2319E

500 MHz to 2.5 GHz RF Digitizer

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 IFR 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 compromizes 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.

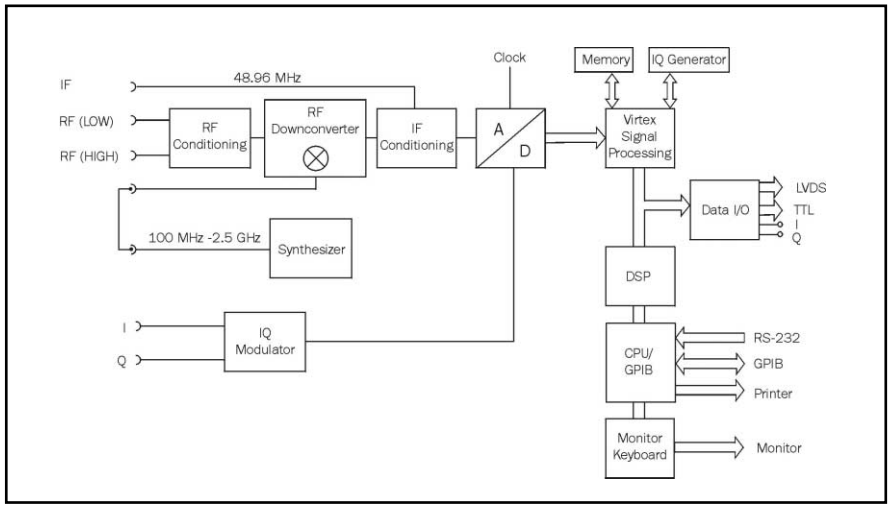

Figure 1 - Basic Instrument Block Diagram

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.

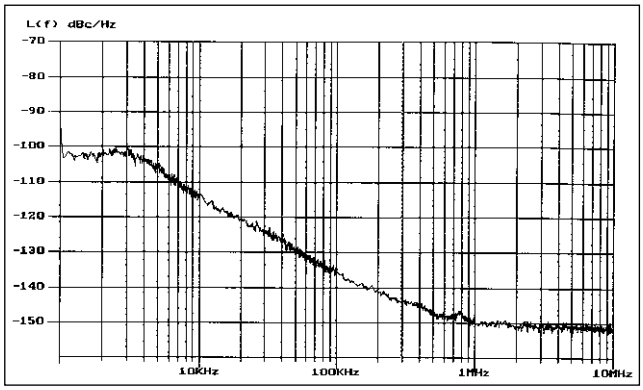

Figure 2 - SSB Phase noise profile of LO at 1 GHz

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.

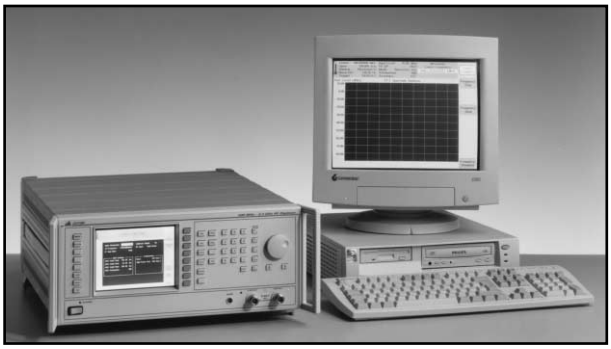

Figure 3 - 2319E Simple PC Applications

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.

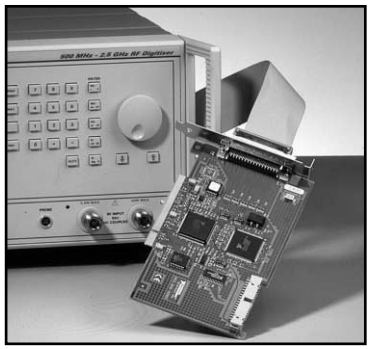

Figure 4 -NI Data aquisition card for interface to 2319E

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

IFR 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 IFR 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

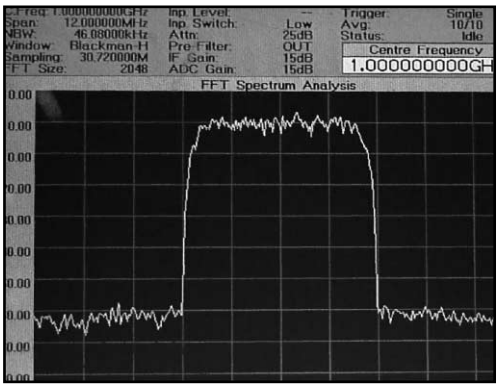

Figure 6 - FFT display of W-CDMA

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 IFR 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.

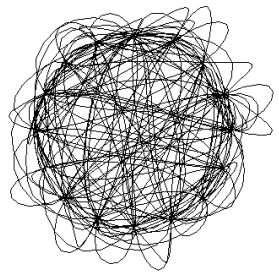

Figure 7 - EDGE Transmitted Vector Diagram

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

$\pm 0.8 \times 10^{-7}$ 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 +10°C to +40°C

Warm Up Time

Output frequency within 2×10^{-7} 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

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

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

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

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.

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

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

Windows

Gaussian and Blackman Harris

ENBW

Gaussian: 0.15% to 50% of sampling frequency
Blackman Harris: 0.15% to 2% of sampling frequency

Display Resolution

501 points per trace on a 10 x 10 graticule

Vertical Resolution

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

Traces

Max/Min hold, Max hold, Infill, Outline
Update rate: 9 per second (max)

Averaging

User settable from 1 to 200 (repeat mode)
User settable from 1 to 20,000 (single mode)

Display Units

dBm, dBµV, dBmV, dBV, dB

Markers

Frequency and level readout
2 markers, A & B

Marker Functions

Delta marker, Delta marker sets span
Marker sets reference level, Marker to centre frequency

PHYSICAL

Dimensions

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

Weight

17 kg

Display

6.5 inch VGA TFT active matrix color LCD

Front Panel Input / Output Connectors

RF inputs x 2	*Type N (f) 50 Ω DC Coupled*
RF probe DC power	*Sub-miniature 3-pin (f)*

Rear Panel Input / Output Connectors

LVDS Data Out

Connector type	*68 way SCSI style (f)*
Signal outputs	
Data	*IF (12 bit precision) or IQ (13 or 14 bit precision depending on decimation setup)*
Clock	
IQ Strobe	

TTL Data Out

Connector type	*25 way D type (f)*
Signal outputs	
Data	*IF (12 bit precision) or IQ (13 to 16 bit precision depending on decimation setup)*
Clock	
IQ Strobe	
Data request	
Data acknowledge	

Analog I and Q Inputs (option 2)

Mode	*Single ended, differential*
Connectors	*BNC x 4*
Impedance	*50 Ω / 1 kΩ*
1 dB Bandwidth	*10 MHz*
Level	*nominal 1v peak (variable)*

Analog I and Q Outputs (option 2)

Connector	*BNC x 2*
Impedance	*50 Ω*
Level	*0.5 V peak*
Amplitude resolution	*12 bits*
Sample rate	*65.28 M/decimation*

Re-construction filter 1 dB bandwidth: 5 MHz

(decimation equals 2^n and n is 1 to 5)

GPIB

Data Transfer Rate
10 kbit/s

Remote Control

GPIB connector (IEEE488.2)

Printer

25 way D-type (female) (Centronics compatible)

External VGA Monitor

15 way compact D-type (female)

Software Download

9 way D-type (male)

Rate - 300 to 9600 bit/s

Local Oscillator RF Out

SMA (female)

Local Oscillator RF In

SMA (female)

Internal 10 MHz Reference Out

BNC (female)

External 1 or 10 MHz Reference In

BNC (female)

External IF In

BNC (female)

External Trigger In

BNC (female)

ELECTRICAL

Mains Frequency

47 Hz to 63 Hz

Voltage Range

100 V to 240 V ± 10%

Power Consumption

<150 VA

ENVIRONMENTAL

RATED RANGE OF USE

Operating Temperature

+10°C to +40°C

CONDITIONS OF STORAGE

Temperature

-20°C to +60°C

Humidity

85% at +30 and +50°C

Altitude

<4,570 m

GENERAL CHARACTERISTICS

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, PP0, DC1, DT1, C0, 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 73/72/EEC and Standard IEC/EN 61010-1 : 1993
Complies with IEC 1010-1, BS EN61010-1 class 1 portable equipment and is for use in a pollution degree 2 environment. The instrument is designed to operate from an installation category 1 or 2 supply.

MINIMUM PC REQUIREMENTS

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

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

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 (1)
81516	GSM / EDGE Real time demodulation application software (2)
87503	National Instruments 777314-01 Data I/O card (PCI bus) (3)
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

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

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