2310 TETRA Signal Analyzer

Setting new standards in TETRA transmitter analysis where speed and accuracy counts

- ***Accurate TETRA transmitter measurements***
- ***Test TETRA base stations, terminals and direct mode radios***
- ***Measurements made conforming to ETSI, ETS300 394-1***
- ***>80 dB instantaneous dynamic range for Adjacent Channel Power (ACP) and Power Profile***
- ***Spectral displays of TETRA signals***
- ***Modulation analysis, with vector and constellation diagrams***
- ***40 W continuous power handling***
- ***Wideband noise and discrete spurious measurements***

The new world standard for mobile radio, TErrestrial Trunked RAdio (TETRA) defined by ETSI, is a digital trunked radio system that uses time multiplexing (TDMA) with $\pi/4$ DQPSK modulation. TETRA offers radio users a high quality Voice and Data (V+D) network and improves upon the spectrum efficiency of older analog networks.

2310 TETRA signal analyzer is the most comprehensive TETRA transmitter tester available. TETRA networks will be used alongside existing analog networks, this places specific demands on the characteristics of the transmitter to prevent interference. A consequence of this requirement is that transmitters need to be designed and hence measured to a higher level of performance than has been necessary with analog systems.

When in the TETRA mode, the 2310 measures the following transmitter parameters, according to ETSI, ETS 300 394-1.

- *Average transmitter output power*
- *Transmitter power vs time*
- *Adjacent channel power due to modulation*
- *Adjacent channel power due to switching*
- *Adjacent channel power due to linearization*
- *Unwanted power in non active transmit state*
- *Modulation and frequency accuracy*
- *Wideband noise emissions*
- *Discrete spurious emissions*
- *Intermodulation Attenuation*

The 2310 architecture is based on single stage down conversion. The use of a local oscillator with low phase noise and a high performance digital IF stage results in an instrument with excellent phase noise and linearity. 2310 digitizes the time domain signal and then performs a FFT in order to display in the frequency domain. This architecture gives the 2310 the capability to measure with high dynamic range and excellent power accuracy. The 2310 can also capture a single TETRA burst with phase and magnitude information for modulation analysis and symbol data extraction.

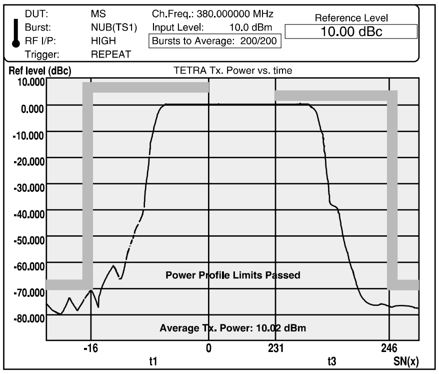
Average Transmitter Power

The 2310 can measure 40 W continuously and up to 50 W with a TETRA like burst profile. This means that all TETRA base station and terminal classes can be measured directly without the need for external attenuation. The average transmitter power is displayed and used as the reference for other relative power measurements, such as ACP (Adjacent Channel Power).

Transmitter Power vs Time

The power profile of a TETRA burst is measured and displayed. A dynamic range of >80 dB means that the full burst profile can be seen when measured through the TETRA filter. The user can select to view the whole burst, or the ramp-up (t1) and ramp-down (t3) periods of the burst in more detail. The burst profile limit mask can be displayed and automatic pass/fail indication is given.

A marker can be positioned on any symbol to measure the power value at each symbol point.



Power in the Non Active Timeslots

The 2310 is capable of measuring the power in each of the three non-active timeslots.

ACP due to Switching

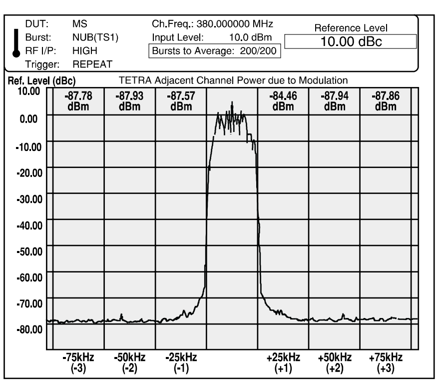
The fast rise and fall of the transmitter burst can result in spectral spreading into adjacent channels. ACP due to switching measures this spectral spreading. The measurement is made at ±25 kHz from the nominal carrier.

ACP due to Modulation

2310 measures ACP due to modulation with >80 dB dynamic range through the TETRA filter. The results can be displayed either in tabular format or viewed as a frequency spectrum. Intelligent limits compare the measured ACP against the appropriate values defined in ETSI, ETS 300 394-1. Alternatively, it is possible to set up user defined limits.

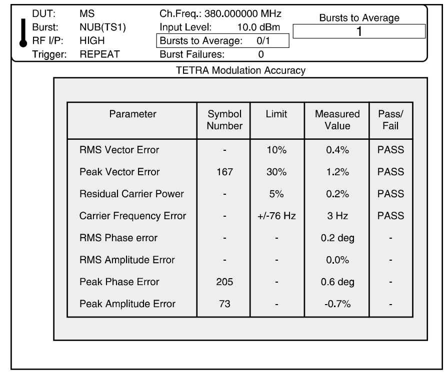
On a production line the ACP values can be measured quickly. The spectrum display provides a powerful diagnostic tool for the investigation of ACP measurement failures.

Measurements are made simultaneously for 3 channel offsets above and below the carrier.



Modulation Accuracy

The 2310 can demodulate and display the TETRA bursts. A symbol table displays the detected bits of a TETRA burst and groups them by symbol. To make interpretation of the data easier on the 2310 display, data is color coded according to function, for example training sequence, scrambled data, guard bits.

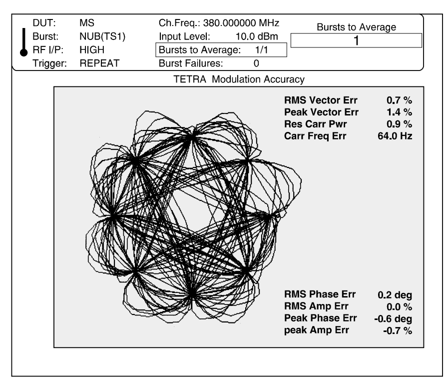


Parameter	Symbol Number	Limit	Measured Value	Pass/ Fail
RMS Vector Error	-	10%	0.4%	PASS
Peak Vector Error	167	30%	1.2%	PASS
Residual Carrier Power	-	5%	0.2%	PASS
Carrier Frequency Error	-	+/-76 Hz	3 Hz	PASS
RMS Phase error	-	-	0.2 deg	-
RMS Amplitude Error	-	-	0.0%	-
Peak Phase Error	205	-	0.6 deg	-
Peak Amplitude Error	73	-	-0.7%	-

The data within a single burst can be output via the GPIB interface.

A constellation diagram gives a display of the modulation accuracy at the symbol points. Vector error tolerance rings can be displayed at each phase state for rapid validation of modulation accuracy. Only symbols from the useful part of the burst are displayed, so for discontinuous bursts the ramp up and ramp down periods are not displayed.

A vector diagram displays both the modulation phase states at the symbol points and the path trajectory between states. Again only the useful part of the burst is displayed. When setting up a digital transmitter modulator it is beneficial to be able to see the overall effect of tuning on the modulation. A special feature of 2310 called rotated vector, superimposes each of the phase states on a single point. Having selected rotated vector it is possible to view the overall effect of any changes to the modulator's characteristic.



For diagnosing problems, EVM, phase and amplitude errors can be displayed as a graph against time.

Wideband Noise

The 2310 is capable of measuring wideband noise over the frequency range 100 MHz to 2.4 GHz. Wideband noise is defined as the broadband power that is transmitted by a TETRA radio and is measured through the TETRA filter at frequency offsets greater than 100 kHz from the on-channel. The user may specify up to 20 frequency offsets. For each offset, the average power of 20 bursts is calculated and displayed. (Additional equipment, materials and assembly required. Please refer to Application Note 46891/887.)

Discrete Spurious Emissions

Discrete spurious emissions are unwanted emissions far from the carrier which occur during the transmission of a TETRA burst. The 2310 is capable of measuring the average power of a discrete signal in the frequency range 100 MHz to 1 GHz. Up to 20 measurement frequencies may be specified by the user. For each frequency, the average power of 20 bursts is measured and displayed. When a discrete spurious signal with a level greater than the allowed limit is detected, the 2310 subtracts the maximum permitted level of wideband noise from the measured value before deciding whether the limit has been exceeded.

To simplify selection of candidate spurious signals, a prescan facility is provided that searches the spectrum for possible spurs.

Linearization Bursts

The 2310 measures the unwanted emissions produced by a mobile or base station when an initial linearization burst is transmitted. The measurement is made in a TETRA filter at frequency offsets ±25 kHz from the on-channel.

Fast Measurement Set-Up

Once TETRA mode is selected, the set up process is a simple five stage procedure:

- *Define the radio type (eg, Base Station/Terminal)*
- *Define the burst type (eg, Normal Downlink/Control Burst)*
- *Enter the transmitter frequency*
- *Enter nominal transmitter power*
- *Select the measurement*

For measurements defined by ETSI, ETS 300 394-1 the 2310 automatically configures itself to average the correct number of bursts and apply the TETRA filter as necessary. This makes measurement set up fast and simple, ensuring that all measurements are made correctly.

Measurement Times

The limits for each measurement as defined by ETSI, ETS 300 394-1 are stored in the 2310. Users can define their own limits for design proving or to take into account external sources of measurement uncertainty.

GPIB code is also minimized reducing the time taken to write production test programmes.

Pre-Conformance Testing and Development Proving

The 2310 can be used to form the basis of a pre-conformance test system. When used with IFR's TETRA signal generator (2050T) and radio test set (2968), all the major TETRA tests can be performed. This enables extensive product evaluation to be made before submitting a radio to a full conformance test house. As a result, the radio is more likely to pass first time. Full data sheets covering the 2050T and 2968 are available from IFR.

Production Testing

In a production test environment, speed of test is paramount. The 2310 is capable of testing TETRA radios faster and more accurately than any spectrum analyzer based system. The use of a single stage downconverter followed by a digital IF stage provides the required dynamic range much faster than is possible with swept frequency systems.

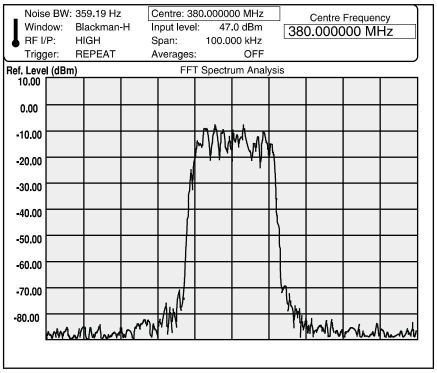
It is also possible to reconfigure the measurement with a minimum of GPIB commands. Measurement results and pass /fail status can be read directly. Radios are tested more quickly and accurately with the 2310.

GPIB Control

Measurement speed in production environments is vital. Due to its dedicated hardware platform, the 2310 can be configured with the minimum of GPIB control commands. The instrument is rapidly set up to pre-determined values or sensible presets. All 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 to have an in-depth knowledge of the instrument. For production test programs, low level commands are given that enable the programmer to use status bits to optimize programming and minimize test time.

A downloadable software driver is available at www.ifrsys.com which is compatible with various commercial packages to help further simplify test system software development.

FFT Spectrum Analyzer



The 2310 can also be used to display the spectrum of any signal in the 100 MHz to 2.4 GHz band. The use of a patented A to D converter gives a dynamic range and sensitivity unmatched by any swept tuned (superhetrodyne), based analyzer. Third order intermodulation free dynamic range is -90 dBc for two tones of -26 dBm at the input mixer. Maximum sensitivity is -150 dBm in a 1 Hz bandwidth. This delivers an instrument that is ideal for measuring unwanted intermodulation products in radio systems and measuring extremely low level spurious. Absolute amplitude accuracy is ±0.5 dB and so signal levels can be measured precisely. Close to carrier analysis is also possible due to the excellent phase noise and use of precise digital filters with good shape factor.

Cost Of Ownership

To minimize cost of ownership, careful consideration has been given to the design and assembly of the 2310. The recommended calibration interval is two 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 or 3.5 in floppy disk drive means the 2310 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 2310 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

TETRA Mode

Specifications in the TETRA mode section of this data sheet apply for frequencies from 100 MHz to 1000 MHz.

All measurements are made conforming to ETSI, ETS 300 394-1.

Burst Types Measured

Mode	Burst Type	Abbreviation
Base Station (Down Link)	Normal Synchronization	NDB SB
Mobile (Uplink)	Normal Control	NUB CB
Direct Mode	Normal Synchronization	DNB DSB

Dynamic range

Capable of measuring over a dynamic range of > 80 dB in a TETRA measurement bandwidth filter.

Input signal level for optimum dynamic range

+3 dBm to +46 dBm on the high power input.
-10 dBm to +27 dBm on the lower power input.
-20 dBm to +27 dBm on maximum sensitivity setting.

Trigger modes

Single; (user defined burst average)
Continuous; (user defined rolling average)

Average Transmitter Output Power

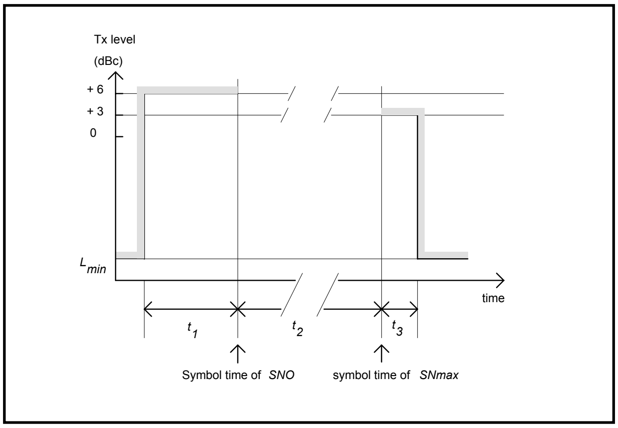
2310 measures the average transmitter output power through the TETRA filter for both base station (BS) or mobile station (MS) power class transmissions.

Accuracy (for input attenuation >10 dB)

±0.5 dB (following self calibration, 100 MHz to 1 GHz, 25°C ±5°C).
±1.0 dB all other conditions.

Transmitter Power Versus Time

2310 measures the power profile of a TETRA burst and compares it to the power versus time mask below:



Accuracy

±0.2 dB ± residual error

Residual noise floor

<-80 dBc

Display Modes

Graph of power vs time for whole burst or for ramp up and ramp down periods only

Tabular result presentation

Unwanted Output Power in Non Active Transmit State

2310 measures unwanted power in each of the 3 non-active timeslots following the transmitter burst through a TETRA filter.

Accuracy

±0.2 dB ± residual error

Residual noise floor

<-80 dBc

Display Modes

Tabular result presentation

Graph of power vs time for the TDMA frame

Adjacent Channel Power due to Modulation

The 2310 measures the average power appearing in the adjacent channels at frequency offsets of ±25 kHz, ±50 kHz and ±75 kHz from the nominal center frequency of the allocated channel.

The measurements are performed over the useful part of a burst through the TETRA filter.

Accuracy

±0.2 dB ± residual error

Residual noise floor

<-80 dBc

Display Mode

Tabular result presentation

Spectrum display of adjacent channel power.

Adjacent Channel Power due to Switching Transients

The 2310 measures the adjacent channel power due to switching transients of the ramp-up (t1) and ramp-down (t3) period of a discontinuous burst. The peak power for each burst is measured. The average peak power over 200 bursts is calculated and displayed.

The measurement is performed at frequency offsets of ±25 kHz from the nominal frequency of the allocated channel through the TETRA filter.

In addition, 2310 logs the peak power of the highest 20 bursts measured.

Accuracy

±0.2 dB ± residual error

Residual noise floor

<-70 dBc

Display Modes

Tabular result presentation.

Graph of power vs time for each of the on-channel and ± 25 kHz adjacent channels.

Modulation Accuracy

The 2310 measures the difference between the actual transmitted waveform and the ideal signal waveform.

RMS Vector Error	<0.01 (<1% in any burst)
Peak Vector Error	<0.03 (<3% for any symbol)
Residual Carrier Magnitude	<0.01%

DISPLAY MODES

(1) Constellation

Samples displayed at symbol times. Updated 3 times per second. All symbols within the t2 period are displayed.

(2) Vector

Display of trajectory between symbol times.

(3) Rotated Vector

Display of all symbol points super imposed onto a single symbol point.

(4) Symbol table

The detected bits of a single TETRA burst are displayed and grouped by symbol.

(5) Tabular result presentation

RMS and peak vector error, residual carrier, plus phase, amplitude and carrier frequency error.

(6) EVM, Phase and amplitude error versus time

Carrier Frequency Accuracy

The difference between the actual transmitted carrier frequency and its nominal value.

Accuracy

±0.01 ppm + frequency standard error

Display Mode

Numeric display as above (5)

Wideband Noise

The 2310 measures the wideband noise level at selected frequency offsets from the on-channel. For each offset, the average power over 20 bursts is calculated and displayed. The measurement is timed to occur during the useful part of the burst (and covering at least 200 symbols in each burst) and is made through the TETRA filter. The average transmitter output power is also measured and is used as the 0 dB reference.

Accuracy

±0.2 dB ± residual noise floor error.

	Residual Noise Floor (18 kHz b/w)	
Offset Frequency	**CW <=520 MHz**	**CW <1 GHz**
100 kHz to 250 kHz	-88.0 dBc	-88.0 dBc
250 kHz to 500 kHz	-98.0 dBc	-98.0 dBc
500 kHz to frb	-100.0 dBc	-99.0 dBc
>frb	-105.0 dBc	-103.5 dBc

Where frb denotes the frequency offset correspond-ing to the near edge of the received band or 5 MHz whichever is greater.

Display modes

Tabular result presentation
Spectrum display of selected frequency offset

Adjacent Channel Power during Linearization Bursts

The 2310 measures the peak power appearing in the adjacent channels during the first linearization period. The measurement is performed at frequency offsets of ±25 kHz from the nominal center frequency of the allocated channel through the TETRA filter.

Accuracy

±0.2 dB ± residual error

Residual Noise Floor

<-70 dBc

Display Mode

Tabular results presentation

Graphs of power vs time for on-channel and ±25 kHz adjacent channels.

Merasurement Time

Measurement Parameter	Bursts	Seconds (typically)	
Transmitted power	200	<25	
Power in non active timeslot	200	<35	1 slot
		<50	2 slots
		<60	3 slots
Adjacent Channel Power	200	<45	± 1 channel
(Mod)	60	<30	± 3 channels
Adjacent Channel Power (switching)	200	<70	± 1 channel
Mod Accuracy and Frequency error	20	<10	
Wideband Noise	20	<30	8 offsets
ACP during linearization	200	<35	

FFT SPECTRUM ANALYZER

Frequency

Frequency range

100 MHz to 2.4 GHz

Total span

10 Hz to 300 kHz 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	<-115 dBc/Hz
20 kHz offset	<-121 dBc/Hz
25 kHz offset	<-122 dBc/Hz
50 kHz offset	<-124 dBc/Hz

Display resolution

501 points per trace

Display update rate

5 updates/second

Amplitude

Accuracy (for input attenuation >10 dB)

±0.5 dB (following self calibration, 100 MHz to 1 GHz, 25°C ±5°C).
±1.0 dB all other conditions.

Dynamic range

Harmonic distortion <-70 dBc

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

Third order intermodulation free dynamic range <-85 dBc (typ. <-90 dBc) for 2 tones of -26 dBm at mixer for tone spacing less than or equal to 100 kHz.

Maximum sensitivity -150 dBm in 1 Hz bandwidth (low power input)

Spurious responses @ off sets <= ± 1 MHz <-80 dBc

Residual response <-110 dBm, (0 dB RF attenuation, input terminated)

Linearity ±0.01 dB per 10 dB plus Thermal Linearity Factor (TLF). Where TLF = 0.00 dB up to +30 dBm and 0.04 dB from +30 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, dBμV, dBmV, dBV

Features

Display

10 x 10 graticule, 501 points per trace

Traces

Max/Min hold, Max hold, Outline, Infill

Marker Resolution

0.001 dB

Averaging

User settable 1 to 200 sweeps (repeat)

User settable 1 to 20000 sweeps (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 centre frequency

RF INPUTS (TETRA AND FFT SPECTRUM ANALYZER MODES)

High Power Input

Maximum Input

40 W (+46 dBm) continuous

50 W (+47 dBm) 50% duty cycle

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

Connector

Type N (f), 50 Ω 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 Ω 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

Display

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

Frequency Standard

Internal OCXO

10 MHz

Ageing

±0.8 x 10^{-7} per year after 30 days
±2.5 x 10^{-8} per month after 30 days
±2.0 x 10^{-8} per month after 60 days
±1.5 x 10^{-9} per day after 30 days
±1.0 x 10^{-9} per day after 60 days

Temperature stability

±5 x 10^{-8} over the temperature range 5 to 40°C

Warm up time

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

Rear Panel Connectors

IF input

10.71 MHz, BNC (f), 50 Ω

Frequency standard

Output:	BNC(f), 10 MHz, 2V pk-pk into 50 Ω
Input:	BNC(f), 1 MHz or 10 MHz
	Requires an input signal of 350 mV to 1.8 V RMS into 1 kΩ.

Printer interface

Parallel (Centronics compatible) 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.

GPIB

See remote control

Instrument Storage

Internal memory

10 non volatile instrument setting stores

Remote Control

GPIB

All major functions except power supply switch control and auto pre-scan 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.

General Characteristics

Electromagnetic compatibility

Conforms with the protection requirements of EEC council directive 89/336/EEC.

Conforms with the limits specified in the following standards.

EN55011:	1991 (emissions) Class B
EN50082-1:	1992 (immunity)
EN60555-2:	1987 (mains harmonics)
CISPR 11	1990 Class B
IEC1000-4-2	
IEC1000-4-3	
IEC1000-4-4	
IEC60555-2	

Safety

Complies with IEC1010-1 EN61010-1 for class 1 portable equipment and is for use in a pollution degree 2 environment. The instrument is designed to operate 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 (10,000ft) (excluding 3.5 in disk drive).

3.5 in 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

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

Power requirements

Mains frequency	*47 Hz to 63 Hz*
Voltage range	*(100 V to 120 V and 210 V to 240 V) ±10%*
Power consumption	*120 VA maximum*

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

2310 100 MHz to 2.4 GHz TETRA Signal Analyzer

Supplied with

AC Supply lead

46882-329 Operating Manual

Options

Option 01 Enhanced Dynamic Range for Wideband Noise (For more information on additional equipment, materials and assembly required please see Application Note 46891/887, Using 2310 with Option 01)

Optional Accessories

46880/081	Service Manual
2388	1 GHz Active Probe
59000/327	MIPlot Measurement Presentation Software
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 m
46884/649	RS-232 cable, 9 way D-type (f) to 25 way D-type (f), 1.5 m
46884/650	RS-232 cable, 9 way D-type (f) to 9 way D-type (f), 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
54112/164	Soft carrying case

CHINA
Tel: [+86] (10) 6467 2823
Fax: [+86] (10) 6467 2821

FRANCE
Tel: [+33] 1 60 79 96 00
Fax: [+33] 1 60 77 69 22

GERMANY
Tel: [+49] (8131) 29260
Fax: [+49] (8131) 2926130

HONG KONG
Tel: [+852] 2832 7988
Fax: [+852] 2834 5364

LATIN AMERICA
Tel: [+1] (972) 899 5150
Fax: [+1] (972) 899 5154

SCANDINAVIA
Tel: [+45] 9614 0045
Fax: [+45] 9614 0047

SPAIN
Tel: [+34] (91) 640 11 34
Fax: [+34] (91) 640 06 40

UNITED KINGDOM
Tel: [+44] (1438) 742200
Toll Free: [+44] (0800) 282 388 (UK only)
Fax: [+44] (1438) 727601

USA
Tel: [+1] (316) 522 4981
Toll Free: [+1] (800) 835 2352 (US only)
Fax: [+1] (316) 522 1360

email **info@ifrsys.com**

web **www.ifrsys.com**

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