace. In either case the results are verified against a test limit.

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Intermod application mode results table



High Sensitivity

The noise of the LO is closely matched to the performance of the A to D converter giving a maximum sensitivity of typically -153 dBm/Hz or -167 dBm when using the narrowest measurement bandwidth available (0.04 Hz).

### Dynamic Range

The third order intermodulation specification of typically <-90 dBc for 2 tones of -26 dBm at the mixer input allows high performance intermodulation measurements to be made.

The accuracy of the converter in making ratiometric measurements ensures that the intermodulation product levels are accurately recorded without the usual scale errors experienced with some spectrum analyzers.

### Unparalleled Figure of Merit (FOM)

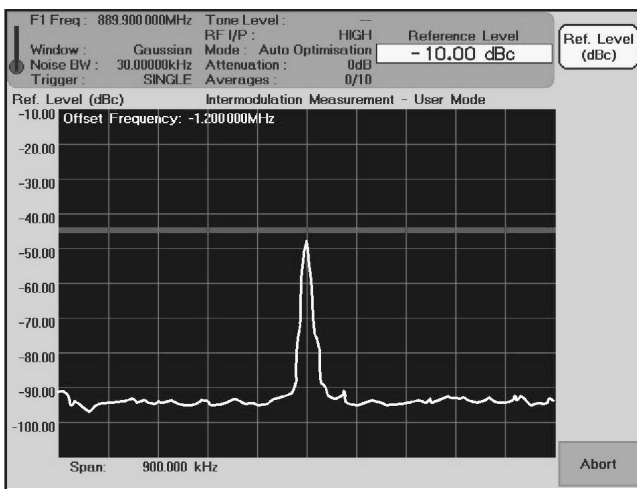
With a mixer TOI (third order intercept) of typically +28 dBm and a NF (noise figure) of typically 21 dB, the 2309 has a FOM of +7 (TOI - NF). Unlike other A to D techniques, this instrument obeys the normal 3:1 improvement in 3rd order intermodulation products with decreased input level.

### High Power

The high power input on the 2309 allows direct measurement on signals up to 50 W (40 W continuous). This eliminates the need for external high power attenuators and their uncertainties such as frequency and thermal responses.

### Attenuators and Switches

Combining superb linearity, high marker resolution and low noise, the 2309 is capable of making excellent attenuation measurements. With a scale linearity of 0.01 dB per 10 dB and 0.0001 dB resolution, the 2309 can be used as an attenuator transfer standard. The low residual floor noise of typically -153 dBm/Hz and narrow FFT based filters allows the 2309 to make measurements over large dynamic ranges. These properties are equally relevant for attenuator and RF switch repeatability testing.



Intermod application mode spectral display

### Speed

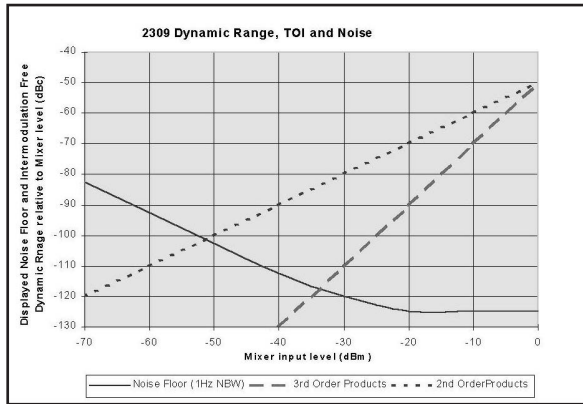
The 2309 is able to make narrow band measurements over 100 times faster than even the best examples of swept tuned spectrum analyzers.

The speed advantage may be used directly to improve test throughput or used to convert into improved sensitivity level by using narrower frequency resolution for the same measurement speed.

### Noise

A low noise local oscillator is used offering excellent close to carrier spurious and SSB phase noise characteristics. This makes the 2309 ideal for making SSB phase noise and spurious measurements on VCOs and synthesisers.

By avoiding the usual 'Up Down' mix techniques used in conventional spectrum analyzers, the noise contribution from the local oscillator is minimized thereby reducing measurement uncertainty.



### Level Accuracy

With a total measurement error of <math><0.5\text{ dB}</math> to 1 GHz, the 2309 is ideal for direct power measurement of transmitters. The excellent scale linearity allows accurate measurement to be made over a wide power range.

### External Processing of Digitized IF Data

With the data cable, Aeroflex part number 43139/401, connected to the Auxiliary I/O port on the rear panel of the 2309, digitized IF data is extracted from the instrument using the National Instruments PCI - 6534 digital I/O card and appropriate PC-based software. The cable and digital I/O card can be supplied as accessories. With this configuration, up to 10 seconds of data can be acquired, at a rate of up to 5 MByte/s for processing on a PC.

### GPIB Control

Measurement speed in production environments is vital. The 2309 can be configured with the minimum of GPIB control commands. The instrument is rapidly set up to pre-determined values or sensible presets. All GPIB programming uses SCPI-like commands and is based on the MEASURE, READ, FETCH structure. This means that programs can be written quickly using high level commands without needing an in-depth knowledge of the instrument.

### Cost of Ownership

To minimize cost of ownership, careful consideration has been given to the design and assembly of the 2309. The recommended calibration interval is 2 years. An accurate internal 400 MHz calibrator provides day to day alignment. A module exchange policy is used for the repair of major assemblies. These assemblies are fully calibrated. As a result, repairs can be carried out in the shortest time possible.

The use of FLASH memory and software download via the RS-232 interface means the 2309 can be upgraded without having to remove its covers.

### Printing Made Easy

By connecting directly to the parallel printer port interface, measurement results and trace data may be sent to any parallel printer which is compatible with the HP PCL printer language PCL3 or higher (eg HP DeskJet/LaserJet)

### MIPlot Measurement Presentation Software

The MIPlot measurement presentation software provides a powerful

tool to enable insertion of measurement traces into standard office PC packages. The software enables the capture of trace data from the 2309 using a PC with a standard GPIB card. The traces can be inserted into word processed documents or graphics packages using .OLE formatting. Once inserted into the document the traces can be rescaled, text and markers added and colors changed.

MIPlot is supplied as an optional accessory and is an excellent tool for report generation or for presentation of results to large groups of people.

## SPECIFICATION

### FREQUENCY

#### Frequency range

100 MHz to 2.4 GHz

#### Span

10 Hz to 300 kHz in a 1, 2, 5 sequence or continuously variable

#### Equivalent noise bandwidth (digital)

Window:-

5 term Blackman Harris ENBW 0.22% to 0.44% of set span

Gaussian ENBW 0.5% to 17.5% of set span

#### Phase noise (at 470 MHz)

10 kHz offset <math><-115\text{ dBc/Hz}</math>

20 kHz offset <math><-121\text{ dBc/Hz}</math>

25 kHz offset <math><-122\text{ dBc/Hz}</math>

50 kHz offset <math><-124\text{ dBc/Hz}</math>

### AMPLITUDE

#### Level Accuracy (for input attenuation >10 dB and S/N ratio >25 dB)

<math>\leq \pm 0.5\text{ dB}</math> (following self calibration, 100 MHz to 1 GHz, 25°C  $\pm$ 5°C).  
<math>\pm 1.0\text{ dB}</math> all other conditions.

#### Maximum input

(See Inputs)

#### Maximum Sensitivity

-164 dBm (0.04 Hz BW)

#### Dynamic range

Harmonic distortion <math><-70\text{ dBc}</math>

(for a single CW signal of -20 dBm at input mixer)

Third order intermodulation products <math>\leq -85\text{ dBc}</math> (for two tones, spaced  $\leq 100\text{ kHz}$  at -26 dBm at the mixer input)

Spurious responses @ offsets  $\leq \pm 1\text{ MHz}$  <math><-80\text{ dBc}</math>

Residual response <math><-110\text{ dBm}</math>, (0 dB RF attenuation, 0 dBm input level, input terminated)

Linearity  $\pm 0.01\text{ dB}$  per 10 dB plus Thermal Linearity Factor (TLF)  
Where TLF = 0.00 dB up to +30 dBm and 0.04 dB from +30 dBm to +47 dBm per 10 dB

#### Reference level setting

High power input +50 dBm to -200 dBm in 0.001 dB steps

Low power input +30 dBm to -200 dBm in 0.001 dB steps

### Input attenuator

0 to 65 dB in 5 dB steps

### Display resolution

0.01 dB to 20 dB/division in a 1, 2, 5, 10 sequence

### Display units

dBm, dB $\mu$ V, dBmV, dBV

## DISPLAY FEATURES

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6.5" VGA TFT active matrix color LCD. External VGA monitor supported via rear panel connector.

### Display

10 x 10 graticule, 501 points per trace

### Display update rate

9/sec

### Traces

Max/Min hold, Max hold, Outline, Infill

### Marker Resolution

0.001 dB

### Averaging

User settable 1 to 200 traces (repeat)

User settable 1 to 20000 traces (single)

### Markers

Frequency and level readout, 2 markers, Delta marker, Peak find, Delta marker sets span, Marker sets reference level, Marker sets reference frequency, Marker to center frequency

## RF INPUTS

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### HIGH POWER INPUT

#### Maximum Input

40 W (+46 dBm) continuous

50 W (+47 dBm) 50% duty cycle

50 W continuous for 30 s after a minimum interval of 30 s with <5 W applied

#### Connector

Type N (f), 50  $\Omega$  DC coupled

#### Input VSWR

<1.1:1, 100 MHz to 500 MHz

<1.22:1, 500 MHz to 1 GHz

<1.43:1, >1 GHz

### LOW POWER INPUT

#### Maximum Input

0.5 W (+27 dBm)

(overload protection to 10 W)

#### Connector

Type N (f), 50  $\Omega$  DC coupled

#### Input VSWR (>10 dB input attenuation)

<1.22:1, <1 GHz

<1.43:1, >1 GHz

#### Input VSWR (no attenuation)

<1.92:1 all frequencies

## FREQUENCY STANDARD

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### INTERNAL OCXO 10 MHz

#### Ageing

$\pm 0.8 \times 10^{-7}$  per year after 30 days

$\pm 2.5 \times 10^{-8}$  per month after 30 days

$\pm 2.0 \times 10^{-8}$  per month after 60 days

$\pm 1.5 \times 10^{-9}$  per day after 30 days

$\pm 1.0 \times 10^{-9}$  per day after 60 days

#### Temperature stability

$\pm 5 \times 10^{-8}$  over the temperature range +5 to +40°C

#### Warm up time

Output frequency within  $2 \times 10^{-7}$  of final frequency within 20 minutes after switch-on at a temperature of 20°C

## DATA CAPTURE & TRANSFER OF DIGITIZED IF DATA

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Data transfer is to a PC for storage and analysis. Transfer is via the rear panel Auxiliary I/O port to a data acquisition card.

Up to 50 MBytes or 10 s of IF sample data.

## DATA ACQUISITION CARD

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For use in an external PC for data transfer via the 2309 Auxiliary I/O port

National Instruments PCI-6534 High Speed Digital I/O PCI Module NI part number 778287-01, Aeroflex part number 87509

#### Data Transfer Protocol

The data is clocked to the NI card by a CLOCK signal from the 2309.

#### Data Transfer Port

Auxiliary I/O port

#### Data Transfer Rate

5 MByte/s

## REAR PANEL CONNECTORS

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### IF input

10.71 MHz, BNC (f), 50  $\Omega$

Input range -14 to -60 dBm (nominal)

### Frequency standard

Output: BNC(f), 10 MHz, 2 V pk-pk into 50  $\Omega$

Input: BNC(f), 1 MHz or 10 MHz of 350 mV to 1.8 V RMS into 1 k $\Omega$

### Printer interface

Parallel (Centronics compatible) 25 way D-type female

### Auxiliary data I/O

25 way D-type female

### External VGA monitor

15 way compact D-type female

### LO In and LO Out

SMA (F)

## RS-232

Connector is 9-way D-type (male), baud rate 300 to 9600 bits per second.

## REMOTE CONTROL

### GPIB

All major functions except power supply switch control are remotely programmable.

### Capabilities

Designed in accordance with IEEE488.2  
Complies with the following subsets as defined in IEEE std 488.1.  
SH1, AH1, T6, L4, SR1, RL1, PPO, DC1, DT1, CO, E2

## INSTRUMENT STORAGE

### Internal memory

10 non-volatile instrument setting stores

## GENERAL

### Electromagnetic Compatibility

Conforms with the protection requirements of EEC council directive 89/336/EEC  
Conforms with the limits specified in IEC/EN61326-1: 1997, RF Emission Class B, Immunity Table 1, Performance Criteria B

### Safety

Conforms with the requirements of EEC Council Directive 73/23/EEC (as amended) and the product safety standard IEC/EN61010-1 : 2001 + C1 : 2002 + C2 : 2003 for Class 1 portable equipment, for use in a Pollution Degree 2 environment. The instrument is designed to be operated from an Installation Category 2 supply.

### RATED RANGE OF USE

Full specification is met over the temperature range +5°C to +40°C (unless otherwise stated).

Humidity up to 93% over specified operating range and elevation up to 3,050 m (10,000 ft. (excluding 3.5" disk drive)

3.5" disk drive - Humidity up to 80% @ 30°C

### CONDITIONS OF STORAGE

Temperature -40 to +70°C  
Humidity 90% at +40°C  
Altitude <4,570 m

### Power requirements

Voltage range 100 V - 240 V~ (Limit 90 - 264 V)~  
Mains frequency 50 - 60 Hz (Limit 45 - 66 Hz)  
Power consumption 120 VA maximum

### CALIBRATION INTERVAL

Recommended 2 years

Re-alignment can be accomplished from the front panel or by GPIB control. There are no mechanical adjustments required for re-alignment

### Dimensions

Width: 419 mm, Height: 177 mm, Depth: 488 mm

### Weight

<17 kg

## VERSIONS AND ACCESSORIES

When ordering please quote the full ordering number information.

### Ordering Numbers

#### Versions

2309 100 MHz to 2.4 GHz FFT Analyzer

#### Supplied with

AC Supply lead

46882/415 Operating Manual

#### Optional Accessories

46880/091 Service Manual (including operating manual)

2388 1 GHz Active Probe (see separate datasheet)

59000/327 MIPlot Measurement Presentation Software

87509 National Instruments 778287-01, PCI - 6534, High Speed Digital I/O PCI Module

43126/012 RF connector cable, TM 4969/3, 50 Ω, 1.5 m, BNC

54311/092 Coaxial adapter N-type male to BNC female

54311/095 RF connector cable, 1 m, N-type connectors

43129/189 GPIB lead assembly, 1.5 m

43139/401 25 way D-type (m) to 68 way SCSI (f) cable assembly 2.5 m

46884/649 RS-232 cable, 9 way D-type female to 25 way D-type female, 1.5 m

46884/650 RS-232 cable, 9 way D-type female to 9 way D-type female, 1.5 m

46884/648 Cable assembly, serial port to printer 9 way D-type female to 25 way D-type male, 1.5 m

46884/560 Cable assembly, parallel port to printer Centronics socket, 2 m

46884/293 Rack mounting kit (with slides) for rack cabinets with depths from 480 mm to 680 mm

46884/294 Rack mounting kit (with slides) for rack cabinets with depths from 680 mm to 840 mm

46884/931 Rack mounting kit containing front brackets only

46662/614 Soft carrying case

(1) -Applies to spurious not occurring at center frequency



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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.