Signal Sources

IFR 3410 Series Digital RF Signal Generators

AEROFLEX
A passion for performance.

An agile signal generator that combines wide frequency cover and high performance vector modulation in a small package, making it ideal for testing wireless communication systems and components

- Wide frequency coverage

  250 kHz to 2 GHz (3412)
  250 kHz to 3 GHz (3413)
  250 kHz to 4 GHz (3414)
  250 kHz to 6 GHz (3416)
- Fast RF frequency and level settling for high speed testing
- High performance vector modulation for improved component test
- Optional dual channel arbitrary waveform generator (ARB)
- Low adjacent channel power for receiver selectivity and amplifier linearity testing
- Fast GPIB response to maximize ATE system performance
- ***IQCreator*** ® RF waveform creation software
- Wide bandwidth FM and AM modulation capability
- Optional Differential I/Q outputs for simplified component test interfacing
- Optional high speed pulse modulation capability
- Compact and lightweight package
- Simple to use touch panel interface
- RF optimization modes - Auto, Low Noise, Low ACP and Higher Power

The IFR 3410 series are portable, lightweight signal generators covering a wide range of carrier frequencies to 6 GHz. High quality analog and vector modulation capabilities make these signal generators ideal for research, development and manufacturing applications.

Careful attention to the design of the modulators and the RF system ensures that these signal generators exhibit low levels of adjacent channel power, making them suitable for the most demanding amplifier linearity and receiver selectivity measurements.

The use of Aeroflex fractional N synthesis techniques, combined with fast level control and an electronic attenuator, ensures the 3410 series signal generators are both frequency and level agile for high speed ATE testing.

Operation

A flexible but intuitive user interface based on a touch panel display system ensures that the signal generator meets the needs of unskilled as well as skilled operators. The instrument can be configured to the required mode of operation very simply, with numerical data being entered by the keyboard or via a rotary control. The display shows the primary parameters in a clear and unambiguous format, minimizing the risk of operator error.

RF Output

The 3410 series signal generators provide peak output power of up to +16 dBm. With a level resolution of 0.01 dB, repeatable and accurate testing of wireless components can be performed.

The electronic attenuator is ideal for high volume applications where attenuator life is critical. A user defined RF level limit can be entered to ensure that the signal generator cannot provide damaging signal levels when testing less robust components. Careful attention to the level control system guarantees that positive level transients cannot be generated. The fast responding electronic reverse power protection system helps ensure long life and high reliability when testing high power systems.

Spectral Purity

Receiver measurements require good spectral purity from a signal generator. The 3410 series has excellent performance with typically 1.5 Hz residual FM at 1 GHz and a floor noise of typically better than -148 dBc / Hz.

Frequency and Level Setting Times

Fast frequency and RF level setting times are key parameters in achieving minimum test execution times and therefore maximum throughput, in production environments. The 3410 series with typical frequency setting times of 2 ms and level setting times of 2.5 ms provide outstanding performance.

In addition to comprehensive sweep functions for carrier frequency, RF level and modulation oscillator 3410 series provides an extremely fast optional sweep mode for frequency and level settings through the use of user stored lists. Option 010, List Mode has a setting time of less than 500 μs and is ideal for frequency hopping and semi-conductor production applications.

Modulation

Comprehensive modulation facilities are provided for supporting the testing of analog or digital RF systems. A single key press turns the modulation on and off, providing a fast method for signal to noise checking.

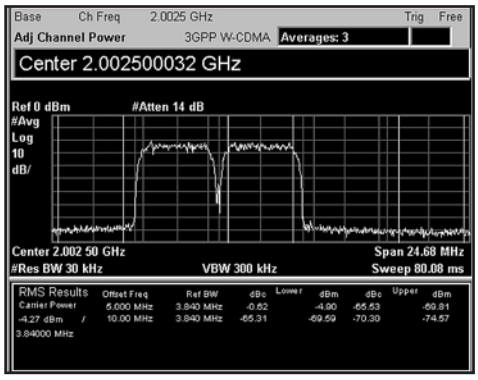
	Int Am1	Int (AM1 + AM2)	Ext AM1	Int FM1	Int (FM1 + FM2)	Ext FM1	Int PM1	Int (PM1 + PM2)	Ext PM1	Internal IQ	External IQ	Pulse	Burst
Int AM1				✓	✓	✓	✓	✓	✓			✓	
Int (AM1 + AM2)				✓		✓	✓		✓			✓	
Ext AM1				✓	✓	✓	✓	✓	✓			✓	
Int FM1	✓	✓	✓									✓	
Int (FM1 + FM2)	✓		✓									✓	
Ext FM1	✓	✓	✓									✓	
Int PM1	✓	✓	✓									✓	
Int (PM1 + PM2)	✓		✓									✓	
Ext PM1	✓	✓	✓									✓	
Internal IQ												✓	✓
External IQ												✓	✓
Pulse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Burst										✓	✓		

Modulation Modes

Vector Modulation

The built-in IQ modulator provides state-of-the-art vector modulated signals with excellent level linearity, low vector error and low noise. With a typical vector bandwidth up to 55 MHz, the modulator is able to support wideband as well as narrow-band wireless standards. Internal calibration systems ensure the modulator performance can be quickly optimized to reduce vector errors and ensure low carrier leak at all operating frequencies.

The linearity of the modulator and the RF output system is reflected in the excellent adjacent channel power when generating multi-carrier non-constant envelope signals such as cellular CDMA and TETRA.



Typical 3GPP 2 carrier test model 1 (64 channels)

Analog Modulation

With typical AM bandwidth to 30 MHz and typical FM bandwidth to 20 MHz, the 3410 series signal generators are ideal tools for testing broadcast systems. The wide bandwidths allow video signals to modulate the carrier with minimal distortion.

The wideband FM facilities allow the generation of fast-swept signals, while the use of a patented DC FM system ensures that carrier frequency errors when the FM is DC coupled are minimal.

The specifications for AM are maintained to high carrier frequencies to support the use in modern EMC testing applications. The signal generator maintains excellent phase noise performance even when generating wideband modulated signals.

Modulation Oscillator

An internal modulation oscillator is provided which can be used to generate two tones in the frequency range 0.1 Hz to 50 kHz (16 MHz with Option 005 ARB Waveform Generator). In addition to sine waves, the modulation oscillator can provide square waves, triangular and sawtooth waveforms for narrow band sweeping.

Digital Modulation

The user has a choice of either a Dual Arbitrary Waveform Generator or a Real Time Baseband Generator for producing digitally modulated output signals.

Dual Arbitrary Waveform Generator

Fitted internally, the optional Dual Channel Arbitrary Waveform Generator allows the user to select from a library of pre-stored IQ modulator drive waveforms to provide accurately modulated carriers simulating the characteristics of digitally modulated communication systems. Burst modulation and alternate level rf attenuation facilities are provided for TDMA signal simulation. Marker output signals can be placed within the waveform to simplify triggering and synchronization with external test equipment. Using a patented technique, the dual channel ARB is able to take waveform files typically four times oversampled and run them through a real time interpolation

system to raise the sampling rate of the file. This ensures the generation of low adjacent channel power and low spectral noise density. The dual channel ARB is suited for the generation of both narrow band and wideband signals, including WCDMA signals, without the use of switched reconstruction filters. Combining a large ARB memory with the smaller file size required to define a waveform allows the ARB to store up to 180 waveforms. Alternatively the whole of the memory can be devoted to a single file. One such file would store over 1.5 seconds of a 3GPP WCDMA waveform signal. The use of interpolation techniques ensures that when narrow band systems are simulated the waveform generator can still operate at a high sample rate without requiring excessively large amounts of data to be loaded or restricting the repetition time. The library waveforms are structured in a directory form to ease their selection and the optimization of the user's generator. The modulation waveforms can be simply changed by selection from a file list with the changeover between waveforms occurring in a few milliseconds rather than the many seconds required in more traditional waveform generators. The file name can be determined by the user to convey a useful description of the contents of the file.

Real Time Baseband Generator

Fitted internally, the optional Real Time Baseband, RTBB, generates baseband signals (I and Q) that modulate an RF source in real time to produce generic FSK, PSK and QAM signals at rates up to 2 Msymbols/sec. The RTBB generates or inputs a set of modulation symbols, modulates them with the chosen scheme, filters them using an appropriate channel filter, and then converts the digital stream to analogue I and Q for the I/Q vector modulator. The source of the symbol data is very flexible. The symbol data can originate from a variety of internal or external sources. Internal data source choices include a PRBS generator, an internal pattern generator or internal memory storage of user downloaded symbols. External real-time symbol data can be input in serial or parallel format via an industry standard Low Voltage Differential Signalling (LVDS) interface.

Digitized I/Q data, available from sources such as basestation simulators, can be input via the LVDS interface as an alternative to external parallel or serial symbol data. Streaming digitized I/Q data samples are available as an output via the LVDS interface from internally generated symbols for testing D/A convertors.

Synchronized clock, RF Burst, RF Burst Attenuation control and marker output signal facilities are available for both internal and external data generation.

An important feature necessary to support GSM signal generation is the ability to frequency hop between channels. The RTBB option provides frequency hopping by re-mixing the I and Q data at baseband. The resultant I and Q vectors then modulate the core synthesizer frequency thus producing a new RF frequency at the output of the signal generator. This method ensures that synchronization is maintained between the IQ data and the hop trigger. In addition, because the main synthesizer hardware remains unchanged, frequency stabilization is nearly instantaneous.

IQCreator®

The 3410 series is supplied with a free copy of ***IQCreator***®, a software package to aid the creation and download of files to the ARB and RTBB options.

IQCreator® is a Windows based software utility that enables a user to set up a modulation scheme and then create an ARB file using modulation templates. The resulting file may be saved on a PC or downloaded into the ARB. User-defined configurations can also be saved. Consequently, it is possible to load previously saved setups to regenerate the ARB files quickly and easily. The capabilities of ***IQCreator***® include:-

Generic Modulation Types

PSK, FSK, MSK, QAM modulation types
Nyquist, Root Nyquist and Gaussian filters
PRBS, fixed pattern and user defined data sources
IQ errors - residual carrier, IQ imbalance, quadrature offset
Multi-carrier

Also included are 2G, 2.5G and 3G cellular TDMA and CDMA digital standards along with WLAN and other cordless phone standards.

In addition, ***IQCreator***® includes a utility that allows user-defined waveforms, created using software simulation tools such as MATLAB, to be converted and packaged into a form that can be downloaded into the 3410 Series ARB.

12345® is continually updated to include new modulation capabilities and facilities. The latest version is available for download at www.aeroflex.com/IQCreator.

Options to have an instrument's ARB pre-loaded with a suite of example waveform files are available. A selection of waveforms from each of the standards, or just waveforms relevant to the user's applications, can be chosen. Although only available at the time of order, all the waveforms are available within IQCreator should any of the files be deleted then required in the future.

I/Q Outputs

Single ended baseband I/Q outputs are available as standard. Differential I/Q outputs, combined with comprehensive voltage bias and offset facilities, are optionally available to simplify component and module testing.

Pulse Modulator

An optional pulse modulator allows the generation of fast rise time RF signals with on/off ratios that meet the most demanding radar and ECM/ECCM test applications.

Remote Control

The 3410 series include both fast GPIB and Ethernet remote control interfaces for flexibility in production environments. RS-232 control is also provided for use in legacy ATE systems.

The protocol and syntax of the GPIB commands have been designed in accordance with IEEE 488.2 to simplify program generation. Plug and play drivers are available that include a virtual front panel for remote instrument supervision and debug.

Frequency Standard

The 3410 series includes a high stability OCXO as standard. The inclusion of a main input power standby mode maintains the oscillator at working temperature while the rest of the instrument is powered down. Time to full specification working is thereby minimized for equipment facilities held on standby.

Size

The 2U rack height ensures the 3410 series occupies minimal space in a manufacturing rack or on the engineer's bench, allowing the provision of more compact test systems. The full rack width ensures easy stacking of instruments while the light weight allows for easy carrying in the laboratory or the field.

SPECIFICATIONS

CARRIER FREQUENCY

Range

250 kHz - 2 GHz (3412)
250 kHz - 3 GHz (3413)
250 kHz - 4 GHz (3414)
250 kHz - 6 GHz (3416)

Resolution

1 Hz, accuracy as frequency standard
The carrier output phase can be advanced or retarded in increments of 0.036°.

FREQUENCY SETTING TIME (NON-LIST MODE)

After receipt of the GPIB interface deliminator (terminator), 23°C ± 5°C

phase noise mode optimised >10 kHz

<5.5 ms, typ 4 ms*

≤375 MHz, to be within ≤200 Hz
>375 MHz, to be within ≤0.1 ppm

phase noise mode optimised <10 kHz

<3 ms, typically 2.5 ms, ≤375 MHz, to be within ≤200 Hz*
<2.5 ms, typically 2 ms, >375 MHz, to be within ≤0.1 ppm*

** For instruments fitted with option 2, add 0.5ms*

FREQUENCY SETTING TIME (OPTION 010 LIST MODE)

After external trigger in List Mode, 23°C ± 5°C

Phase Noise Mode Optimized >10 kHz

<4 ms, typically 3 ms, ≤375 MHz, to be within <200 Hz
>375 MHz, to be within <0.1 ppm

Phase Noise Mode Optimized <10 kHz

<600 µs, typically 500 µs, ≤375 MHz, to be within <200 Hz
<500 µs, typically 450 µs, >375 MHz, to be within <0.1 ppm

RF OUTPUT

The RF output is controlled by an ALC system in normal operation. When IQ modulation is enabled alternative control modes are available to optimize the performance of the signal generator.

Range

Electronic Attenuator

≤10 MHz	*-140 to +13 dBm*
≤2 GHz	*-140 to +16 dBm*
≤3 GHz	*-140 to +16 dBm*
≤3.75 GHz	*-140 to +13 dBm*
≤4 GHz	*-140 to +10 dBm*
≤6 GHz	*-140 to +8 dBm*

Mechanical Attenuator

≤10 MHz	*-140 to +16 dBm*
≤2 GHz	*-140 to +19 dBm*
≤3 GHz	*-140 to +16 dBm*

No Attenuator

≤10 MHz	*0 to +21 dBm*
≤3 GHz	*0 to +22 dBm*
≤3.75 GHz	*0 to +20 dBm*
≤4 GHz	*0 to +17 dBm*
≤6 GHz	*0 to +18 dBm*

When AM is selected the maximum RF output is linearly reduced by up to 6 dB depending on the requested AM depth.

When IQ modulation is selected maximum output is reduced by 6 dB below 100 MHz.

Resolution

0.01 dB

RF Level Units

Units can be set to µV, mV, V EMF or PD; dB relative 1 µV, 1 mV, 1 V EMF or PD; or dBm. Conversion between dB and linear units may be achieved by pressing the appropriate units key (dB or V, mV or µV).

RF Output Accuracy (@ 23°C ± 5°C)

Electronic Attenuator

RF Mode		*-127 to -30 dBm*	*>-30 dBm*
Auto	*≤2 GHz*	*±0.75 dB*	*± 0.50 dB*
	≤3 GHz	*±1.00 dB*	*±0.75 dB*
		-110 to -30 dBm	*>-30 dBm*
	≤6 GHz	*±1.25 dB*	*±1.00 dB*

Mechanical Attenuator

RF Mode		*-127 to -28 dBm*	*>-28 dBm*
Auto	*≤2 GHz*	*±0.75 dB*	*± 0.50 dB*
	≤3 GHz	*±1.00 dB*	*±0.75 dB*

No Attenuator

RF Mode		*>0 dBm*
Auto	*≤ 2 GHz*	*±0.50 dB*
	≤ 3 GHz	*±0.75 dB*
	≤ 6 GHz	*±1.00 dB*

Level Accuracy With IQ Modulation

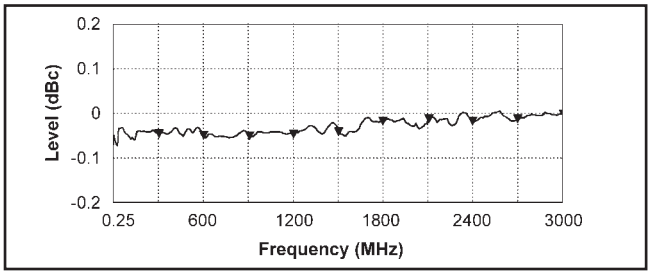
For constant envelope modulation systems: typical standard level error ±0.15 dB

For non-constant envelope modulation systems: typical standard level error ±0.25 dB

Temperature Stability

±0.01 dB/°C, ≤3 GHz
±0.02 dB/°C, ≤4 GHz, ±0.02 dB/°C typical, ≤6 GHz

RF Flatness



Typical flatness at 0 dBm

LEVEL SETTING TIME

Electronic attenuator, Option 003 is assumed in all cases.
ALC loop bandwidth 'Moderate' or 'Broad', to be within ≤0.3 dB

Level Setting Time (Non-List Mode)

After receipt of the GPIB interface deliminator (terminator), 23°C ± 5°C

<4.5 ms, typically 2.5 ms

Level Setting Time (Option 010 List Mode)

After external trigger in List Mode, 23°C ± 5°C

<3 ms, typically 1.5 ms

Output VSWR

Electronic Attenuator

For output levels <0 dBm

Frequency	Output VSWR
≤2 GHz	<1.25:1
≤3 GHz	<1.40:1
≤4 GHz	<1.50:1
≤6 GHz	<1.60:1

For output levels >0 dBm VSWR is <1.5:1 ≤4 GHz, <1.8:1 ≤6 GHz

Mechanical Attenuator

For output levels <0 dBm

Frequency	Output VSWR
≤3 GHz	1.33:1

For output levels >0 dBm VSWR is <1.5:1, ≤3 GHz

No Attenuator

Frequency	Output VSWR
≤4 GHz	<1.5:1
≤6 GHz	<1.8:1

Attenuator Repeatability

Mechanical attenuator typically 0.1 dB

Output Connector

Front panel 50 Ω type N female to MIL-PRF-39012 class 2

Output Protection

Protects the instrument from externally applied RF power (from a 50 Ω source) of 50 W up to 3 GHz and 25 W up to 4 GHz

The RPP trip may be reset from the front panel or via the remote interface. For safety, the protection is also provided when the instrument is switched off.

3416 damage level 0.5 W (+27 dBm) from a max 5:1 VSWR, all frequencies

SPECTRAL PURITY

Harmonics

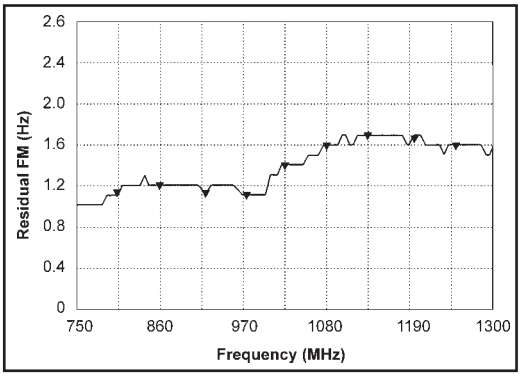
<-30 dBc, typically <-40 dBc for output levels ≤+7 dBm

Sub- and Non-Harmonics

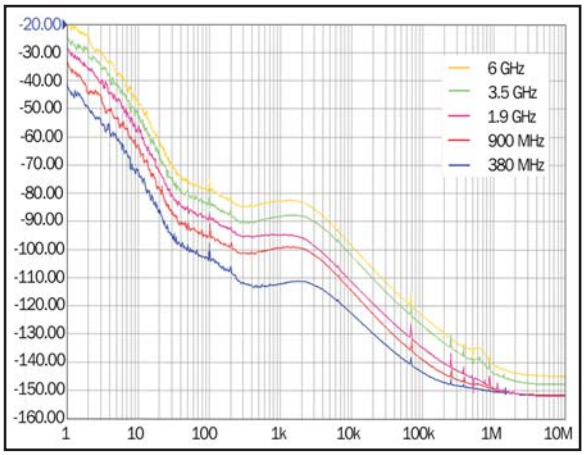
For offsets >10 kHz
<-70 dBc for carrier frequencies ≤3 GHz
<-60 dBc for carrier frequencies ≤6 GHz

Residual FM (FM on CW)

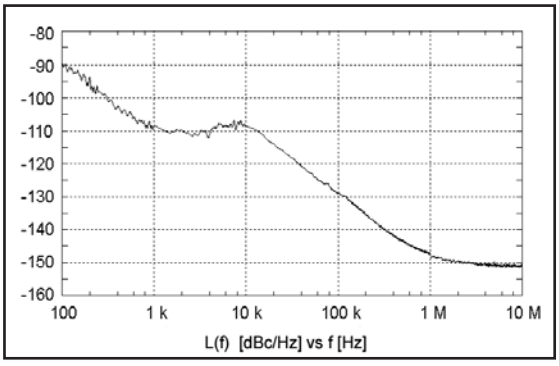
<2.5 Hz RMS (typically 1.5 Hz) at 1 GHz in a 300 Hz to 3.4 kHz unweighted bandwidth



Typical Residual FM



Typical SSB Phase Noise, phase noise optimized >10 kHz offset

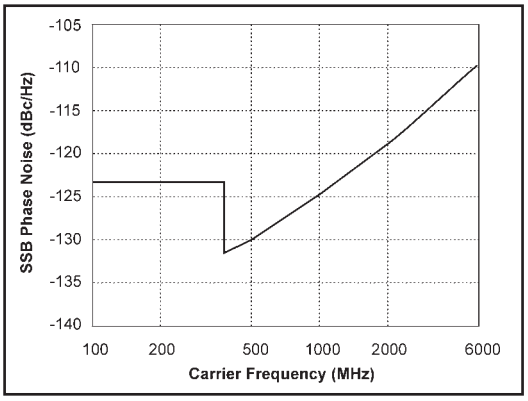


Typical SSB Phase Noise at 1 GHz, phase noise optimized <10 kHz offset

SSB Phase Noise

For 20 kHz offset, Noise Optimized mode

	CW/IQ
≤375 MHz	<-115 dBc/Hz
500 MHz	<-124 dBc/Hz
1 GHz	<-118 dBc/Hz
2 GHz	<-112 dBc/Hz
3 GHz	<-108 dBc/Hz
4 GHz	<-106 dBc/Hz
6 GHz	<-102 dBc/Hz

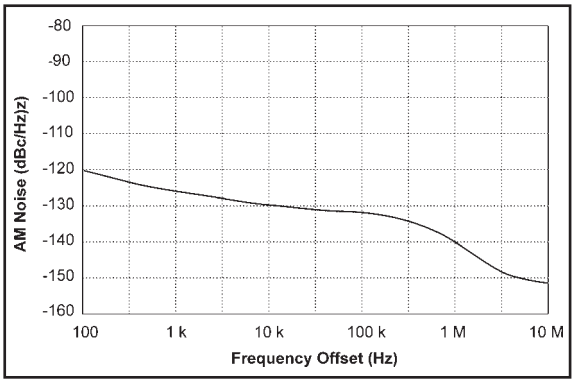


Typical SSB Phase Noise Performance at 20 kHz Offset, phase noise optimized >10 kHz offset

-SSB AM Noise

SSB AM noise at 20 kHz offset (Typical values) measured at levels >0 dBm

Frequency MHz	*CW/IQ (dBc/Hz)*
≤ 3 GHz	*-130*
≤ 6 GHz	*-125*



Typical AM Noise at 1 GHz

RF Leakage

<0.5 µV PD at the carrier frequency into a single turn 25 mm loop 25 mm or more from the case of the signal generator, for carrier frequencies <3 GHz.

Wideband Noise

Applicable for all carrier levels at offsets >5 MHz and <50 MHz excluding thermal noise (23°C ±5°C). Maximum output level dependant on RF mode.

RF Mode	*≤375 MHz (dBc/Hz)*	*≤3 GHz (dBc/Hz)*	*≤6 GHz (dBc/Hz)*
Power	*<-138*	*<-142 (-148 typ)*	*<-136*
Noise	*<-138*	*<-142 (-148 typ)*	*<-136*
ACP	*<-135*	*<-140*	*<-134*

MODULATION

FM, AM and ΦM can be applied to the carrier using internal or external modulation sources. The internal modulation source is capable of generating two simultaneous signals into any one of the modulation channels. The internal and external modulation sources can be simultaneously enabled in order to produce combined amplitude and frequency (or phase) modulation.

Internal and external IQ modulation can be applied. In this mode, FM, AM and ΦM are not permitted.

Optional Pulse modulation can be used in combination with FM, AM, ΦM and IQ from an external pulse source.

FREQUENCY MODULATION

Peak Deviation

Frequency	*Maximum Peak Deviation*
250 kHz to 375 MHz	*7.5 MHz*
375 MHz to 750 MHz	*3.75 MHz*
750 MHz to 1.5 GHz	*7.5 MHz*
1.5 GHz to 3 GHz	*15 MHz*
3 GHz to 6 GHz	*30 MHz*

Displayed resolution is 4 digits or 1 Hz.

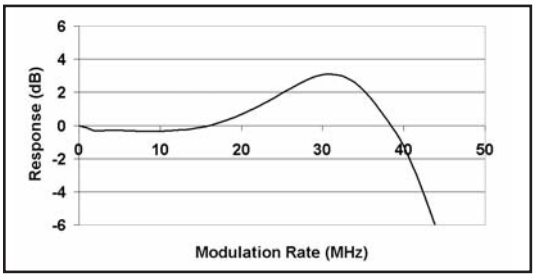
FM Accuracy

At 1 kHz rate
±3% of set deviation excluding residual FM

FM Bandwidth

0.5 dB DC to 200 kHz (DC coupled, 100 kΩ)
10 Hz to 200 kHz (AC coupled, 100 kΩ)

3 dB Typically 20 MHz (DC or AC coupled, 50 Ω)



Typical FM Bandwidth

Carrier Frequency Offset

For DC coupled FM ±(1 Hz + 0.1% of set deviation) after performing a DCFM null operation

Total Harmonic Distortion

At 1 kHz rate
<0.15% for deviations up to 2% of maximum allowed deviation
<0.6% for deviations up to 20% of maximum allowed deviation
<1.5% at maximum deviation

PHASE MODULATION

Phase Deviation

0 to 10 radians
Displayed resolution is 4 digits or 0.01 radians.

Accuracy

At 1 kHz rate
±4% of set deviation excluding residual phase modulation

Bandwidth

0.5 dB 100 Hz to 10 kHz (AC coupled, 100 kΩ)

Total Harmonic Distortion

At 1 kHz rate
<0.5% at 10 radians deviation
Typically <0.1% at 1 radian deviation

AMPLITUDE MODULATION

Specifications apply for carrier frequencies from 2 MHz up to 2 GHz, usable to 4 GHz and 'Noise' or 'ACP' RF modes.

Maximum specified output power is reduced by 2 dB, ≤10 MHz for 'No attenuator' Option 001 with AM selected.

Modulation Depth

0 to 99.9%, Displayed resolution is 3 digits or 0.1%

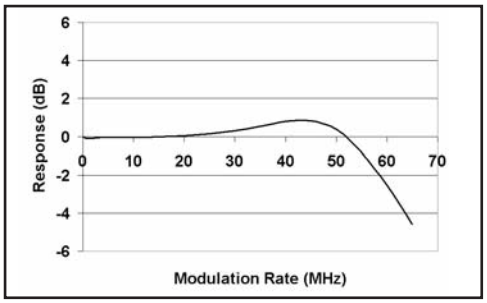
Accuracy

At 1 kHz rate
±4% of set depth ±1% excluding residual AM

AM Bandwidth

1 dB DC to 200 kHz (DC coupled, 100 kΩ)
10 Hz to 200 kHz (AC coupled, 100 kΩ)

3 dB Typically 30 MHz (DC or AC coupled, 50 Ω)



Typical AM Bandwidth

Total Harmonic Distortion

For 1 kHz modulation rate
<1% for depths ≤30%
<2% for depths ≤80%

FM on AM

Typically <20 Hz for 30% AM depth at a modulation rate of 1 kHz and carrier frequency of 500 MHz

ΦM on AM

Typically <0.02 radian for 30% AM depth at a modulation rate of 1 kHz and carrier frequency of 500 MHz

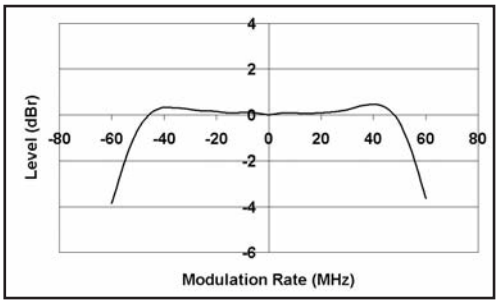
IQ MODULATION

Performance applicable in ACP and Noise modes only

IQ Inputs

BNC connector inputs, selectable 50 Ω/100 kΩ input impedance

Full scale input $(I^2+Q^2)^{0.5}$ occurs for 0.5 V rms (The level requested is obtained by applying 0.5 VDC to either the I or Q input)



Typical IQ Bandwidth

Modulation Bandwidth Relative to DC

At 23°C ± 5°C:
±0.5 dB for frequencies DC up to 5 MHz
1 dB for frequencies DC up to 10 MHz 3 dB:

RF Mode	*≤2.8 GHz*	*≤6 GHz*
Noise	>42 MHz, 50 MHz typ	>35 MHz, 45 MHz typ
ACP	>48 MHz, 55 MHz typ	>40 MHz, 50 MHz typ

DC Vector Accuracy

Relative to Full Scale (0.5 V RMS)

Static Error Vector Magnitude (EVM)	*<1% RMS at full scale*
Magnitude error	*<0.5% RMS at full scale*
Phase error	*<0.5° RMS at full scale*

Residual Carrier Magnitude:

For 0 V input voltage, relative to full scale

RF Mode

Noise	*<-45 dBc, typically <-55 dBc*
ACP	*<-40 dBc, typically <-50 dBc*

Valid for 12 hours after executing an IQ self-calibration and within ±5°C of the calibration temperature. The instrument displays a warning if the time or temperature limits are exceeded.

Static EVM and phase error measured with residual carrier magnitude removed.

IQ Image Suppression

At 10 kHz modulation frequency
Typically <-50 dBc @ 10 kHz

Linearity (See linearity chart over page)

Adjacent Channel Power (ACP), in ACP mode for continuous and discontinuous signals at RF output levels ≤ 0 dBm, over the temperature range 23°C ± 5°C

RF BURST CONTROL

A digital control bit is used to generate an analog ramp (up or down) of the RF output. The Burst Gate control signal can either be generated internally as part of the optional internal base-band source, or provided externally by the user on the rear panel connector. When internally generated, the Burst Gate control signal appears on the rear panel auxiliary connector that then serves as an output.

On/Off Ratio

For the temperature range 23°C ± 5°C
>90 dB for carriers ≤ 3 GHz
>80 dB for carriers ≤ 4 GHz
>65 dB for carriers ≤ 6 GHz

Ramp Profile

Rise and fall time after the L-H and H-L transitions of the burst control bit respectively can be defined by the user from 10 µs to 999 µs in 0.1 µs steps.

Burst Gate control input is a TTL level (HCT), 50 Ω impedance BNC input on the rear panel.

RF ramp can be adjusted in time by ±50 µs in increments of 0.1 µs with respect to the trigger event.

RF BURST ATTENUATION CONTROL

A digital attenuation control bit (in conjunction with the ramp control bit) is used to decrease the RF level from the set level to an alternative level during burst modulation. The Burst Attenuation Trigger signal can be provided internally as part of the optional dual arbitrary waveform generator (ARB), or externally on a rear panel connector. When internally generated, the Burst Attenuation Trigger control signal appears on the rear panel auxiliary connector that then serves as an output.

Attenuation range available is 0 to 70 dB.

Burst Attenuation Trigger control is a TTL level (HCT), 50 Ω impedance signal available on the rear panel Auxiliary connector.

RF burst attenuation requires Electronic Attenuator Opt 003.

LINEARITY CHART

	TETRA	*GSM 900 / 1800 / 1900 GSM EDGE (Enhanced Data rate for GSM Evolution)*	*802.11a** Wireless LAN (Spectral Mask)*	*IS-95 (CDMAone)IS-95*	*802.16e (WiMAX)*
Frequency Range(s)	130 MHz - 1 GHz	850 MHz - 1 GHz 1700 - 1900 MHz	5.15 - 5.825 GHz	824 - 894 MHz 1850 - 2000 MHz	2.3 - 2.5 GHz 3.3 - 3.8 GHz
ACLR (Continuous & Discontinuous)	<-70 dBc @ 25 kHz offset <-80 dBc* @ 50 kHz offset <-80 dBc* @ 75 kHz offset	<-35 dBc @ 200 kHz offset <-70 dBc @ 400 kHz offset <-80 dBc @ 600 kHz offset	<-25 dBr @ 11 MHz offset <-45 dBr @ 20 MHz offset <-60 dBr* @ 30 MHz offset	<-65 dBc @ 885 kHz offset <-75 dBc @ 1.25 MHz offset <-80 dBc @ 1.98 MHz offset	
EVM	0.8%*	0.4% (EDGE)	0.6%*		0.6%*
Phase Error		0.4°* (GSM)			
	3GPP/WCDMA	*NADC (IS - 54, IS - 136)*	*JDC/PDC*	*PHP/PHS*	*LTE*
Frequency Range(s)	1855 - 2200 MHz	824 - 894 MHz 1850 - 2000 MHz	810 - 826 MHz 940 - 956 MHz 1429 - 1513 MHz	1895 - 1918 MHz	800 - 1900 MHz
ACLR (Continuous & Discontinuous)	<-70 dBc @ 5 MHz offset <-72 dBc* @ 5 MHz offset	<-40 dBc @ 30 kHz offset <-78 dBc* @ 60 kHz offset <-80 dBc* @ 90 kHz offset	<-65 dBc @ 50 kHz offset <-80 dBc* @ 100 kHz offset	<-75 dBc @ 600 kHz offset <-80 dBc @ 900 kHz offset	
EVM	0.9%*				0.6%*

** denotes typical value ** At RF o/p level ≤ -4 dBm*

INTERNAL MODULATION OSCILLATOR

The internal modulation source is capable of generating up to two simultaneous signals into any one of the modulation systems.

Frequency Range

0.1 Hz to 50 kHz (16 MHz with Option 005) with 0.1 Hz or 5 digits of resolution

Accuracy

As frequency standard

Distortion

<0.1 % for a sine wave at 1 kHz

In addition to a sine wave the following waveforms can be generated:

Triangle 0.1 Hz to 10 kHz (2 MHz with Option 005)
Ramp 0.1 Hz to 10 kHz (2 MHz with Option 005)
Square 0.1 Hz to 5 kHz (1 MHz with Option 005)

(Note: modulation frequency can be set to 50 kHz irrespective of waveform type)

Level

Modulation source signals are available on the rear panel I/AM OUT and Q/FM OUT at nominal level of 1 V peak EMF from 50 Ω source impedance.

EXTERNAL MODULATION SOURCE

External inputs are available with a selectable input impedance of 50 Ω or 100 kΩ (default setting), AC or DC coupled.

Apply 1 V RMS (default) or 1 V peak for the set modulation.

A HI/LO indicator when the applied signal is greater than ±6% from nominal

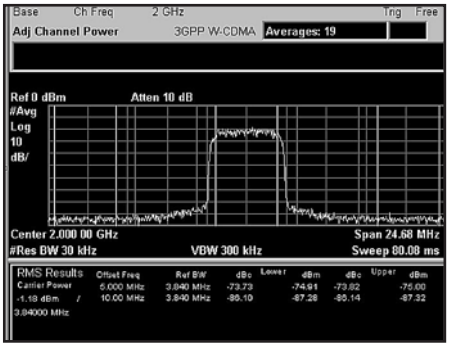
External AM is input to EXT I/EXT AM front panel BNC connector.

External FM is input to EXT Q/EXT FM front panel BNC connector.

INTERNAL DUAL CHANNEL ARB SOURCE (OPTION 005)

A high performance Dual Arbitrary (ARB) Waveform Generator that provides IQ signals for the IQ modulator

The ARB enables files to be downloaded with sample rates from 17 kHz to 66 MHz. The ARB uses an interpolation system to increase the digital to analog converter sample rate and avoid the use of reconstruction filters.



Typical 3GPP test model 1 (64 channels)

ARB CHARACTERISTICS

Flash Memory Size

23,592,960 sample pairs

Maximum Number of Files

180

Sample Format

32 bits of data - 14 bits I, 14 bits Q, 3 associated marker bits

Sample Rate Tuning

± 20 ppm, 0.1 ppm step resolution

D-A Converter Resolution

14 bits

D-A Sample Rate

44 to 66 Msamples/s

Interpolation Factor

Automatically selected

ARB Bandwidth

±10 MHz, typically 0.1 dB

±14 MHz, typically <3 dB

Reconstruction Filter Stop Band Attenuation

>70 dB

ARB Spectral Purity

Spurious free dynamic range	*>70 dB, typically >80 dB*
20 kHz offset phase noise	*<-120 dBc/Hz*
Floor noise	*<-140 dBc/Hz*

***IQCreator™** Windows based software package is provided for the creation, formatting and downloading of ARB waveform files to the 3410 series.*

*A waveform library is provided on a CD containing a selection of files for testing 2G, 2.5G, 3G and 4G systems. Files can be downloaded from www.aeroflex.com/**IQCreator™**.*

Marker Control Bits

Up to 3 marker bits (1-3) can be attached to each sample of IQ data. These can be used to indicate significant points in the waveform and are available as HC CMOS outputs via the rear panel Aux IN/OUT connector. Marker bit 1 can be used as RF Burst Control signal. Marker bit 2 can be used as Burst Attenuation Trigger signal to decrease (attenuate) the RF level from its nominal value.

MULTICARRIER

Frequency Offset Setting Range

-10 MHz to +10 MHz

Single Carrier Gain

-60 dB to 0 dB, 0.01 dB resolution

Single Carrier Start Phase

-180° to+180°, 0.01° resolution

Single Carrier Delay

Dependant on file length, 1 ms resolution

Control Mode

Continuous, single or triggered operation of the ARB

An external TTL trigger input signal is available on the AUX IN/OUT rear panel connector.

IQ Outputs (Not applicable with Option 009 fitted)

The IQ signals produced by the ARB are available on the rear panel I/AM OUT and Q/FM OUT BNC connectors. Output level is 0.5 V RMS EMF (vector sum) from a source impedance of 50 Ω.

REAL TIME BASEBAND (OPTION 008)

Allows the creation of digitally modulated signals using generic modulation formats. An internal data source provides PRBS or fixed patterns. External real-time data in the form of symbol data, or digital IQ data may be applied via an LVDS interface.

Generic Modulation Formats

PSK	*BPSK, QPSK, 8PSK, 16PSK* *8PSK EDGE (8PSK with 3π/8 rotation)* *π/2 DBPSK, π/4 DQPSK, π/8 D8PSK* *DBPSK, DQPSK, D8PSK* *OQPSK (time offset)*
MSK	*GMSK*
FSK/GFSK	*2 and 4 level symmetric*
QAM	*16, 32, 64, 128, 256 levels*

For data bit to symbol mapping information refer to Technical Note "IFR 3410 Option 8 RTBB Ancillary Information"

SYMBOL RATE

Range

5 kHz to 2 MHz. Resolution 1 Hz

BASEBAND CHANNEL FILTERS

Filter Types

Nyquist	*a = 0.1 to 0.8, resolution 0.01*
Root Nyquist	*a = 0.1 to 0.8, resolution 0.01*
Gaussian	*Bt 0.1 to 1.0, resolution 0.1*
EDGE	*"Linearized Gaussian" as defined in GSM 05.04*

DATA SOURCE

Formats

Internal Data	*PRBS - PN9, PN11, PN15, PN16, PN20, PN21, PN23.* *Fixed Pattern consisting of -* *0, 0, 0, 0, 0, 0 ....* *0, 1, 0, 1, 0, 1 ....* *1, 0, 1, 0, 1, 0 ....* *1, 1, 1, 1, 1, 1 ....* *User-defined symbol file stored in non-volatile memory (Max size 256 kB)*

External Serial Data

A single bit stream representing symbol information can be applied. The bit to symbol conversion is determined from the selected modulation type.

External Parallel Data

Symbol information consisting of 1 to 8 data bits can be applied. External parallel and serial data is input via the LVDS connector on the rear panel.

DATA ENCODING

None, Differential, GSM Differential, Inverted

TIMING/SYNCHRONIZATION

All clock and synchronization signals are provided internally by Option 8 RTBB and made available to the user on the rear panel LVDS connector. An external clock may be phase aligned to the internal clock via a "sync" operation.

External Serial Data Clock

Eight times the symbol rate, for all modulation types.

External Parallel Data Clock

Nominal symbol rate

FREQUENCY HOPPING

Frequency Hop List

Up to 32 frequency values. The frequency values entered represent offset values from the current RF frequency.

Frequency Offset Values

Offset values range ±10 MHz

MODES

Linear

On receipt of a hop trigger, the next frequency in the list is indexed.

Random

On receipt of a hop trigger, an internal PRBS generator indexes through the frequency list. PN length and polynomial initial seed value are user selectable. PN values selectable from - 9, 11, 15, 16, 20, 21, and 23.

External

On receipt of a hop trigger, the 5-bit hop address lines applied to the LVDS connector are used to index the frequency list.

Hop Rate

Max hop rate (hops/sec) is half symbol rate. Hopping is synchronized to symbol transition.

DIGITAL IQ DATA

Digital IQ data is available via the LVDS connector on the rear panel.

EXTERNAL IQ DATA IN

External 16-bit IQ data can be applied to an LVDS interface. The data can then be filtered or not, depending on the application, by the base-band board and fed to the DACs. All clock and sync signals are located on the LVDS connector. These can be used to synchronize to an externally applied clock.

INTERNAL IQ DATA OUT

16-bit IQ data is available on the LVDS interface when the modulation is generated internally. Outputs can be disabled.

TONES

A tone (CW) only mode is available. Up to 2 tones may be selected. Each tone may be independently enabled and disabled.

Frequency Range	*carrier frequency ± 10 MHz*
Relative Level	*60 dB*

DIFFERENTIAL I/Q OUTPUT (OPTION 009)

When differential I/Q outputs are enabled signal generator RF carrier output is CW only.

Output Impedance

Can be used with single ended 50 Ω loads or differential 100 Ω loads. Delivered bias voltages are halved with single ended loads.

I/Q Bias Voltages

Independent I and Q channel bias voltages settable within the range of ±3 V

Bias Voltage

Resolution	*1.0 mV nominal*
Accuracy	*±2% ±4 mV max, ±1% ±2 mV typical*
Offset	*See Bias Voltage above.*

Differential Offset Voltage

Range	*±300 mV*
Resolution	*100 µV nominal*
Accuracy	*±2% ±3.3 mV max, ±1% ±0.7 mV typical*

Level Mode

Variable IQ signal level over 45 dB range

Differential Signal Balance

typ 0.15 dB @10 MHz

I/Q Channel Balance

±0.2 dB @1 MHz

I/Q Level Imbalance Adjust

±4 dB nominal continuously variable

I/Q Signal Amplitude

22.4 mV to 4 V pk-pk per channel

I/Q Signal Amplitude Accuracy

<2% at 20 kHz, typ 1.5%, excludes termination errors

Baseband Purity (2 V p-p set voltage at 1 MHz)

2nd Harm -70 dBc
3rd Harm -65 dBc
IMD -70 dBc (100 kHz tone spacing, at 1 MHz)

SWEEP FACILITY

Provides a digital sweep of RF frequency, RF level and Analog Modulation Sources in discrete steps

Start, stop, step size, number and step time can be controlled. Step time may be set from 2.5 ms to 60 s with 0.1 ms resolution. (20 ms for mechanical attenuator Option 002)

The sweep can be set to be continuous, single or externally triggered from the rear panel. TTL BNC Female rear panel.

Frequency Sweep

Linear step size: 1 Hz minimum step
Logarithmic: 0.01% to 50%, 0.01% step

Level Sweep

0.01 dB minimum step

Modulation Oscillator

0.1 Hz minimum frequency step

LIST MODE

Up to 500 frequencies and levels can be entered in the list. Start address, stop address and dwell time can be controlled. Dwell time can be set from 500 µs to 10 s. Requires Option 003 Electronic Attenuator

FAST PULSE MODULATOR (OPTION 006)

This option requires Electronic Attenuator Option 003 to be fitted.

On/Off Ratio

>80 dB for carrier levels ≥ -60 dBm

Rise/Fall Time

<20 ns typical (10 to 90%)

Pulse Delay

Typically <50 ns

RF Level Accuracy

RF mode = 'auto', as standard ±0.2 dB

The above specification is met for all power levels above 150 MHz.

AM Depth and Distortion

AM operation is unspecified below 10 MHz.
AM depth and distortion specification is degraded for operation above 0 dBm at carrier frequencies <150 MHz.

Video Breakthrough

RF Mode 'Auto'

< ± 140 mV for RF levels > -4 dBm

< ± 70 mV for RF levels in the range -10 dBm to -4 dBm

< ± 50 mV for RF levels <= -10 dBm

Modulation Source

PULSE IN BNC (female) connector rear panel

Input Impedance

50 Ω

Input Level

TTL level (HCT)

Control Voltage

A HCT logic 0 (0 V to 0.8 V) turns the carrier OFF
A HCT logic 1 (2 V to 5 V) turns the carrier ON

Max. Safe Input Level

±10 V

NON-VOLATILE MEMORY STORES

Full instrument configurations can be saved to 100 memory stores (0 - 99).

FREQUENCY STANDARD

10 MHz OCXO fitted as standard

Ageing Rate

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

Temperature Coefficient

$< \pm 5 \times 10^{-8}$ over the temperature range 0°C to 50°C

Output Frequency

Within 2×10^{-7} of final frequency after 10 minutes from connecting supply power and switching on at a temperature of 20°C

Standby power is provided while the instrument is off but connected to the supply.

Output of 2 V pk-pk from 50 Ω is provided on a rear panel BNC connector.

EXTERNAL STANDARD INPUT

1 MHz or 10 MHz at a level of 300 mV RMS to 1.8 V RMS into 1 kΩ on the rear panel BNC connector

REAR PANEL OUTPUTS (OPTION 007)

With this option fitted RF output, EXT I/EXT AM input and EXT Q/EXT FM input connectors are transferred to the rear panel. When Option 009 is fitted only RF output connector is transfered to the rear panel. The standard signal generator specification remains unaltered.

GENERAL

WARRANTY

2 years with options for 3, 4 and 5 years

CALIBRATION INTERVAL

Recommended at 2 years

REMOTE CONTROL INTERFACES

Ethernet

All signal generator parameters except the supply switch are remotely programmable. The following LAN protocols supported:

VXI-11
Telephone Network (TELNET)
File Transfer Protocol (FTP) (instrument firmware upgrades only)

GPIB

All signal generator parameters except the supply switch are remotely programmable. The GPIB is designed in accordance with the IEEE 488.2.

RS-232

All functions except the supply switch are remotely programmable. Can be used for upgrading the instrument firmware without removal of the instrument covers.

Interface Functions

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, E2

DIMENSIONS AND WEIGHT

	Height	Width	Depth
Overall	107 mm	468 mm (19")	545 mm max
Rackmount *	89 mm	425 mm	545 mm max

** Occupies 2U of rack height excluding removable feet bottom feet and front handles*

Weight

3412/13/14	*10.5 kg*
3416	*11.5 kg*

RATED RANGE OF USE

MIL-T-28800E Class 5

Temperature

0°C to 50°C

Humidity

45%, 0°C to 50°C
95%, 30°C to 40°C

Altitude

700 mbars (3050 m, 10,000 feet)

CONDITIONS OF STORAGE AND TRANSPORT

MIL-T-28800E Class 5
Temperature -40°C to +71°C
Altitude 570 mbar (4570 m, 15,000 feet)

POWER REQUIREMENTS

AC Supply

100 - 240 V ~ (Limit 90 - 264 V)
50 - 60 Hz ~ (Limit 45 -66 Hz)
185 VA Max

ELECTROMAGNETIC COMPATIBILITY

Conforms to EC directives 89/336/EEC and standard IEC/EN 61326-1:1997;RF emission class B, immunity table 1 and performance criterion 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.

VERSIONS, OPTIONS AND ACCESSORIES

When ordering please quote the full ordering number information.

Ordering Numbers	Versions
3412	250 kHz to 2 GHz Digital RF Signal Generator
3413	250 kHz to 3 GHz Digital RF Signal Generator
3414	250 kHz to 4 GHz Digital RF Signal Generator
3416	250 kHz to 6 GHz Digital RF Signal Generator
	Supplied with AC power supply lead and the following CD-ROMs:
	CD-ROM containing Operating Manual and VISA Plug 'n' Play driver software
	CD-ROM containing Factory Test Results (for the unit supplied) and Certificate of Calibration
	CD-ROM containing ***IQCreator*** ® ARB data file creation and download software and a library of example waveforms

Attenuator Options

3410 must be ordered with one of the following attenuator options. Refer to main specification for details.

Option 001	No attenuator
Option 002	Mechanical attenuator (Not available on 3414/3416)
Option 003	Electronic attenuator

Further Instrument Options

Option 005	ARB waveform generator (Not available with Option 008)
Option 006	Pulse Modulation (Requires Option 003, not available with Option 009)
Option 007	Rear panel outputs (RF Output only with Option 009)
Option 008	Real Time Baseband (Not available with Option 005 or 009)
Option 009	Differential I/Q output (Requires Option 005, not available with Option 006)
Option 010	List Mode (Requires Option 003)
Option 020	2G CDMA software license
Option 021	2G and 3G CDMA software licenses

Warranty Options

Option 203	3 year warranty
Option 204	4 year warranty
Option 205	5 year warranty

Pre-Loaded Example Waveforms Options

(Requires Option 005 ARB Waveform Generator)

Option 300	Example waveforms - a selection from each of the standards (Requires Option 021)
Option 301	CDMA example waveforms; 3GPP; CDMA2000; IS-95 (Requires Option 021)
Option 302	Cellular example waveforms; GSM; EDGE; IS136; PDC
Option 303	PMR example waveforms; TETRA, P25
Option 304	Avionics example waveforms; VDL
Option 305	WLAN example waveforms; 802.11; Bluetooth
Option 306	Satellite/Cable example waveforms; Various QAM formats
Option 307	Digital cordless example waveforms; DECT; PHS

For details on each waveform included in option 300 series, refer to Technical Note 3410 Option 300 waveform information, Part Number 46891/942

Optional Accessories

46882/499	Operating manual (paper format)
46880/111	Service manual (includes semi-automatic adjustment software)
82542	Breakout box (for Auxilliary connector)
43129/189	1.5 m GPIB lead
46662/745	Soft carry case
46884/650	RS-232 cable, 9 way female to female, 1.5 m
46884/649	RS-232 cable, 9 way to 25 way female, 1.5 m
46885/138	Rack mounting kit (front panel brackets)
43139/042	RF double screened connector cable 50 Ω, 1.5 m, BNC (m)
54311/095	RF double screened connector cable 50 Ω, 1 m, type N connectors
54311/092	Coaxial adapter N male to BNC female
59999/163	Precision coaxial adapter N male to SMA female

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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.

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