

Introducing the IFR 3410 Series



The New Face of Digital RF Signal Generators

Product Backgrounder



An Aeroflex Company

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The IFR 3410 Series Digital RF Signal Generators

The users of RF signal generators today vary widely in their expertise and professional discipline. They range from seasoned RF hardware engineers to newly qualified graduates and include software engineers and technicians. Experienced users appreciate a traditional “look and feel” with dedicated controls, while those from the PC generation tend to prefer graphical-based operation. As a result, the user interface, while remaining intuitive, must be versatile in the range of choices it makes available to the user.

As development in second and third generation wireless communications systems grows rapidly worldwide, users demand products with digital modulation capabilities. This places new performance requirements on the RF signal generator. It must deliver wider baseband modulation bandwidth and improved dynamic range, provide more arbitrary waveform generator memory and run at greater speeds.

With many wireless formats having their own special characteristics, additional functionality has to be made available to the user. Consequently, supporting digital and vector modulation places increased demands on the user interface of the RF signal generator. It is important that this added functionality does not result in a product that is cumbersome and unfriendly to use.

IFR has responded to the challenge with a new generation of digital RF signal generators. Designed for R&D and manufacturing test applications, the 3410 series sets a new standard in compact size and weight and incorporates an entirely new user interface that makes even the most complex test scenario easy to configure.

Introducing the 3410 Series – the New Face of Digital RF Signal Generators

For the first time, an RF signal generator is now available that combines full digital, vector and analog modulation in a small package. The 3410 series from IFR is a no-compromise, high performance family of digital RF signal generators in a 2U rack size aimed at R&D and manufacturing applications.



The 3410 series is available in three frequency ranges: 2 GHz, 3 GHz and 4 GHz

Based on a compact touch-panel display system that also offers a keyboard control alternative, the 3410 series provides a novel, yet simple user, interface that is capable of controlling all the advanced features required for digital and vector modulation.

No Compromise in Performance

Containing a system architecture that is new for IFR signal generators, the 3410 series provides RF carriers up to 4 GHz and includes both analog (FM, AM, phase and pulse modulation) and broadband vector modulation as standard. A digital dual-channel arbitrary waveform generator (ARB) is available as an option. Fitted internally and providing excellent modulation accuracy and linearity, the ARB is capable of generating 2G, 2.5G, 3G and PMR digital radio signals.

With its compact size and uncompromising levels of RF performance, the 3410 series is an ideal tool for RF test applications. Meeting all customer expectations for third generation (3G) cellular testing, the 3410 series performance equals and improves upon the performance of its larger and more expensive counterparts.

An Ideal Match of RF Level Accuracy and Low Output VSWR

The 3410 series offers excellent RF level accuracy of ± 0.5 dB. Combined with a low output VSWR specification, measurement errors for real world applications are kept to a minimum. Test system uncertainty is consequently reduced allowing a greater measurement standoff to be defined between the test system and the device under test (DUT), resulting in better yield. This unprecedented performance ensures that precise and repeatable measurements can be performed on even the most sensitive analog or digital receivers. Additional modes of operation are provided that allow the user to optimize the signal generator for specific measurement tasks.

The Right Combination of Benefits

- ***For component testing***

The high setting speed and modulation quality make the 3410 series a perfect choice for use in the development and production of digital components and modules.

The high intermodulation suppression of the IQ modulator ensures excellent adjacent channel power ratios (ACPR) of the modulated output signal for conclusive linearity measurements of amplifier components.

The high spurious suppression of > 70 dB of the output signal allows accurate measurements on mixer components to be performed.

Files for use with the dual-channel ARB can be created that conform to the TDMA and CDMA standards regarding timing, spectral distribution and amplitude probability distribution, ensuring that correct signal conditions are being applied to the component under test.

- ***For manufacturing***

The prerequisite for any manufacturing system is to maximize throughput. This is accomplished by fast testing using reliable equipment that gives repeatable results. With current signal generators only offering part of the solution, careful decisions have to be made where speed is traded off against reliability.

With fast GPIB operation and the incorporation of a high performance electronic attenuator, the 3410 series offers the only no-compromise solution. Carrier frequency and RF level switching speeds are <5 ms and the instrument is “hardware ready” to support USB 1.1 interfaces. The use of an electronic attenuator ensures that test system down time is kept to a minimum due to the extended life capabilities offered by solid-state technology.

With a dual-channel ARB supporting 2G, 2.5G and 3G testing, it is possible to handle the multi-mode multi-band phones of the future. The ARB can quickly switch between CDMAone (IS-95) and CDMA2000, or GSM and EDGE without incurring any load time overhead for new files.

Combining these attributes with its compact footprint, the 3410 series provides an ideal solution to meet the requirements of the manufacturing environment.

- ***For research and development***

For R&D, the requirements for a digital RF signal generator are straightforward. The instrument must be easy to configure, offer all the functionality and performance levels needed to meet today’s requirements while at the same time remain flexible enough to address tomorrow’s challenges.

The 3410 series combines touch-panel technology with conventional keyboard control. This eliminates a deeply nested menu structure and results in a refreshingly simple and intuitive user interface. Wherever touch control is provided, an equivalent hard-key method is available allowing the signal generator to be used in the harshest working environments where gloved operation is required. IFR’s new design makes the 3410 series easier to use than products based on larger display formats.

The proprietary IFR patented IQ modulator in the 3410 series is the basis for the excellent modulation characteristics, with spurious suppression of more than 70 dB. In addition to a bandwidth that is designed to meet the needs of future broadband systems, the modulator features high intermodulation suppression. With digital modulation, this results in excellent adjacent channel power and modulation accuracy characteristics.

The lightweight, shallow depth and full width of the 3410 series provides added convenience for operation on the bench, particularly where instruments are stacked.

Total Control at Your Fingertips

Until now, RF signal generators have adopted two methods of main parameter selection. The first method uses dedicated function keys. When pressed, they cause an associated function label on the LCD to highlight. A second method adopts a soft-key approach where, in addition to displaying an associated function label, the LCD is used to show equivalent function key text. Some signal generators provide both methods of hard-key and soft-key selection.

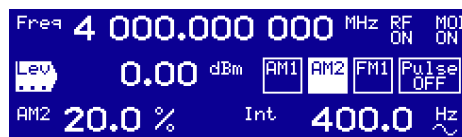
Using the touch-screen to combine the selection and indication process, the 3410 series eliminates the need for dedicated function keys. Main screen operation parameters are selected and made the current function by pressing the appropriate function label (e.g. Freq, Lev, AM1, IQ, W'form) on the touch-screen. The selected parameter is highlighted. Consistent with pointing devices, the touch-screen adopts an action-on-release operation.

Once a parameter has been selected, its value can be changed in a conventional manner using the numeric keypad, increment/decrement keys or rotary control.

Selection and control of any summarized modulation is also made using the touch-screen. Pressing the required modulation summary box causes the display area to be re-configured and the selected modulation settings are displayed. The modulation parameters can now be adjusted by touching the appropriate function label.

For those who don't want to use the touch-screen controls an alternative keyboard operation is provided.

Whether configured for basic CW operation or when complex modulation schemes are required, the display area is rearranged to ensure that the selected test scenario is clearly visible.



Function Sub-menus

Function sub-menus contain advanced features and additional controls for the main signal generator screen parameter selected. The availability of sub-menus is indicated by the symbol (...) appearing in the current function label and access is achieved using the [↵/...] key.



The available sub-menus are indicated at the bottom of the display as a series of touch <tabs> and can be selected in turn by pressing the touch-screen. The use of <tabs> avoids a deeply nested menu structure with only a two-tier menu structure created.

The main signal generator screen can be re-displayed at any time by pressing the [↵/...] key. Indication of this is given by the ↵ symbol, positioned adjacent to the [↵/...] key, in the bottom right hand corner of the display.

Modulation

- **Vector modulation**

Using the external IQ inputs, the 3410 series provides an RF modulation bandwidth of up to 100 MHz. Over this bandwidth and covering the full frequency range of the signal generator, excellent modulation accuracy is achieved through the use of a proprietary IQ modulator design. With an Adjacent Channel Power (ACP) performance of typically better than -68 dBc for a 3GPP FDD signal, the performance of the 3410 series meets the most exacting requirements of testing 3G radio receivers and power amplifiers.

- **Digital modulation**

With an optional dual-channel ARB, the 3410 series is capable of generating digitally modulated carriers with an RF modulation bandwidth of 45 MHz. Using interpolation technology the ARB operates at a high sample rate that allows smaller file sizes to be created and eliminates the need for selectable hardware filtering and the associated errors that this can introduce.

- **Analog modulation**

Recognizing the fact that CW and analog testing are still predominant in the manufacturing environment, the 3410 series offers the full range of analog modulation modes. Wide bandwidth FM and AM is provided as standard allowing the instrument to be used in a wide variety of applications, including jitter tolerance assessment in telecommunications systems and the transmission of analog TV signals.

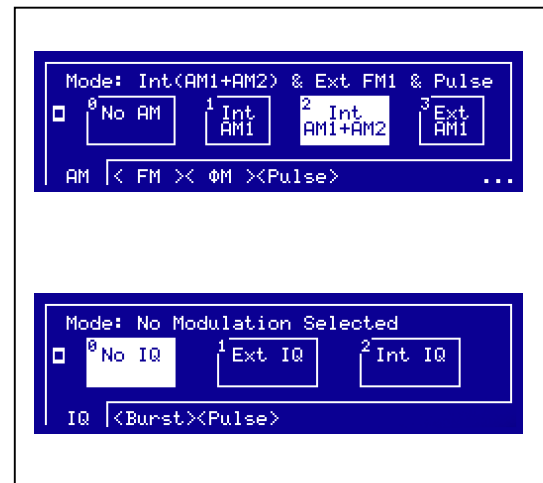
In DC-coupled FM mode, a patented technique is implemented that results in exceptional frequency accuracy and low drift. This allows the 3410 series to be used to simulate a voltage-controlled oscillator when designing a receiver or to precisely reproduce digital signaling for FM receivers that have selective squelch control.

Complex Modulation Modes Made Simple

Touch-screens have gained general acceptance in all walks of life from ATM machines to point-of-sale terminals in restaurants. One of the biggest applications is where a 1-of-n selection has to be made. With the 3410 series offering over 30 different modulation combinations, touch-panel technology provides an ideal solution to the tricky problem of ensuring that the selection process is made as straightforward as possible.

Dedicated [IQ MOD] and [ANALOG MOD] keys are used to define the modulation configuration. For both cases, the same concepts apply.

The overall modulation mode is summarized at the top of the display. Each modulation type (IQ, AM, FM, Φ M, Pulse) can be selected in turn by pressing the appropriate <tab> on the touch-screen. As each modulation type is selected, the user is presented with a selection of touch-targets representing the possible configurations available for the specific modulation type selected. A highlighted touch-target indicates the current choice.



Pressing one of the touch-targets makes a new selection. The overall modulation mode is changed to reflect the new setting and the touch-target highlighted.

Alternatively, selections can be made using the numeric keypad. Each touch-target has a numeric label attached that corresponds to an equivalent key on the keyboard. For example, with IQ as the specified modulation type, pressing the numeric key 0 on the keypad is equivalent to selecting “No IQ”. The same display format is thus presented to the user regardless of the mode of operation. For applications that do not lend themselves ideally to touch-panel technology, the equivalent key operation is always indicated and available. As a result, the user does not have to remember cryptic or “shortcut” key operations.

Dual-Channel Arbitrary Waveform Generator is Best in Class

The 3410 series includes an optional dual-channel ARB (arbitrary waveform generator) that incorporates an interpolation filter design. This technique significantly reduces the ARB configuration process to a simple file selection operation. The interpolation rate of the filter is automatically set in such a way that aliasing products of the wanted signal are shifted into the stop band range of the anti-aliasing (reconstruction) filter. The confusing reconstruction filter selection process, required on less sophisticated ARBs is eliminated. As a result, incorrect instrument configuration is avoided and correct file generation is guaranteed.

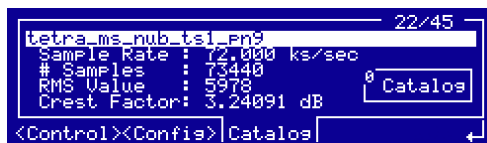
Files loaded into the 3410 series ARB can have sample rates ranging from 17 kHz to 66 MHz. Such a broad range of sample rate is possible because the interpolation filters ensure that the digital-to-analog convertors (DACs) receive an optimal sample rate. In addition, the interpolation hardware takes care of the $\sin x / x$ distortion that is a direct consequence of the sampling process.

Hardware interpolation allows files to be created that have low nominal sample rates, which results in smaller file sizes. This is in contrast to most competing systems that rely either on higher over-sampling rates, which increase the file size, or switched banks of anti-alias (reconstruction) filters to reduce noise and sample harmonics.

The user can inspect the files stored in the ARB. The list can be scrolled up and down and the required file selected.



Additional file information, including stored sample rate and file size, can be viewed by pressing the W'form Details touch-target.



The 3410 series ARB is capable of storing a maximum of 22.5 Msamples. The ARB's memory is partitioned into 60 sectors, each of which can be further divided into 3 sub-sectors. Consequently, up to 180 files can be stored at any given time. Sectors and sub-sectors can be merged together to form larger files. In fact, it is possible to save one file that uses all the available memory space. As a result, the 3410 series ARB is capable of storing a 3GPP file representing 153 frames (1.53 s).

The 3410 series can be loaded with files representing different wireless RF transmission formats. This allows handsets from two different manufacturing lines – one devoted to GSM phones, for example, and the other to CDMA phones – to be fed into a single test bay. The 3410 series can instantly switch back and forth between testing sets of GSM phones and batches

of CDMA handsets, without ever having to wait to download new files. When lengthy interruptions for downloading test data are eliminated, manufacturers can rigorously test their wireless RF systems faster.

ARB files can be generated once or looped continuously. Marker bits can be used to gate the RF signal on and off using defined RF level versus time profiles to simulate the operation of Time Division Duplex (TDD) and Time Division Multiple Access (TDMA) signals.

The 3410 series is supplied with a software support package to aid the creation and download of files to the ARB. ***IQCreator*** is a windows-based software utility that enables a user to set up a modulation scheme and then create an ARB file. This file may be saved 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*** will include:

- **Generic Modulation**

- 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*

- **TDMA Digital Standards**

- GSM 900, 1800, 1900*
 - EDGE*
 - TETRA*
 - DECT*
 - IS-136*
 - PDC*
 - PHS*

- **CDMA Digital Standards**

- CDMAone (IS-95)*
 - 3GPP FDD*
 - 3GPP TDD*
 - TD-SCDMA*
 - CDMA2000*

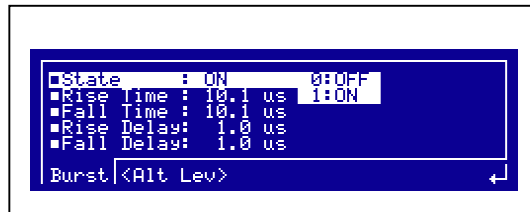
- **WLAN**

- Bluetooth*
 - 802.11b*
 - 802.11g*

IQCreator also includes a utility that allows the user generated files in binary or ASCII format to be converted and packaged into a form that can be interpreted by the ARB.

Convenient Burst Generation for TDMA Standards

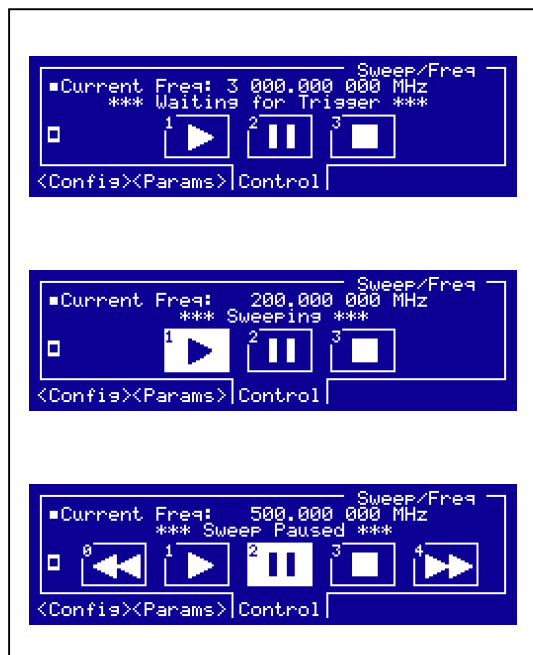
The testing of TDMA receiver designs often requires the RF signal power to be varied in a controlled manner. The 3410 series digital RF signal generator provides a convenient method for RF burst generation. A digital burst control bit is used to generate an analog power ramp that turns the carrier on and off. The control signal can be generated internally using marker bits incorporated in an ARB file, or externally using a rear panel connector. The rise and fall of the signal can be altered to simulate different air interface schemes. The signal generator's RF leveling system ensures that the RF signal level does not change from the specified level when the carrier is reinstated on the next burst. Using this facility the signal generator can provide both TDD and TDMA formats. Mobile or base stations can be simulated for reference sensitivity or switching transient measurements.



Applying the Power of Graphical Icons to Sweep

Providing an automated method of changing parameters, such as carrier frequency and RF level, has become a standard feature on signal generators. Defining the sweep requirement consists of:

- *Specifying the sweep parameters – start, stop, step size, step time.*
- *Configuring the sweep operation – sweep type, trigger mode (single/continuous).*
- *Controlling the sweep process – start, pause, continue, reset.*



The 3410 series provides a very simple method of sweep configuration that uses a novel method of user interface control never seen before on a signal generator product.

Sweep operation is set up and controlled by pressing a dedicated [SWEEP] key.

Globally recognized icons are displayed that mimic the controls seen on compact disk players and videocassette recorders. Pressing the appropriate touch-target allows the sweep to be started, paused and reset. When paused, additional controls are displayed that allow the sweep to be manually stepped backwards and forwards.

Parameter settings are accessed via the <Params> tab. From here, start, stop, step size and step time may be entered. Likewise, configuration settings are available from the <Control> tab. The parameter to be swept can be defined (e.g. carrier frequency) and the trigger operation (single shot / continuous) specified.

Reducing the Cost of Ownership

The 3410 series is supplied with a CD providing instrument documentation and customer support information. The operating manual is supplied in both electronic and paper formats. The electronic manual ensures that the version of the manual supplied, including the product specification, can be directly related to the product serial number. The free CD includes a complete set of test results for the customer's product and an electronic Certificate of Calibration. The information can be easily loaded onto an electronic database and readily recovered upon request.

A performance verification software package is also provided that can be used to semi-automate the acceptance procedures outlined in the operating manual. The CD also includes ***IQCreator***, additional software support material for the ARB, and instrument drivers including a soft front panel.

For customers with their own calibration and repair facilities, an optional maintenance manual is available. Containing information that allows fault finding diagnosis to module level, the manual also includes a CD containing a software package that performs automatic realignment and calibration. The labor costs of routine calibration and test are significantly reduced.

Summary

For the first time, an RF signal generator is now available that combines full digital, vector and analog modulation in a small package. The 3410 series from IFR is a no-compromise, high performance family of digital RF signal generators in a 2U rack size aimed at R&D and manufacturing applications.

Providing an unrivalled combination of:

- Excellent modulation linearity
- Electronic attenuator
- "Seamless" changeover between ARB files
- Fast frequency switching < 5 ms
- Fast RF level switching <5 ms
- High output power combined with low output VSWR
- Small size (2U) single box solution
- Easy to use unique touch-screen user interface

the 3410 series is ready to meet all of tomorrow's challenges today.

Key Specifications of the IFR 3410 Series Digital RF Signal Generators

Carrier Frequency

Range: 250 kHz to 2 GHz (3412)
250 kHz to 3 GHz (3413)
250 kHz to 4 GHz (3414)

RF Output

Maximum Level Range: -140 dBm to +16 dBm (Electronic Attenuator)
-140 dBm to + 19 dBm (Mechanical Attenuator)
Resolution: 0.01 dB
Level Accuracy (CW): ± 0.5 dB

Spectral Purity

Noise Floor: < -142 dBc/Hz > 5 MHz offset in AM, CW modes,
typically < -148 dBc/Hz
Adjacent Channel Power: < -65 dBc 3GPP test model 1 64 channel, typically < -68 dBc

FM Modulation

Bandwidth: With input impedance set to $100\ \Omega$, the 1 dB bandwidth is 200 kHz.
With the input impedance set to $50\ \Omega$, the 3 dB upper bandwidth is typically 20 MHz.

AM Modulation

Bandwidth: With input impedance set to $100\ \Omega$, the 1 dB bandwidth is 200 kHz.
With the input impedance set to $50\ \Omega$, the 3 dB upper bandwidth is typically 30 MHz.

Pulse Modulation

Rise/Fall Time: < 20 ns
On/Off Ratio: > 80 dB (for RF levels greater than -60 dBm)

IQ Modulation

Bandwidth: ± 0.5 dB relative to DC for frequencies up to 5 MHz.
Typically ± 3.0 dB relative to DC for frequencies up to 50 MHz.
DC Vector Accuracy: EVM $< 1\%$
Residual carrier leak < -50 dBc

Optional Dual-Channel Arbitrary Waveform Generator (ARB) Characteristics

Memory Size: 23,592,960 sample pairs
Maximum number of files: 180
D/A converter resolution: 14 bits
D/A sampling rate: 44 – 66 Msamples
The interpolator included in the ARB automatically sets the sample rate.

Dimensions and Weight

Weight: 10.5 kg
Dimensions (h x w x d): 107 mm x 419 mm x 510 mm