

# Signal Analyzers

## 2319E 500 MHz to 2.5 GHz RF Digitizer

**AEROFLEX**  
A passion for performance.



### 2319E for the ultimate in flexibility

- Conversion of RF signals to digital IF and IQ data for external processing on a PC
- 500 MHz to 2.5 GHz frequency range
- 20 MHz wide digitization bandwidth
- External triggering
- 65.28 M Samples/s sample rate
- 12 bit ADC resolution
- Low phase noise,  $-121$  dBc / Hz
- High sensitivity,  $-153$  dBm / Hz
- Built in FFT spectrum monitor
- 1 M sample internal IQ data memory
- Optional analog IQ inputs and outputs
- Application software for GSM/EDGE real time demodulation

*2319E is a high precision RF instrument designed to provide good quality digital conversion of RF input signals. Designed with 3G applications in mind, 2319E operates across a wide frequency range including all 2G and 3G bands and provides a generous digitization bandwidth sufficient to capture four 5 MHz wide UMTS radio channels. Digital IQ or IF data is output on a choice of convenient interfaces for external processing, either in real time as required in radio demodulation applications, or in bursts as required for parametric signal analysis.*

Rapid advances are being made in digital communications techniques driven by the demands of 2nd and 3rd generation cellular systems. Now more than ever before it is necessary to stay at the forefront of technological developments to retain a competitive advantage. 2319E from Aeroflex provides the flexibility to satisfy this need. 2319E helps design engineers track down problems by providing a truly flexible platform from which customized solutions can be developed.

Radio systems are designed around complex signalling protocols, their development and ongoing revision can be greatly accelerated by having versatile test equipment right from the early stages. Commercially available full blown system simulators are rarely able to keep pace with rapidly evolving radio standards. 2319E provides the basis from which customized system simulators can be developed which are versatile and easily modified to track standards.

#### **A truly flexible concept**

This approach ensures that signal analysis functions can be developed optimally against the needs of each application and allows applications to be developed not only by the equipment vendor but also by third parties and customers. In this way the compromises that can occur with integrated test instruments are avoided. This approach leads to much faster application development specific to the needs of individual end users. An added advantage of this approach is the ease and speed with which the very latest advances in data processing technology can be incorporated into signal analysis systems.

2319E redefines the boundary between signal capture and signal processing by moving the signal processing function to a PC.

## Versatile and Scaleable Digital Design

Digitized IQ or IF data is available at a variety of interfaces at a rate up to 65.28 M Samples/second. IQ data is output in real time or in bursts. Internal sample memory is provided to store up to 1 M digitized IQ samples (decimated or undecimated) or 2 M digitized IF samples.

## Triggering

Triggering on an external TTL signal allows precise data capture for external analysis.

## Performance

2319E accepts RF input across a broad RF frequency range from 500 MHz to 2.5 GHz. Digitization is performed across a bandwidth of 20 MHz at an intermediate frequency of 48.96 MHz.

A to D conversion is performed with 12 bit resolution. The digitizer performance is equally matched by the instrument's highly linear RF down converter. The switched RF input attenuator provides up to 65 dB of attenuation in steps of just 5dB ensuring optimum dynamic range can be maintained.

The excellent phase noise characteristic of the phase locked fractional N based internal local oscillator is typically -121 dBc/Hz at 20 kHz offset from a carrier of 1 GHz and is shown in figure 2. Noise floor performance is typically <-145 dBc/Hz at carrier offsets beyond 1 MHz. Elimination of YIG technology yields higher reliability and lower complexity.

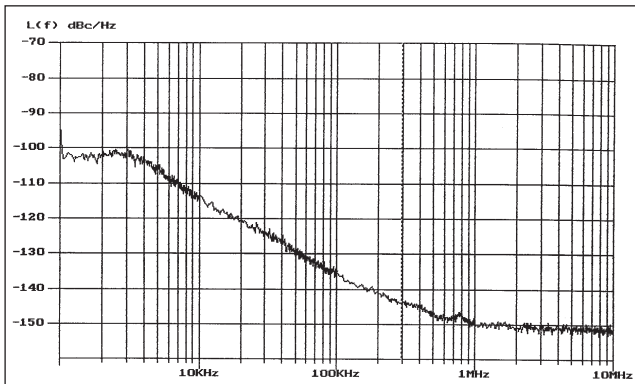


Figure 2 - SSB Phase noise profile of LO at 1 GHz

The mixer IF signal is amplified and filtered to provide 85 dB of alias rejection before the signal is directly digitized. 2319E performs an FFT on the digitized data and displays the result as a single trace on the front panel display. This provides an excellent indication of the spectral content of the digitized data. Marker functions are available to aid closer scrutiny.

The A to D converter yields an overall spectral density of -139 dBc/Hz

## External Processing

2319E is supported by a selection of interface types. At the most basic level, data is extracted via GPIB. This provides both an instrument control interface and data extraction.

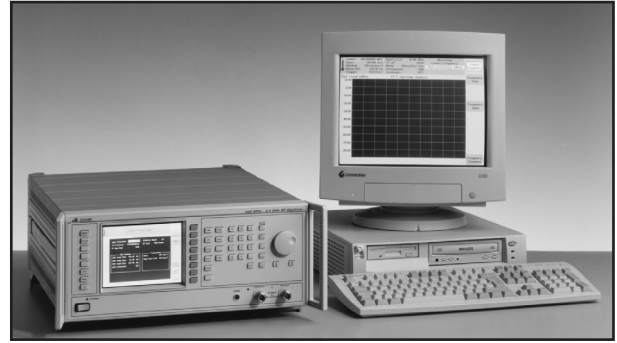


Figure 3 - 2319E Simple PC Applications

For higher rate data, 2319E is fitted with a proprietary interface supporting IF data transfer rates up to 16 M Samples/s. A National Instruments PC based data acquisition card can be supplied as an accessory. Signal processing is then performed in the PC CPU.

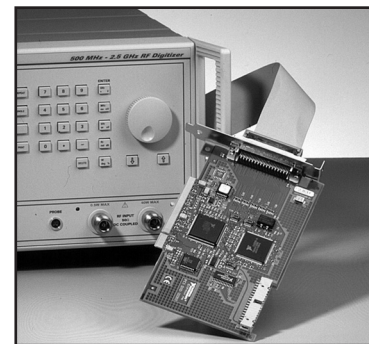


Figure 4 - NI Data acquisition card for interface to 2319E

For the highest data rates, i.e. 65.28 M Samples/s, data is output via an LVDS (Low Voltage Differential Signalling) interface.



Figure 5 - Sundance PCI DSP/FPGA card

Aeroflex has selected Sundance Microprocessor Technology Ltd. as a supplier for high powered external processing hardware because of their versatility and advanced technology. Sundance products comply with the TIM (Texas Instruments Mezzanine) module standard making them easily reconfigurable to support new requirements and they interface directly to the Aeroflex 2319E via LVDS. Up to 4 TIM sites are available on the PCI TIM module carrier card which includes highly flexible comm-port technology. The Sundance SMT332 single width DSP TIM module features a 200 MHz TMS320C6201 processor with 16 Mbyte of DRAM and 1 Mbyte of

SRAM. The Sundance SMT358 single width FPGA module features the Xilinx Virtex range of FPGA devices, 400 k equivalent gates of software configurable resource (or higher if required), high speed ZBT RAM, 200 MB/s data pipe speed and LVDS interfacing. Each module can be supported by a variety of carrier cards including PCI, cPCI and VME.

**Operation**

2319E can be operated from the front panel but the primary user interface is via remote control using GPIB. All hardware control features apart from mains AC power are controllable via GPIB.

**Ergonomics**

- 4U high, 19" wide for bench top or rack mounting.
- 6.5" Color VGA LCD backlit panel display for waveform and instrument status display.
- A range of soft and hard key controls for manual control of hardware set up.
- High power (up to +47 dBm) and Low power front panel RF inputs.

**FFT Spectral Monitor**

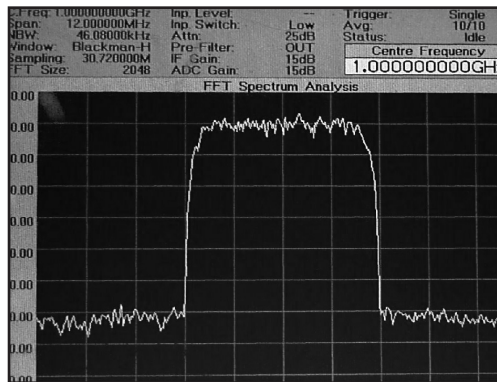


Figure 6 - FFT display of W-CDMA

The FFT Monitor provides a single trace spectral display of the captured data. Span settings of up to 16 MHz can be selected with Blackman Harris or Gaussian windowing. The FFT spectral display is supported by various marker functions. Data can be viewed in max or min hold, samples, averaged and infill.

**Reliability and Support**

2319E includes many design features which improve reliability and simplify routine calibration.

- Field replaceable modules for simple and rapid repair by inexperienced operators.
- MTTR (mean time to repair), less than 45 minutes.
- Standard 2-year factory warranty.

**Applications**

Applications for 2319E are determined entirely by external application software within the limitations of the hardware platform, examples of which include:

**Real time demodulation for radio emulation and verification**

2319E can be used as a substitute for a mobile or base station receiver during early R&D phases of new system development.

Real time continuous demodulation of radio signals can be performed on an external DSP card in conjunction with Aeroflex software. Custom solutions can be provided.

**GSM /EDGE (Part Number 81516)**

This application runs on a PC mounted external DSP card, part number 87500.

GSM / EDGE demodulation conforms to the requirements of GSM 05.02, 05.04, and provides GSM, GMSK and EDGE, 3π/8 8PSK single slot per frame real-time demodulation to raw symbols. The application software auto detects which modulation type is being received and performs synchronization, tracking and data extraction for normal burst types and for GSM RACH burst types. Synchronization is performed without the need for any external frame or slot triggering. Data is output from the external DSP card via a 4 wire serial interface although the actual implementation of the data interface can be made customer specific, including using the host back plane.

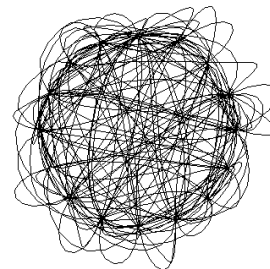


Figure 7 - EDGE Transmitted Vector Diagram

**SPECIFICATION**

**RF PERFORMANCE**

**Frequency Range**

500 MHz to 2.5 GHz with a setting resolution of 1 Hz

**Frequency Reference**

Internal OCXO 10 MHz  
External 1 MHz or 10 MHz

**Ageing**

- ±0.8 x 10<sup>-7</sup> per year after 30 days
- ±2.5 x 10<sup>-8</sup> per month after 30 days
- ±2.0 x 10<sup>-8</sup> per month after 60 days
- ±1.5 x 10<sup>-9</sup> per day after 30 days
- ±1.0 x 10<sup>-9</sup> per day after 60 days

**Temperature Stability**

±5 x 10<sup>-8</sup> over the temperature range +10°C to +40°C

**Warm Up Time**

Output frequency within 2 x 10<sup>-7</sup> of final frequency 20 minutes after switch on at a temperature of 20°C

**INPUT LEVEL RANGE**

**High Power Input Maximum level**

+46 dBm (40 W) continuous

+47 dBm (50 W) 50% duty cycle

#### Low Power Input Maximum level

+27 dBm continuous

#### Displayed Average Noise Level, (DANL)

-150 dBm/Hz Low power input  
-127 dBm/Hz High power input

#### Input VSWR

<1.22:1 to 1 GHz  
<1.43:1 above 1 GHz  
<1.92:1 with 0 dB input attenuation (low power input selected)

#### Input Attenuator

0 to 65 dB in 5 dB steps

#### Phase Noise at 1 GHz

10 kHz offset	-109 dBc/Hz
20 kHz offset	-115 dBc/Hz
50 kHz offset	-118 dBc/Hz
100 kHz offset	-130 dBc/Hz
600 kHz offset	-140 dBc/Hz
1 MHz offset	-142 dBc/Hz

### IF PERFORMANCE

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#### Frequency

48.96 MHz

#### External Input Level Range

-37 dBm to +5 dBm

#### 1 dB Bandwidth

20 MHz

#### Anti Alias Stop Band Rejection

85 dB

### DIGITAL PERFORMANCE

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#### Sampling Rate

65.28 M Samples/s

Selectable re-sampling filter generates I and Q samples at 30.72 M Samples/s (equal to UMTS chip rate x 8)

#### ADC Resolution

12 bits

#### Spectral Density

-139 dBc/Hz

equating to -73 dBc in 4 MHz channel [0 dB crest factor]

#### Internal Memory

1 M Samples of IQ data pairs

2 M Samples of IF data

#### Output Data

Selectable as either digital IQ or digital IF

#### Data Length

IF data is 12 bits

IQ data is up to 16 bits I followed by up to 16 bits Q

#### Output Port

Selectable from GPIB, TTL data out or LVDS data out interfaces

LVDS port supports digital IF or IQ data output at full sampling rate

TTL data out port supports IF data output at either 8 Ms/s or 16 Ms/s

TTL data out port supports IQ data output at either 8 Ms/s or 4 Ms/s

#### IQ Decimation

User selectable IQ decimation by  $2^n$   
where n is 1 to 5

### DATA CAPTURE & TRANSFER

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Data transfer is by block data transfer to a PC for storage and analysis. Transfer is via a TTL Port to a data acquisition card or via the GPIB interface. The act of data capture can be made dependant upon an external trigger, as described below.

#### Memory

Up to 2 M samples in IF output mode  
Up to approximately 30 ms of IF data

Up to 1 M IQ data pairs in IQ mode  
Up to approximately 15 ms of IQ data with no decimation, non-resampled

Up to approximately 490 ms of IQ data with x32 decimation, non-resampled

Up to approximately 32 ms of IQ data resampled

### TRIGGERING

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#### External Trigger

Input: External TTL signal

Trigger Point: Rising edge  
Falling edge

Connector: BNC on rear panel

Application of an external TTL signal will trigger the filling of the sample RAM. The data is then transferred to a PC via the data acquisition card or GPIB interface.

Note: For data capture via the GPIB a more limited form of external triggering is provided, whereby only a single TTL trigger event should be generated before the data has been transferred. Operation using repetitive trigger pulses is not guaranteed because of the slower data transfer speed with the GPIB interface.

#### Trigger Off

The data capture is not dependant upon an external trigger event. Instead, the data acquisition card or GPIB interface controls the data capture and transfer process.

### FFT SPECTRAL MONITOR

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Reference level setting +50 dBm\* to -200 dBm in 0.001 dB steps  
\*reduces to +30 dBm for low power input.

#### Update Mode

Single and Repeat Modes

SINGLE and REPEAT operation is only relevant to the FFT spectral monitor mode. It is not applicable in the Data Capture modes (i.e. via TTL port or GPIB).

#### Frequency Span

32 MHz / Decimation

Decimation equals  $2^n$  where n is 1 to 5



## **ENVIRONMENTAL**

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### **RATED RANGE OF USE**

#### **Operating Temperature**

+10°C to +40°C (+50°F to +104°F)

### **CONDITIONS OF STORAGE**

#### **Temperature**

-20°C to +60°C (-4°F to +140°F)

#### **Humidity**

85% at +30°C and +50°C (+86°F and +122°F)

#### **Altitude**

<4,570 m

## **GENERAL CHARACTERISTICS**

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Remote Control

### **GPIB**

All major functions except power supply switch control are remotely programmable

### **Capabilities**

Designed in accordance with IEEE 488.2.  
Complies with the following subsets as defined in IEEE std 488.1,  
SH1, AH1, T6, SR1, RL1, PPO, DC1, DT1, CO, E2, L4

### **ELECTROMAGNETIC COMPATIBILITY**

Conforms with the protection requirements of the EEC Council Directive 89/336/EEC. Conforms with the limits specified in the following standards:  
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/EN 61010-1 : 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.

## **MINIMUM PC REQUIREMENTS**

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PCI configured DSP/FPGA card accessory (part number 87500) requires a full length PCI slot of 2 slot widths and the PCI interface should supply 3.3 V DC. Windows 95™, Windows NT™ operating system.

## **DATA ACQUISITION CARD**

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For use in external PC for data transfer via the 2319E TTL Data Out Port.  
National Instruments Data Acquisition Card 777314-01 (PCI), Aeroflex part number 87503, is recommended.

### **Data Transfer Protocol**

NI DAQ card asserts ACK line to request data transfer, releases ACK line to inhibit data transfer.  
Following data capture completion instrument asserts REQ line to enable data transfer, releases REQ line when data transfer complete.

### **Data Transfer Port**

TTL Data Output Port

### **Data Transfer Rate**

128 Mbit/s (16 x 8 MSamples/sec) (1 m cable maximum)

64 Mbit/s (16 x 4 MSamples/sec) (2 m cable maximum)

## VERSIONS AND ACCESSORIES

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When ordering please quote the full ordering number information.

### Ordering

#### Numbers Versions

2319E 500 MHz to 2.5 GHz RF Digitizer

#### Supplied with

46882/457 2319E Operating & programming manual (English)

#### Options

Option 01 Not applicable

Option 02 Analog IQ inputs and analog IQ outputs

#### Accessories

46880/102 Service Manual (includes operating and maintenance manuals)

87500 Configured DSP/FPGA PCI TIM module carrier card with DSP/FPGA/LVDS TIM modules. Supplied with 46882-462 System configuration guide <sup>(1)</sup>

81516 GSM / EDGE Real time demodulation application software <sup>(2)</sup>

87503 National Instruments 777314-01 Data I/O card (PCI bus) <sup>(3)</sup>

28531/051 National Instruments 777073-01 PCI-GPIB Interface card (Windows NT compatible)

43129/189 GPIB lead assembly, 1.5 m

23435/696 68 way SCSI (m) interconnecting cable assembly 1.8 m

23435/697 68 way SCSI (m) interconnecting cable assembly 3 m

43139/269 25 way D type (m) to 68 way SCSI (f) cable assembly 1 m

43139/270 25 way D type (m) to 68 way SCSI (f) cable assembly 2.5 m

46884/650 Serial port to PC cable, 9 way D-type (f), 1.5 m

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

54311/092 Coaxial adapter N-type (m) to BNC (f)

43139/042 RF cable 50 ohm BNC - BNC, 1.5 m

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

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

2388 1 GHz Active probe

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### Notes

1 Requires accessory 23435/696 or 23435/697

2 Requires accessory 87500 DSP/FPGA card (not fitted internally)

3 Requires 43139/269 25 way D type male to 68 way SCSI cable assembly 1 m or 43139/270 D type male to 68 way SCSI cable assembly 2.5 m

**CHINA Beijing**

Tel: [+86] (10) 6467 2761 2716  
Fax: [+86] (10) 6467 2821

**CHINA Shanghai**

Tel: [+86] (21) 6282 8001  
Fax: [+86] (21) 62828 8002

**FINLAND**

Tel: [+358] (9) 2709 5541  
Fax: [+358] (9) 804 2441

**FRANCE**

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

**GERMANY**

Tel: [+49] 8131 2926-0  
Fax: [+49] 8131 2926-130

**HONG KONG**

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

**INDIA**

Tel: [+91] 80 5115 4501  
Fax: [+91] 80 5115 4502

**KOREA**

Tel: [+82] (2) 3424 2719  
Fax: [+82] (2) 3424 8620

**SCANDINAVIA**

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

**SPAIN**

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

**UK Burnham**

Tel: [+44] (0) 1682 604455  
Fax: [+44] (0) 1682 662017

**UK Stevenage**

Tel: [+44] (0) 1438 742200  
Fax: [+44] (0) 1438 727601  
Freephone: 0800 282388

**USA**

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

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[www.aeroflex.com](http://www.aeroflex.com)  
[info-test@aeroflex.com](mailto:info-test@aeroflex.com)



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