3020 Digital RF Signal Generator PXI Module

Operating Manual

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About this manual

This manual applies to instruments with software issues of 2.0 and higher.

This manual explains how to set up and configure an Aeroflex 3020 digital RF signal generator PXI module. Where necessary, it refers you to the appropriate installation documents that are supplied with the module.

This manual provides information about how to configure the module as a stand-alone device. However, one of the advantages of Aeroflex 3000 Series PXI modules is their ability to form versatile test instruments, when used with other such modules and running 3000 Series application software.

Getting Started with afSigGen (supplied on the CD-ROM that accompanies each module (see Associated documentation)) explains how to set up and configure a 3020 Series digital RF signal generator with a 3010 Series RF synthesizer module. Using the signal generator soft front panel and/or dll or COM object supplied, the modules form an instrument that provides the functionality and performance of an integrated, highly-specified signal generator, but with the adaptability to satisfy a diverse range of test or measurement requirements.

Intended audience

Users who need accurately-generated signals in the UHF spectrum.

This manual is intended for first-time users, to provide familiarity with basic operation. Programming is not covered in this document but is documented fully in the help files that accompany the drivers and associated software on the CD-ROM.

Driver version

This PXI RF module is designed to be used with the latest software driver version supplied on the Aeroflex 3000 Series PXI Modules CD-ROM part no. 46886/028. Operation with earlier versions of driver software may not be supported.

Structure

Associated documentation

The following documentation covers specific aspects of this equipment:

PXI Modules CD-ROM	Part no. 46886/028	Compilation containing soft front panels, drivers, application software, data sheets, getting started and operating manuals for this and other modules in the 3000 Series.
3000 Series PXI Modules Common Installation Guide	Part no. 46882/663	Detailed information on installing modules into a chassis, external connections, powering up and installing drivers.
3000 Series PXI Modules Installation Guide for Chassis	Part no. 46882/667	Explains how to set up a populated chassis ready for use.
PXI Studio User Guide	Part no: 46892/809	Setting up and using the universal PXI application for system configuration and operation.
Getting Started with afSigGen	Part no. 46892/678	Setting up and using the signal generator application for 3010 Series and 3020 Series modules.

Preface

The PXI concept

VXI and GPIB systems meet the specific needs of instrumentation users but are often too large and expensive for mainstream applications. PC-based instrumentation may cost less but cannot meet the environmental and operational requirements of many systems.

PXI (PCI Extensions for Instrumentation) is based on CompactPCI, itself based on the PCI standard. PCI was designed for desktop machines but CompactPCI was designed for industrial applications, and features a rugged Eurocard format with easy insertion and removal. PXI adds to the CompactPCI specification by defining system-level specifications for timing, synchronization, cooling, environmental testing, and software. While PXI extends CompactPCI, it also maintains complete interoperability so that you can use any CompactPCI-compliant product in a PXI system and vice versa. PXI also makes use of Windows software, VXI timing and triggering, and VXIplug&play instrument drivers to provide powerful and affordable systems.

Abbreviations/acronyms

AM	Amplitude Modulation
ARB	Arbitrary Waveform Generator
CW	Continuous Wave
DAC	Digital-to-Analog Converter
dB	Decibels
dBc	Decibels relative to the carrier level
dBm	Decibels relative to 1 mW
FM	Frequency Modulation
FPGA	Field Programmable Gate Array
GND	Ground
ISP	In-System Programming
LO	Local Oscillator
LVDS	Low-Voltage Differential Signaling
PCI	Peripheral Component Interconnect
Pk-Pk	Peak-to-Peak
PXI	PCI eXtensions for Instrumentation
RF	Radio Frequency
RMS	Root Mean Square
SCSI	Small Computer Serial Interface
SDRAM	Synchronous Dynamic RAM
SFP	Soft Front Panel

SMA	SubMiniature version A (connector)
SMB	SubMiniature version B (connector)
TDMA	Time Division Multiple Access
TRIG	Trigger
UUT	Unit Under Test
VCO	Voltage-Controlled Oscillator
VXI	VMEbus Extension for Instrumentation

Chapter 1 GENERAL INFORMATION

Introduction

Welcome to the operating manual for the 3020 digital RF signal generator PXI module.

The 3020 is an RF signal generator output module that provides a frequency range of 250 MHz to 2.5 GHz and a level range of +5 dBm –120 dBm. Modulation can be digital or vector, and the module contains an IQ baseband arbitrary waveform generator. An external local oscillator provides an LO signal: the 3010 Series RF synthesizer is recommended, where the two modules together form a digital RF signal generator that occupies only three slots in a 3U PXI chassis.

Applications

The 3020's performance makes it ideal for generating complex modulated waveforms for digital radio communications test applications. When used with other Aeroflex PXI RF modules, complete RF test systems can be designed.

Wide frequency coverage

The 3020 produces IQ-modulated or CW signals between 250 MHz and 2.5 GHz with an IQ bandwidth of up to 14 MHz. A low noise frequency agile LO input can be provided by the 3010 Series RF synthesizer module. The 3020 is ideal for multi-purpose applications in radio communications, especially important when testing multi-mode cellular terminals.

Low noise and frequency-agile

When used with a 3010 Series synthesizer, the 3020 provides the low noise floor and speed necessary to provide high-productivity RFIC testing or the stimulus to frequency-hopping radios.

RF bursting

As well as maintaining accurate RF output levels, the 3020 can generate modulated RF bursts to simulate TDMA signal characteristics.

Arbitrary waveform generator (ARB)

The ARB can store 32 MSamples, either as a single long waveform or any number of smaller waveforms up to the capacity limit of the sample memory. Waveforms transfer quickly between the PXI controller and the ARB because of the wide bandwidth of the PCI backplane.

IQ vector modulation

The 3020 provides high-quality vector modulation either from the internal ARB or from an external source via the LVDS data connector.

Triggering

The 3020 provides versatile triggering facilities to provide flexibility when used with other instruments. Trigger inputs can be routed directly through the LVDS front panel input or across the PXI backplane. Triggers can generate power bursts and can be programmed into waveforms to provide trigger outputs for other instruments.

Signal routing

A configurable routing matrix provides flexibility in how you interconnect signals on the PXI backplane, the LVDS front-panel input and the module's internal functions. Predefined routing scenarios can be loaded, or new scenarios created to meet particular requirements.

Software

The 3020 is supplied with a VXI PNP driver and soft front panel for use as a self-contained module. An instrument-level signal generator soft front panel, dll and COM object are also supplied, which allow you to use the 3020 together with a 3010 or 3011 RF Synthesizer. Refer to *Getting Started with afSigGen* (part no. 46892/678) supplied on the PXI Modules CD-ROM part no. 46886/028.

IQCreator ® allows you to design your own, or system-specific, complex modulation files for use with the 3020's ARB.

PXI Studio, supplied with the module, configures your PXI modules as logical instruments using an intuitive and powerful graphical interface. Currently, PXI Studio provides comprehensive signal generator, digitizer and spectrum analyzer applications and further development will provide analysis plugins to suit any modulation scheme.

RF Investigator, also supplied with the module, is an application that provides combined operation of all Aeroflex 3000 Series modules from a single user interface, especially useful for acceptance testing.

Deliverable items

- 3020 RF Signal Generator PXI module
- PXI Modules CD-ROM part no. 46886/028, containing soft front panels, drivers, application software, data sheets, getting started and operating manuals for this and other modules in the 3000 Series
- *3000 Series PXI Modules Common Installation Guide*, part no. 46882/663
- *3000 Series PXI Modules Installation Guide for Chassis*, part no. 46882/667
- SMA connector cable, part no. 43139/590 (2 off)

Cleaning

Before commencing any cleaning, switch off the rack and disconnect it from the supply. You can wipe the front panel of the module using a soft cloth moistened in water, taking care not to wet the connectors. Do not use aerosol or liquid solvent cleaners.

Putting into storage

If you put the module into storage, ensure that the following conditions are not exceeded:

Temperature range:	–20 to +70°C (–4 to +158°F)
Humidity:	5 to 93%, non-condensing

Chapter 2 INSTALLATION

WARNING

Initial visual inspection

Refer to the 3000 Series Common Installation Guide 46882/663.

CAUTION

Handling precautions

Refer to the 3000 Series Common Installation Guide 46882/663.

Hardware installation

Installing the module into the PXI chassis

Refer to the 3000 Series Common Installation Guide 46882/663 and Installation Guide for Chassis 46882/667.

Connector care and maintenance

How to connect and torque an SMA connector

1 First, ensure that the mating halves of the connector are correctly aligned.

2 Next, engage the threads of the nut and tighten it by hand, ensuring that the mating halves do not move relative to each other.

3 Then use a torque spanner to tighten the connector, in order to ensure consistent matching and to avoid mechanical stress.

Torque settings for connectors are:

0.56 Nm test torque (development use, semi-permanent installations)

1 Nm final torque (permanent installations)

Never use pliers to tighten connectors.

Maintenance

SMA

Clean connectors regularly, using a cotton bud dipped in isopropyl alcohol. Wipe within the connector cavity, then use a dry cotton bud to finish off. Check for any deposits.

Do not use other cleaners, as they can cause damage to the plastic insulators within the connectors.

Cap unused connectors.

PCI

Protect PCI connector pins by keeping modules in their original packing when not fitted in the rack.

Chapter 3 OPERATION

Front-panel connectors

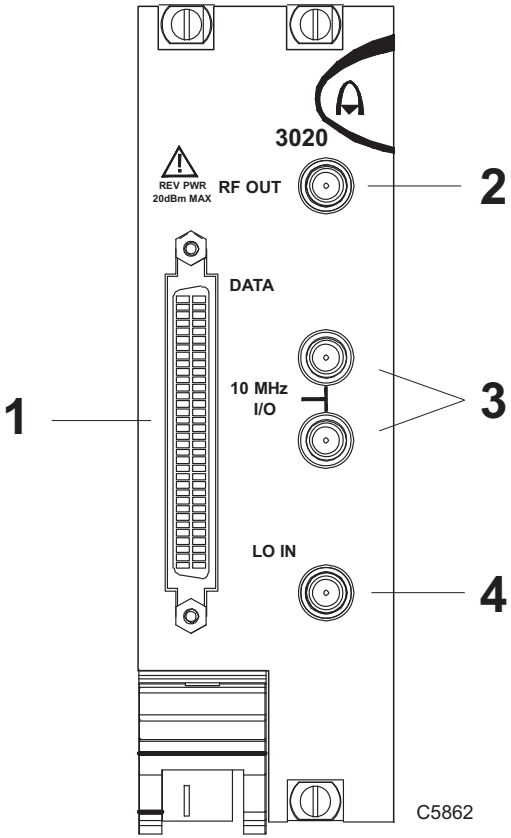


Fig. 3-1 3020 front panel

1	DATA	68-way SCSI connector for LVDS I/O. See Appendix B for details.
2	RF OUT	RF output, –120 to +5 dBm. SMA socket, 50 Ω.
3	10 MHz I/O	Two SMA I/O sockets in parallel. **Input** Frequency standard input for sampling clock. 0.4 to 4 V pk-pk into 50 Ω. **Output** Link-through from input.
4	LO IN	1.5 to 3 GHz, nominally 0 dBm. SMA socket, 50 Ω.

CAUTION

Maximum safe power

Reverse power handling: not to exceed **+20 dBm**

Soft front panel (af3020_sfp)

The soft front panel provides a graphical interface for operating the module. It is intended for testing and diagnosing, for demonstration and training, and for basic operation of the module. It represents most of the functions available in the instrument driver. It is not however a comprehensive application suitable for measurements; for this, use the afSigGen DLL or afcomSigGen COM object.

Installation

The soft front panel is installed during the driver installation process (refer to the 3000 Series PXI Modules Common Installation Guide, part no. 46882/663).

Open the *AF3020_sfp.exe* file: this is in the *C:\VXIPNP|WinNT\af3020* directory on a Windows NT machine, for example. It is also accessible from the Windows Start menu under *Programs\Aeroflex\PXI Module Front Panels\AF3020 Front Panel*. The soft front panel, similar to that in Fig. 3-2, is displayed.

Detailed help information

Soft front panel controls are all available as driver export functions unless noted otherwise, and are documented in the help files (page 3-25). This operating manual provides an overview of the facilities that the module provides and summarizes its operation; however, refer to the help files for detailed descriptions of functions together with their parameter lists and return values.

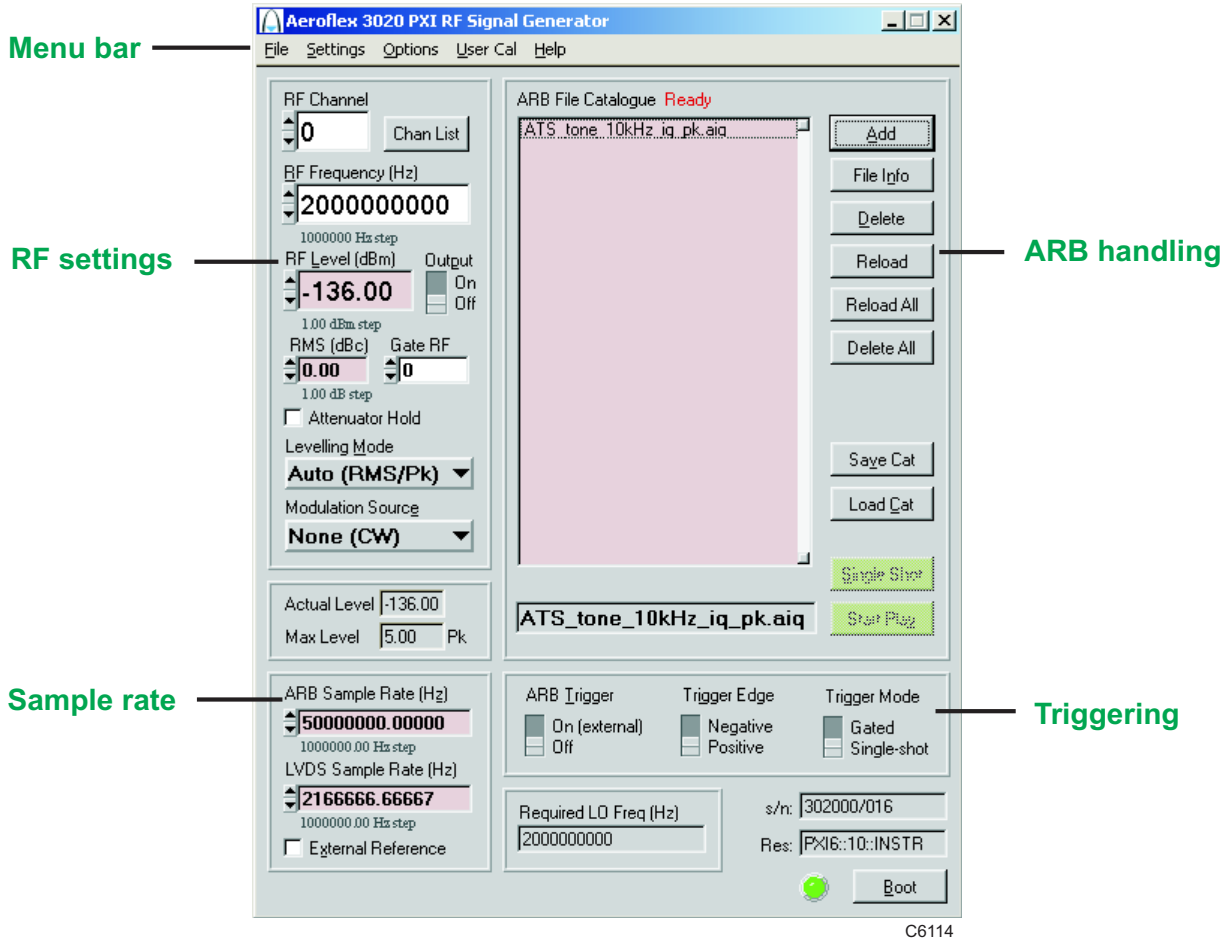


Fig. 3-2 3020 soft front panel

Soft front panel controls

Menu bar

File

Click **Exit** to close the application.

Settings

Load and **Save** allow you to load and save soft front panel configurations from and to your preferred locations. If you did not change the default location when installing the software, it is *C:\VXIPNP\WinNT\af3020\settings*, and configurations are saved as *.ini* files.

> You can edit, copy and paste settings files as required; for example, you may want to save only a new routing setup without changing other parameters. Edit the saved *.ini* file using a text editor (for example, Notepad) to remove unwanted parameters. Ensure only that you do not delete the General (VendorID, DeviceID) and Version (Major/Minor) parameters. Save the changed file. When the settings file is next loaded, the configuration of the soft front panel changes to match the parameters remaining in the settings file, leaving all other settings unchanged.

Directories lets you choose the locations for your front-panel configuration settings, ARB files and catalogs, synthesizer plugin DLLs and calibration files.

Synthesizer plugins must support a VXIPNP (VISA) RF synthesizer resource capable of 1.5 GHz to 3 GHz. Certain exported functions are also required: refer to online help for details.

LVDS: select the Data Size (14-bit or padded to 16-bit) and Sign (unsigned/signed) to match different data types.

IQ Bandwidth Correction. Normally off. On Manual, provides up to 3 dB compensation to correct for roll-off on the internal analog IQ path. The maximum correction of 3 dB provides a nominally flat response across 14 MHz. The maximum available power from the module is reduced by the correction figure selected.

Routing Scenarios allows you to select a predefined routing matrix connection. A tick against the scenario's title shows that it is selected.

If you select a scenario, and then a second, any connected or enabled outputs common to both scenarios are overwritten by the second. Enabled outputs in the first scenario that do not appear in the second also remain active. If the second scenario changes any outputs that were used by the first, the first scenario is invalidated. This process extends to further scenarios.

Routing Matrix displays a matrix that provides interconnection between input and output signals on the PXI backplane bus, the DATA connector and the 3020's internal circuitry, as shown diagrammatically in Fig. 3-3. This provides great flexibility in how you route signals between modules.

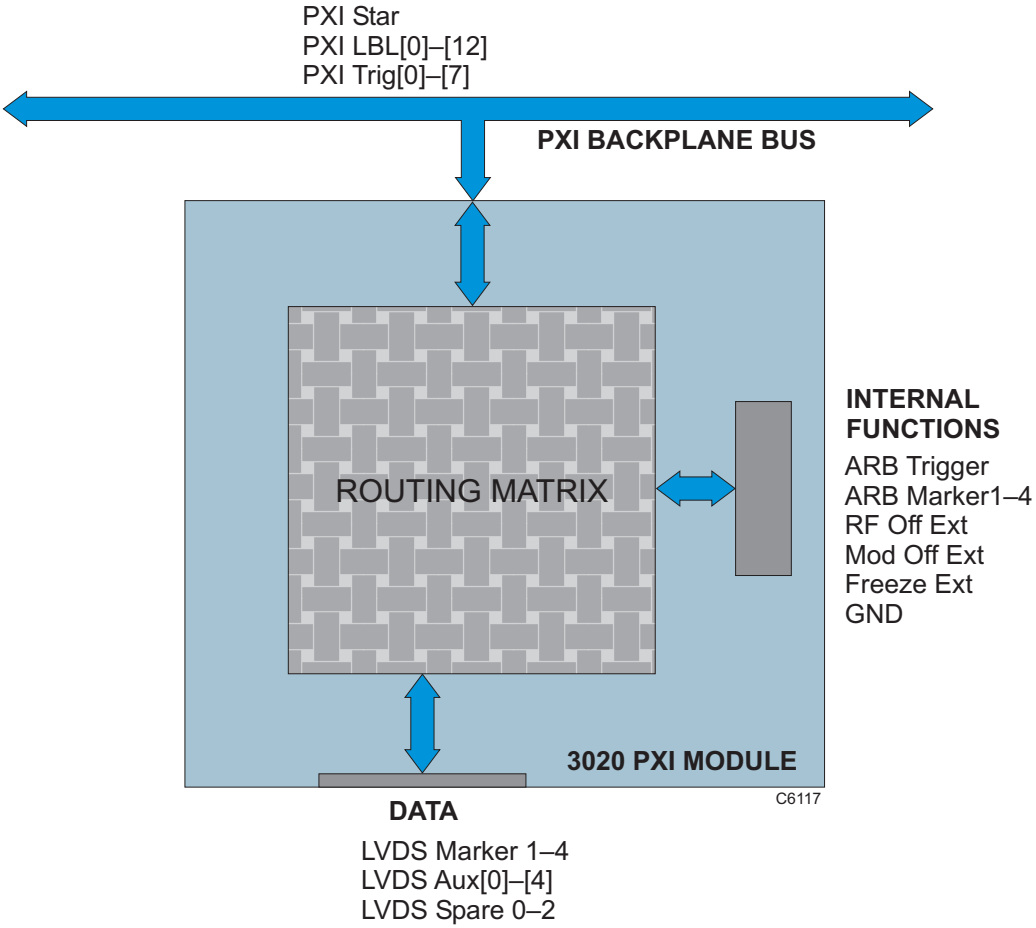


Fig. 3-3 Routing matrix in 3020

Use the routing matrix (Fig. 3-4) to interconnect signals. Output signals form the body of the matrix. Select appropriate input signals from the drop-down menus under each down-arrow to create the interconnections.

Check the boxes to enable the outputs. **Reset** sets all input signals to GND, which is the default state.

When operating the 3020 in default signal generator mode (routing matrix reset), all necessary input, output and trigger signals are available on front-panel DATA or SMA connectors and there is no need to configure the matrix. If you need to set up particular signal routings, you can define these using the drop-down menus on the matrix and save them using the **Load** and **Save** commands in **Settings**, or use **Routing Scenarios** to access pre-set alternative routings, or contact Aeroflex if you need assistance in defining particular routing requirements.

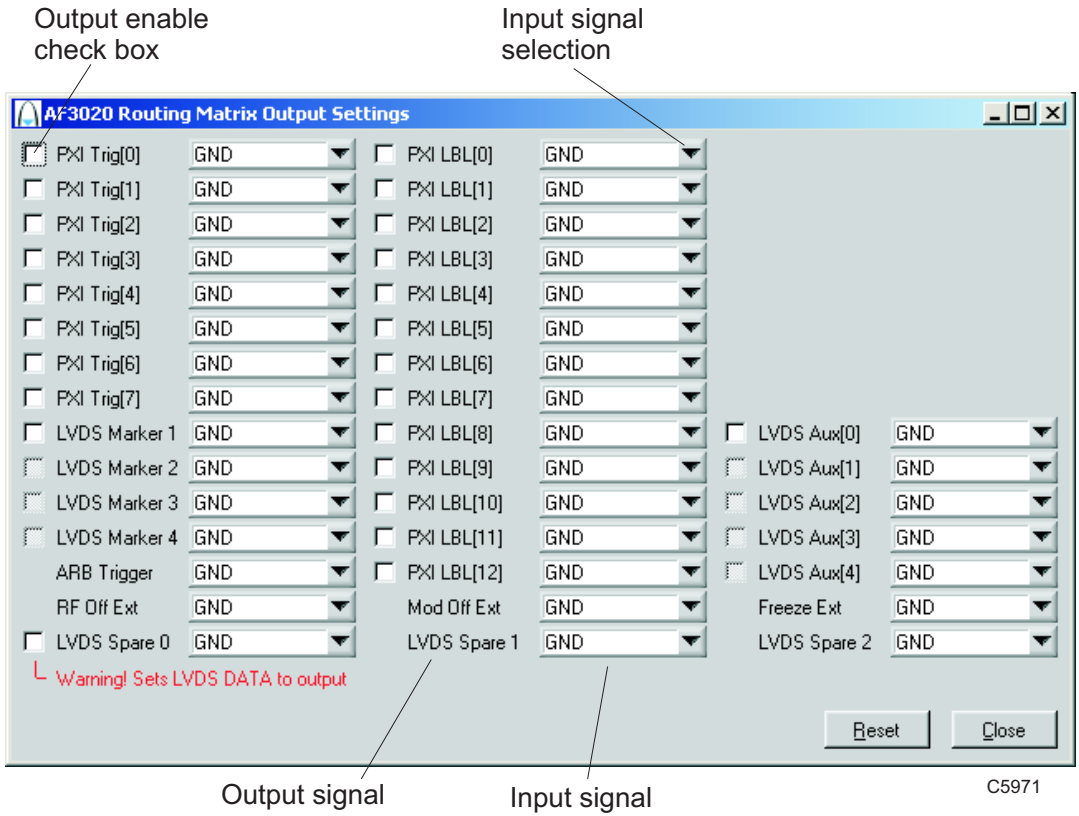


Fig. 3-4 Routing matrix inputs and outputs

Analog Modulation displays the screen for setting up internal AM and FM modulation (Fig. 3-5). Analog modulation is enabled when **Modulation Source** is set to Internal AM or Internal FM.

The modulation source for internal AM/FM analog modulation is a sinusoid with user-settable frequency (modulation rate).

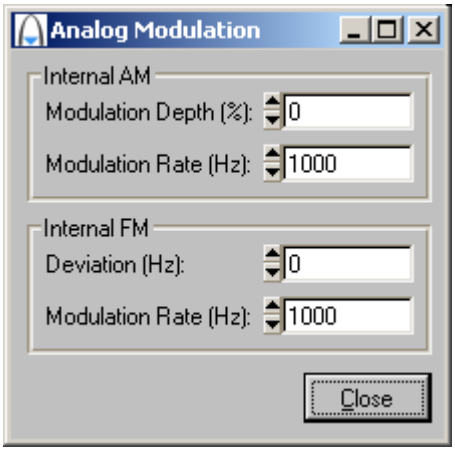


Fig. 3-5 Analog modulation setup screen

Analog Modulation

Modulation Depth (%) sets AM modulation depth, in %.

Modulation Rate (Hz) sets AM modulation rate, in Hz.

Deviation (Hz) sets FM deviation, in Hz.

Modulation Rate (Hz) sets FM modulation rate, in Hz.

Options

Allows you to enable or disable additional instrument options if you have the appropriate password (available from the Aeroflex sales desk).

Click **Edit** to display the options screen. Disabled options are shown grayed out. To enable an option, enter the appropriate password. Click **Enable**. The enabled option is shown highlighted in green. Click **OK**.

User Cal

Calibration is needed to ensure that some specifications — such as carrier leak — are met, and are guaranteed only if a user calibration has been performed. The module calibrates at the current frequency, or at a range of frequencies, and stores the results so that if you change frequency and return again, the calibration still applies.

In some cases, an LO signal is required; the user calibration screen prompts for the LO Plugin Filename. You can browse for this and boot the selected device from the User Calibration screen.

IQ Calibration

Cal Current Frequency calibrates the IQ modulator at the current frequency. Calibration is valid for frequencies within ±1 MHz of the current frequency. The plugin is not used, but the LO signal must be present at the correct frequency.

Cal All Bands calibrates the IQ modulator over the entire frequency range of the module and returns the instrument to its current state. The plugin is required.

Cal Selected Band calibrates the IQ modulator over individual bands and returns the instrument to its current state. The plugin is required.

Store Single Point/Banded to File lets you save calibrations using the standard Windows browser. Calibrations are saved as *.ciq* files.

Restore Single Point/Banded from File lets you restore *.ciq* calibrations using the standard Windows browser.

Detector Zero

Zero sets the levelling detector to zero. This ensures that the module meets the level accuracy specified in the data sheet. No LO plugin or LO signal is needed.

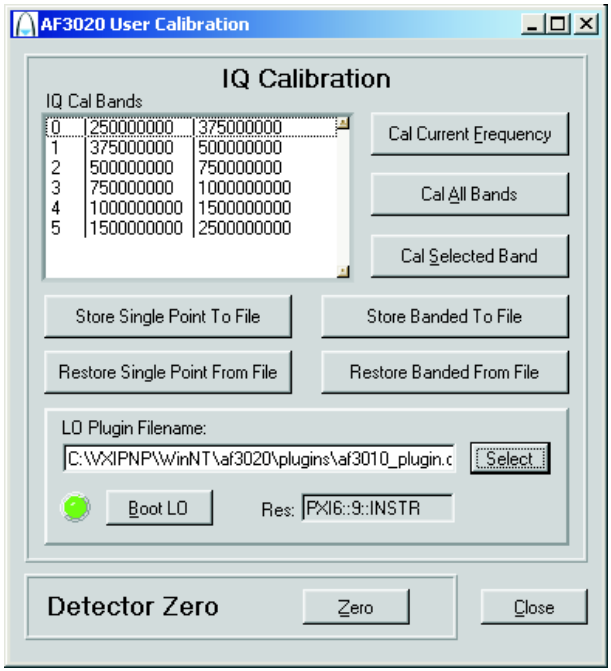


Fig. 3-6 User calibration screen

Help

Instrument Information provides the module's PXI resource code and serial number, revision numbers for driver, FPGA and PCI, and its last calibration date.

About provides the version and date of the soft front panel.

Boot

Click **Boot** to initialize the module and view the Boot Resource window. Resources available for initializing are shown in blue.

Select the 3020 you want to boot.

Boot default FPGA configuration box.
Check this. Do not change the configuration unless you are advised otherwise.

EEPROM caching box.
Check this, so that when you boot a particular module for the first time, calibration data is read from the module and placed in the local cache that you define in the EEPROM Cache Path. This initial boot time is of the order of 45 seconds. Then check the EEPROM caching box at subsequent power-ups of this module to provide considerably faster boot times. The EEPROM caching box is cleared at each power-down.

Click **OK**. While you select the boot resource, the indicator is amber. Once the module has initialized, the indicator changes to green in a few seconds.

If no calibration data is available, the driver returns a caution. If this happens, return the module for calibration.

s/n:

After the module initializes, this field displays its serial number.

Res:

After the module initializes, this field displays its VISA resource string.

RF settings

The controls available in this group allow you to configure up to 128 channels for frequency, level, leveling mode, and other parameters. These parameters are stored, and are recalled as each channel is selected. Select by clicking the up/down arrows of the RF Channel field.

RF Channel

Sets the currently active channel in a range of 0 to 127.

Chan List

Click this to set up each of up to 128 channels (Fig. 3-7). You can edit, copy and paste (page 3-4) the settings to make setup quick and easy.

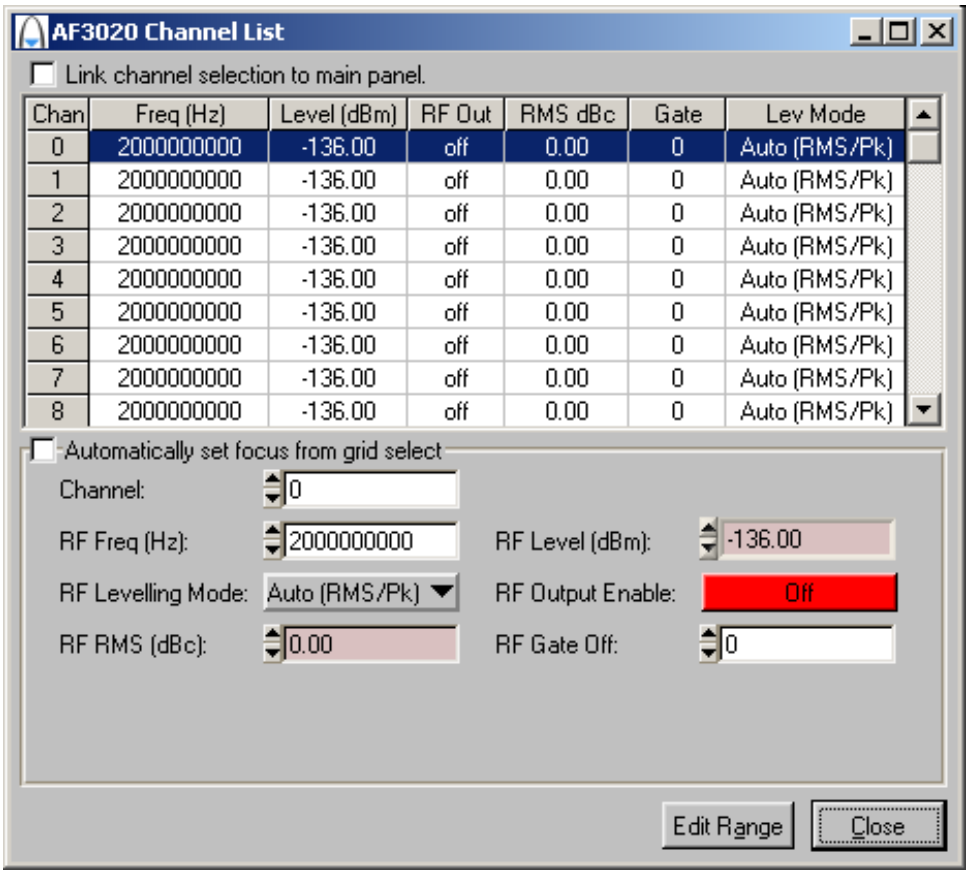


Fig. 3-7 Edit all channel settings

Edit the grid in the upper part of the screen by means of the fields in the lower part. Most fields (Channel, RF Freq (Hz), etc) are similar to those on the soft front panel. Edit each channel individually or by range for:

Channel
RF Freq (Hz)
RF Levelling Mode
RF RMS dBc
RF Level (dBm)
RF Output Enable
RF Gate Off

Click on the link for details. Names of fields on the soft front panel may differ slightly from these, but the function is the same.

Check the **Automatically set focus from grid select** box to make the associated field active when you click on a channel parameter in the grid.

If you check the **Link channel selection to main panel** box, clicking on any parameter of a channel on this screen makes it become the active channel on the soft front panel.

Click **Edit Range** to display the Edit Channel Range screen (Fig. 3-8), which lets you apply changes to a set of channels simultaneously, speeding up channel setup.

Define start and finish values for address numbers in the **Chan range, from:** and **to:** fields.

Insert values and click **Set** for each field. You are asked to confirm each action. When finished, click **Close** to return to the Channel List screen.

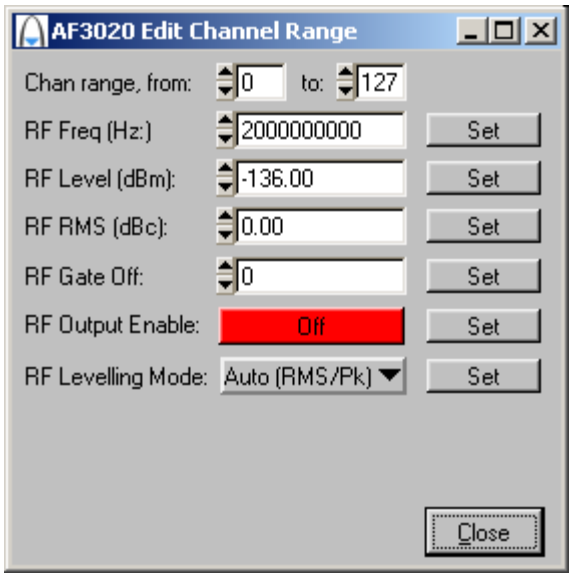


Fig. 3-8 Edit all channel settings

RF Frequency (Hz)

Set the output frequency using the up/down arrows or by entering the frequency in Hz or scientific (e) notation, in the range 250 MHz to 2.5 GHz.

***Note**: the* Required LO Freq (Hz*) box shows the frequency that needs to be set on the 3010/3011 synthesizer to give the chosen RF frequency at the 3020's output.*

Step size: double-click on the step value under the frequency field to set up the size of frequency step.

RF Level (dBm)

Set the output level using the up/down arrows or by entering the value in dBm in the range –120 to +5 dBm with 0.01 dB resolution.

Step size: double-click on the step value under the RF level field to set up the size of level step.

Output

Enable or disable the RF output.

RMS (dBc)

IQCreator ® files contain header information that indicates the RMS power level of the waveform. When using other sources of IQ, this information may not be present, in which case the RMS value needs to be entered in order to achieve the calibrated output level.

For files that do not contain RMS level header information, you can enter the RMS value of the signal here, and select **RMS** in the Levelling Mode field. The power output then matches that selected in the RF Level (dBm) field.

Gate RF

Determines whether RF output is turned off below a predetermined level. If set to 1 (enabled), this turns the RF output for the active channel off when $\sqrt{(I^2 + Q^2)}$ is near to zero. This minimizes IQ leakage to a nominal –80 dBc during periods when the signal is 'off'.

Attenuator Hold

As the step attenuator changes range, small changes in VSWR can occur. Check the box to freeze the attenuator on its current range.

The maximum positive excursion is restricted to the 8 dB range of the attenuator pad, but you can reduce the RF level over a range of up to 40 dB. However, the level accuracy specification is invalid if you exceed the pad's range by more than a few dB.

With **attenuator hold disabled**, the RF level hardware is set for optimum level accuracy and spectral purity, and changes to the attenuator setting are possible.

Note that level accuracy and spectral purity cannot be guaranteed outside the normal level range.

The current active RF channel cannot be changed while attenuator hold is on.

Levelling Mode

Auto (RMS/Pk) sets leveling automatically to RMS for ARB files that contain appropriate header information (most ***IQCreator*** ® files), and to peak-to-peak for inputs that do not contain header information (for example, inputs via the DATA connector).

Frozen freezes leveling at the current settings.

Peak causes the set RF Level to appear at the RF output if you apply maximum full-scale I and Q sample values. As I and Q are decreased, the output decreases proportionally.

RMS causes the set RF Level to appear at the RF output if the RMS value of the applied IQ data stream equals the value set in the RMS (dBc) field. When you select this leveling mode, the RMS (dBc) field is set to a default value of 0.

Modulation Source

Select between:

LVDS (external modulation via DATA connector on front panel)
ARB (internal modulation using the arbitrary waveform generator)
None (CW) (no modulation, carrier wave only). None (CW) sets I and Q to maximum level.
Internal AM
Internal FM

Actual Level

Shows the current actual output level achieved by the module. A red indicator beside the RF Level (dBm) field shows either that attenuator hold is enabled or that the output level is not achieving the level requested.

Max Level

Shows the maximum possible output achievable by the module for the current settings and waveform selected.

Sample rates

ARB Sample Rate (Hz)

Set the ARB's sample rate when Modulation Source is set to ARB.

LVDS Sample Rate (Hz)

Sets the LVDS sample rate when Modulation Source is set to LVDS. The instrument calculates the interpolation automatically to place the interpolated frequency in the range 44 to 66 MHz.

External Reference

Checked:	External 10 MHz reference via front-panel SMA connector
Unchecked:	10 MHz reference from PXI chassis.

LO frequency

Required LO Freq (Hz)

Shows the frequency that needs to be set on the 3010/3011 synthesizer to give the chosen RF frequency at the 3020's output. Double-click in this field, copy the value, and paste into the RF Frequency (Hz) field on the 3010/3011 soft front panel.

ARB handling

Introduction

The **ARB** is a dual-channel arbitrary waveform IQ baseband source generator. It is used to generate signals from samples stored in non-volatile memory. Four marker bits may be stored with the samples, and these are processed to maintain their time relationship to the output waveforms.

IQCreator ® is a software package that allows you to create and package an arbitrary waveform file that can be loaded onto a 3020 RF signal generator. It is also possible to package and download files that have been created using other tools. Arbitrary waveforms that can be created by ***IQCreator*** ® cover a wide range of digital modulation schemes.

IQCreator ® is supplied on a CD-ROM together with a 'getting started' manual (part no. 46882/599) that explains how to create, download and package waveforms to run on the ARB, and a user guide (part no. 46882/627) that details the different modulation schemes supported. ***IQCreator*** ® and its associated documentation are also available to download from the Aeroflex website http://www.aeroflex.com/iqcreator.

ARB File Catalogue

This field displays files currently loaded into the ARB's memory.

Add

Lets you add an ARB waveform to the ARB File Catalogue, using the standard Windows browser. The file must be in .aiq format (as generated by ***IQCreator*** ®). Details of the format of ARB files and headers are given in *Format of ARB Files* (page A-1).

File Info

Provides information about the currently selected ARB file, such as file name and maximum output level.

Delete

Deletes the currently selected ARB file from the specified catalog.

Reload

Reloads an ARB file from hard disk to the specified catalog.

Reload All

Reloads all ARB files from hard disk. This may improve performance if the ARB memory has become fragmented.

Delete All

Deletes all ARB files from the specified catalog.

Save Cat

Saves a catalog of the currently loaded files into a new folder. This function is available only on the soft front panel.

Load Cat

Loads a previously saved catalog of files from a named folder.

Start Play

Plays the selected ARB file and displays its filename. This function automatically sets the IQ source to ARB, and the VCO frequency appropriate to the file being played.

Triggering

Trigger setup for the external ARB trigger. ARB trigger sources are:

PXI backplane	Trigger bus
LVDS AUXiliary inputs	Front-panel DATA connector
TTL TRIG input on front panel	SMB
Star trigger	Star controller card in Slot 2.

Select trigger sources with the routing matrix (page 3-8).

ARB Trigger

On (external)	Dependent on Trigger Edge and Trigger Mode
Off	Internal software triggering

Trigger Edge

Selects the positive- or negative-going edge of a pulse to trigger the ARB.

Trigger Mode

Gated	Begins playing the ARB file continuously on receipt of the leading edge of a gate pulse. After the trailing edge of the gate, the ARB file continues playing until its end, then stops.
Single-shot	Plays the ARB file once through.

Driver export functions

On-line help and functional documentation for driver export functions are available on the CD-ROM supplied with your module. They are installed onto your computer at the same time as the drivers.

Driver installation folder

Find help and functional documentation in the driver installation folder on your computer. This is typically:

C:\vxipnp\winnt\af3020

Help

Within the driver installation folder are help files that provide descriptions, parameter lists and return values. Help files are provided in three formats:

af3020.doc	3020 function documentation	Text file
af3020.hlp	3020 Visual BASIC function reference	Windows Help file format
af3020_C.hlp	3020 C language function reference	

We recommend that you use the C or Visual Basic formats, as these are easier to navigate.

The file opens at the Contents page:

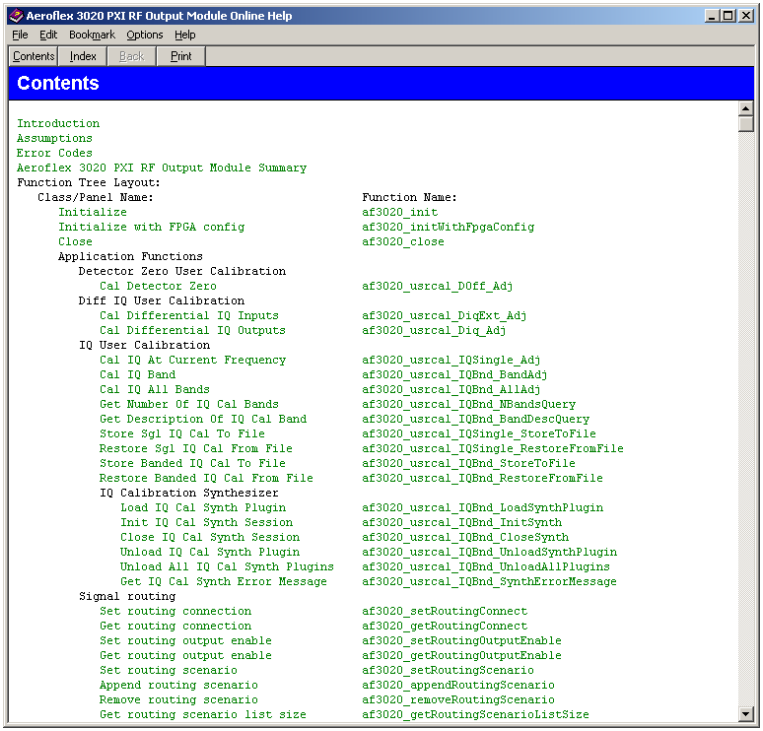


Fig. 3-9 Online help contents — example

Hyperlinks from here take you to

- Introduction
- Assumptions
- Error codes
- Functions listings.

Functions listings

Functions are grouped by type. Click on the hyperlink for details of the function. Each function has a description of its purpose, and may have a list of parameters and return values.

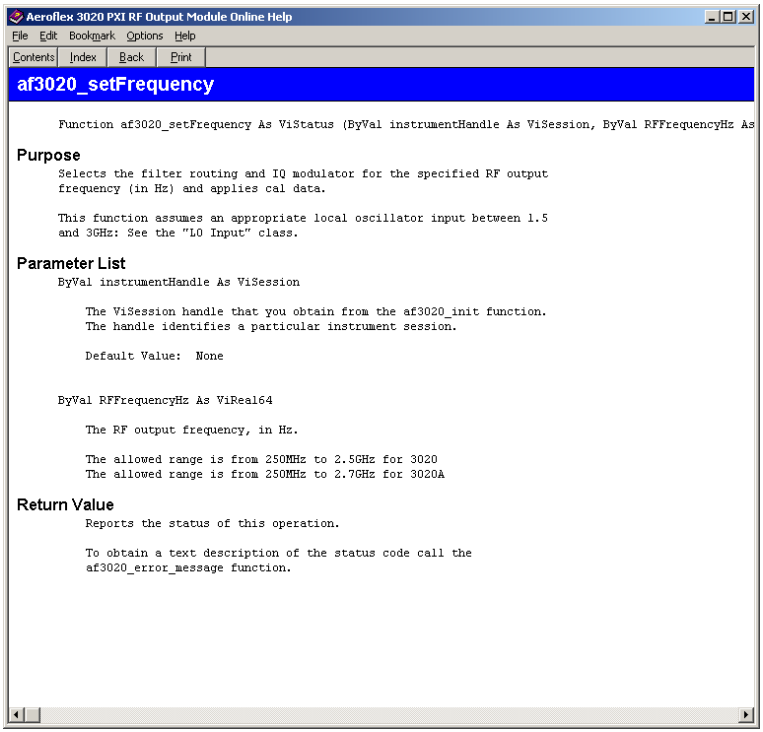


Fig. 3-12 Function description — example

Digital RF signal generator using 3010/3011 and 3020

Refer to *3000 Series PXI Modules Installation Guide for Chassis* (part no. 46882/667) and *Getting Started with afSigGen* (part no. 46892/678), both supplied on the CD-ROM with the module, for detailed information on creating a fully functional digital signal generator using the 3020 and 3010/3011 together. The afSigGen soft front panel and associated dll/COM object combine the functions of the individual modules to provide a single interface with the appearance and functionality of an integrated instrument.

Appendix A
Format of ARB files

General

The ARB stores digital representations of waveforms. Any number of waveforms can be stored, up to a total capacity of 32 Msamples. The memory used is volatile.

Each waveform consists of two components, I and Q. When the ARB is enabled and one of the waveforms selected, it is converted into a pair of analog signals that can be used to drive the I and Q channels of the RF modulator. Waveform data files are created externally and require packaging before they can be used by the ARB.

Each sample contains two 14-bit numbers, one each for I and Q. To minimize the required file size and reduce aliasing problems, the ARB includes an interpolator to increase the D-A converter sample rate by factors of between 2 and 3072 so that the D-A converter runs at between 44 and 66 M sample/s.

A waveform is looped continuously. The rate at which the sample plays is set during file creation.

An example showing data rates and sizes for an IS-95 waveform

IS-95 has a chip rate of 1.2288 Mchip/s. For our purposes we will consider a chip to be the significant symbol. Each symbol must be sampled at least four times. This would give a rate of 4.9152 Msample/s. There are 24 576 symbols per 20 ms frame. Four frames would have 98 304 symbols, which after oversampling gives 393 216 samples. As the oversample ratio increases, the file becomes larger.

When the above waveform is selected and played, it is read out of the memory at 4.9152 Msample/s. The ARB interpolates this data stream so that it has a data rate of 58.9824 Msample/s.

The data is written to the two 14-bit D-A converters at 58.9824 Msample/s. The analog outputs from the D-A converters are then filtered to remove switching and quantization noise and high-frequency images. The I and Q outputs are then routed to the RF modulator.

Markers

Markers are used to mark important events within the file; for example, the start of a TDMA slot or frame.

Format for header of ARB IQ files (*.aiq)

	Comment	No. of bytes
[File]		
Date=	Date file was created (mm/dd/yyyy)	12
Time=	Time file was created (hh:mm:ss)	10
PackSWVers=nn.nn	SW version of Packager (files that are created using software other than ***IQCreator*** ® must set nn.nn = 00.00)	5
Samples=	No. of IQ Samples as an ASCII number	8
Title=	Name of AIQ file without extension and without path	80
SampleRate=	In Hz, in steps of 100 Hz, converted from user entry in packager	8
Description=	Description field entered in packager	120
RMS=	RMS value of the stored waveform	9
RelRMS=	RMS relative to maximum (dB)	8
CrestFactor=	Crest factor of stored waveform	8
[Assign]		
Mkr1=	Marker 1 assignment (not used or general)	12
Mkr2=	Marker 2 assignment (not used or general)	12
Mkr3=	Marker 3 assignment (not used or general)	12[1]
Mkr4=	Marker 4 assignment (not used or general)	12[1]

All headers are stored as ASCII strings, each line terminated with CR/LF.

The header is terminated by a ^Z. Data following the header is the IQ and marker data stored as IQIQIQ…

The format is:

bit number	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
	S	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	M2	M1

bit number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	S	I	I	I	I	I	I	I	I	I	I	I	I	I	M4	M3

where Mn = marker number n, S = sign bit.

The last 32-bit value in the file is a checksum that is calculated as the running unsigned sum of the 32-bit numbers.

Appendix B
DATA connector and timing

The DATA connector is a 68-way female SCSI-type LVDS (low-voltage differential signaling) interface. It can be used to input data and associated control and timing signals.

The DATA connector is shown in Fig. B-1. Signals are transmitted using LVDS to ANSI/TIA/EIA-644.

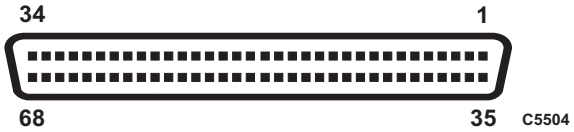


Fig. B-1 DATA connector (looking onto front panel)

The DATA interface provides:

- input for IQ data
- input/output for trigger and marker signals.

The electrical level is LVDS: V_{OH} typically 1.38 V, V_{OL} typically 1.03 V

Table B-1 DATA pin-out

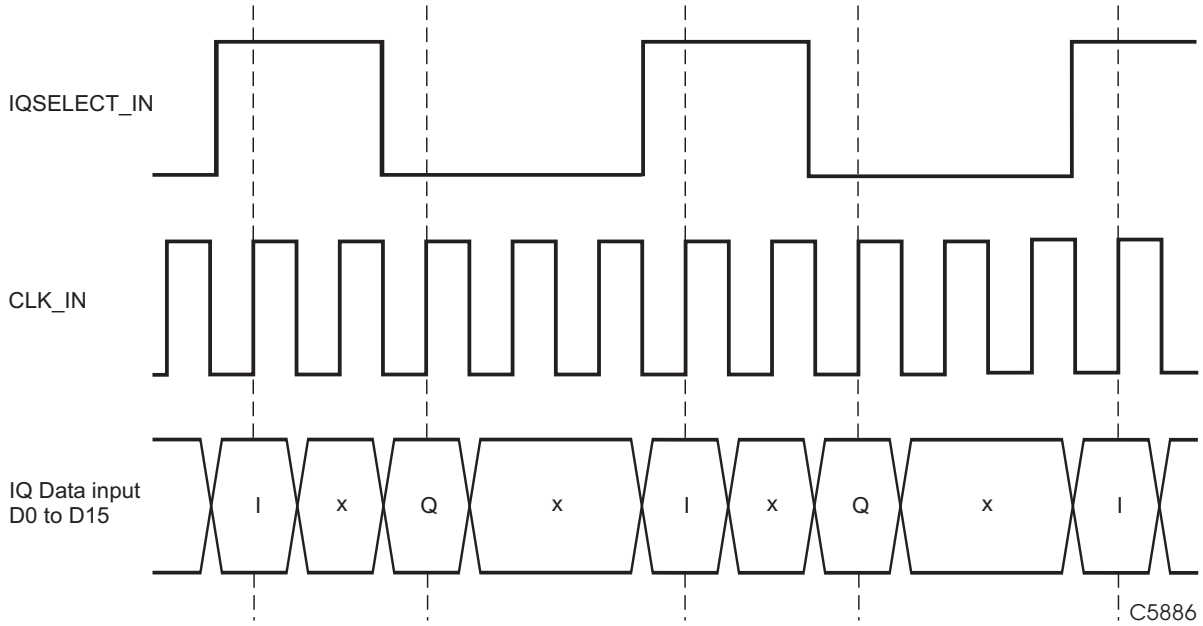
Contact	Function	Contact	Function
1	AUX0-	35	AUX0+
2	AUX1–	36	AUX1+
3	AUX2–	37	AUX2+
4	SPARE1–	38	SPARE1+
5	SPARE2–	39	SPARE2+
6	CLK_OUT–	40	CLK_OUT+
7	GND	41	GND
8	CLK_IN–	42	CLK_IN+
9	D0–	43	D0+
10	D1–	44	D1+
11	D2–	45	D2+
12	D3–	46	D3+
13	D4–	47	D4+
14	D5–	48	D5+
15	D6–	49	D6+
16	D7–	50	D7+
17	D8–	51	D8+
18	D9–	52	D9+
19	D10–	53	D10+
20	D11–	54	D11+
21	D12–	55	D12+
22	D13–	56	D13+
23	D14–	57	D14+
24	D15–	58	D15+
25	IQSELECT_IN–	59	I/QSELECT_IN+
26	IQSELECT_OUT–	60	IQSELECT_OUT+
27	SPARE0–	61	SPARE0+
28	GND	62	GND
29	MARKER1–	63	MARKER1+
30	MARKER2–	64	MARKER2+
31	MARKER3–	65	MARKER3+
32	MARKER4–	66	MARKER4+
33	AUX3–	67	AUX3+
34	AUX4–	68	AUX4+

LVDS data used as IQ input

Data is supplied to the LVDS interface using a 16-bit bus. The D/A converters are 14 bits and by default the 3020 uses bits [15:2]; however, it is possible to select to use [13:0] instead. Similarly, data is signed two's complement by default, but it is possible to select unsigned instead. See **LVDS** (page 3-4).

IQ data pairs are clocked sequentially, with I always followed by Q. I data is clocked into the 3020 on the first CLK_IN edge following IQSELECT_IN going high. Q data is clocked in on the first edge following IQSELECT_IN going low.

Multiple CLK_IN cycles can occur between IQSELECT_IN changing state, and CLK_IN can be any frequency up to 132 MHz. However, the resulting IQ sample pair rate must be the same as the sample rate set for the instrument. For this to occur, it is important to lock CLK_IN to the same 10 MHz reference that the instrument is using, otherwise frequency drift will cause periodic data errors.

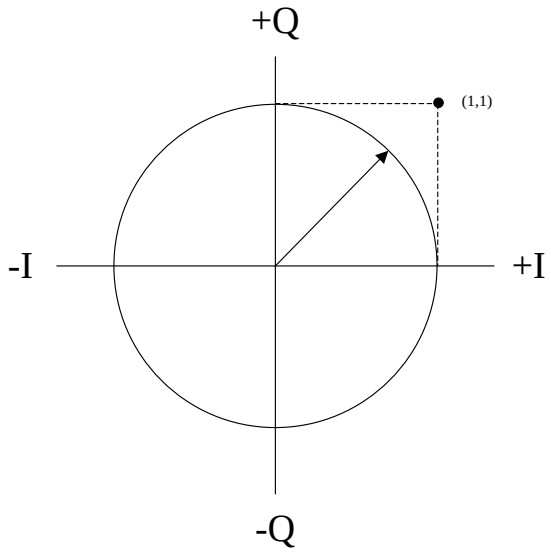


Data in is latched on the rising edge of CLK_IN. CLK_IN must be locked to the same 10 MHz reference as the 3020.

Output power level

The IQ leveling loop is referenced to maximum I and Q level (1,1 on the vector diagram), and the maximum RF power using IQ data is also referenced to this. Output level for a modulated signal with constant envelope (for example, GSM) is reduced by 3 dB on the maximum available CW level. This type of signal will fall on the unit circle.

For complex modulation schemes that include amplitude modulation, the maximum achievable mean power depends on the ratio of mean to peak signal levels; this value is provided in the header information (RelRMS) of files generated in ***IQCreator*** ®.



Markers

There are four marker inputs on the DATA connector. The markers can be used for various functions such as triggered or addressed frequency hopping.

Chapter 4 BRIEF TECHNICAL DESCRIPTION

Introduction

The 3020 is a Digital RF Signal Generator PXI module. It contains dividers to give a frequency range of 250 MHz to 2.5 GHz, IQ modulators, leveling control, step attenuation to –120 dBm, and an IQ baseband arbitrary waveform generator. It does not contain a local oscillator, relying instead on a 3010 RF Synthesizer to provide an LO signal. The two modules together then form a digital RF signal generator.

The 3020 comprises two printed circuit boards, both aligned with the PXI card slots. The logic and control board contains the PCI interface, baseband VCO, IQ ARB, leveling control and an external LVDS data interface. The RF board is housed in a full clamshell shield, containing RF dividers, IQ modulators, output amplifier and step attenuator.

Only the logic board connects to the PXI backplane, so power and control to the RF board is routed through the logic board. A single 40-way ribbon cable connects the boards, handling power to the RF board, differential analog IQ, analog leveling signals and various switched control signals.

A block schematic for the instrument is shown in Fig. 4-1.

Logic and control board

The PCI interface uses an FPGA, which boots up at power-on from a local ISP PROM. The interface provides all the required PCI-compliant handshaking and data transfer. A serial EEPROM is used for calibration data as well as all module information, such as serial number.

A baseband VCO generates a clock signal for the IQ generation and processing. This is a fractional-N-based system, operating from 88 to 132 MHz and using either the PXI 10 MHz clock or an external 10 MHz signal as its reference.

Analog IQ signals are generated by two DACs, their clocks supplied directly from the VCO at 88–132 MHz. The DACs interpolate at 2x, giving a data rate of 44–66 MHz. The DACs each produce differential signals that are fed through filters, two for each DAC. The data for the DACs has three possible sources: static registers for CW operation, the internal ARB, or the LVDS data interface.

The ARB consists of SDRAM devices configured as 64-bit-wide memory. An SDRAM controller handles bursted writing and reading from the memory. The ARB sample width is 32-bit: 14-bit I, 14-bit Q, and 4-bit markers. The memory is configured as 64-bit to provide capacity to set up bursts and perform the frequent auto-refreshes required of SDRAM.

The LVDS interface provides a digital input. A rate-matching FIFO is used to allow the data source to use an independent clock, but it must be assumed that it is locked to the same reference for correct operation.

Digital interpolation filters allow a range of data rates less than the 44 to 66 MHz clock range. The highest order of interpolation is 3072, which means the lowest sample rate is 14.323 kHz. These filters are used on both ARB and LVDS data. The 3020 applies all corrections to IQ data in the digital domain. This includes DC offset, gain imbalance and phase skew between I and Q. Additional digital filters are used to correct for inaccuracy in the analog reconstruction filters and frequency response of the DACs.

A closed-loop leveling control drives leveling on the RF board via a 14-bit DAC. The signal from an RF detector after this stage is converted by an ADC.

The leveling loop derives its error signal by comparing the input to the comparator from the RF detector ADC, and the wanted IQ power. The IQ power is converted to detector volts in a look-up table. During bursted IQ data, the loop can be frozen while ramping IQ data up or down, and can also switch off the signal between bursts, improving on-off ratio.

A burst of data from the detector ADC can be stored and retrieved by the software driver, which is useful for operations such as offset-nulling the ADC and performing IQ calibration. During IQ calibration short test-signals are loaded to the ARB, and by synchronizing ADC data capture, the driver can make the necessary calculations and corrections to IQ offsets, gain and skew.

RF board

LO input and RF output is via front-panel-mounted SMA connectors. The LO input is in the range 1.5 to 3 GHz at a nominal level of 0 dBm. Frequency division extends the available RF output frequency range down to 250 MHz. The RF signal is generated using an IQ modulator, which accepts divided LO and IQ baseband signals.

The LO input signal drives a chain of three dividers. A signal at the required output frequency is routed from the appropriate divider to one of two IQ modulators via harmonic filtering.

One modulator covers frequencies from 250 MHz to 1 GHz; the other, frequencies from 1 GHz to 2.5 GHz. Filtering is repeated after the modulators. The appropriate signal is routed to the output section.

A PIN attenuator operates over a range of at least 20 dB. The drive to this level control incorporates a shaping network to approximate to logarithmic control. The leveling is entirely under software control and as such is completely flexible.

Level detection takes the form of voltage sensing behind a 50 ohm resistor.

The switchable step attenuator operates in increments of 8 dB, from 2 dB up to 130 dB. The attenuator uses 50 ohm resistive pads that are switched in and out of circuit. The incremental attenuation values are 32, 8, 32, 16 and 32 dB.

The detector output is amplified and buffered before being fed back to the logic board for A-D conversion. A temperature-sensing mode is provided, where the detector is disabled and the output replicates the voltage. This can be measured and used to periodically adjust calibration in accordance with temperature and stored data.

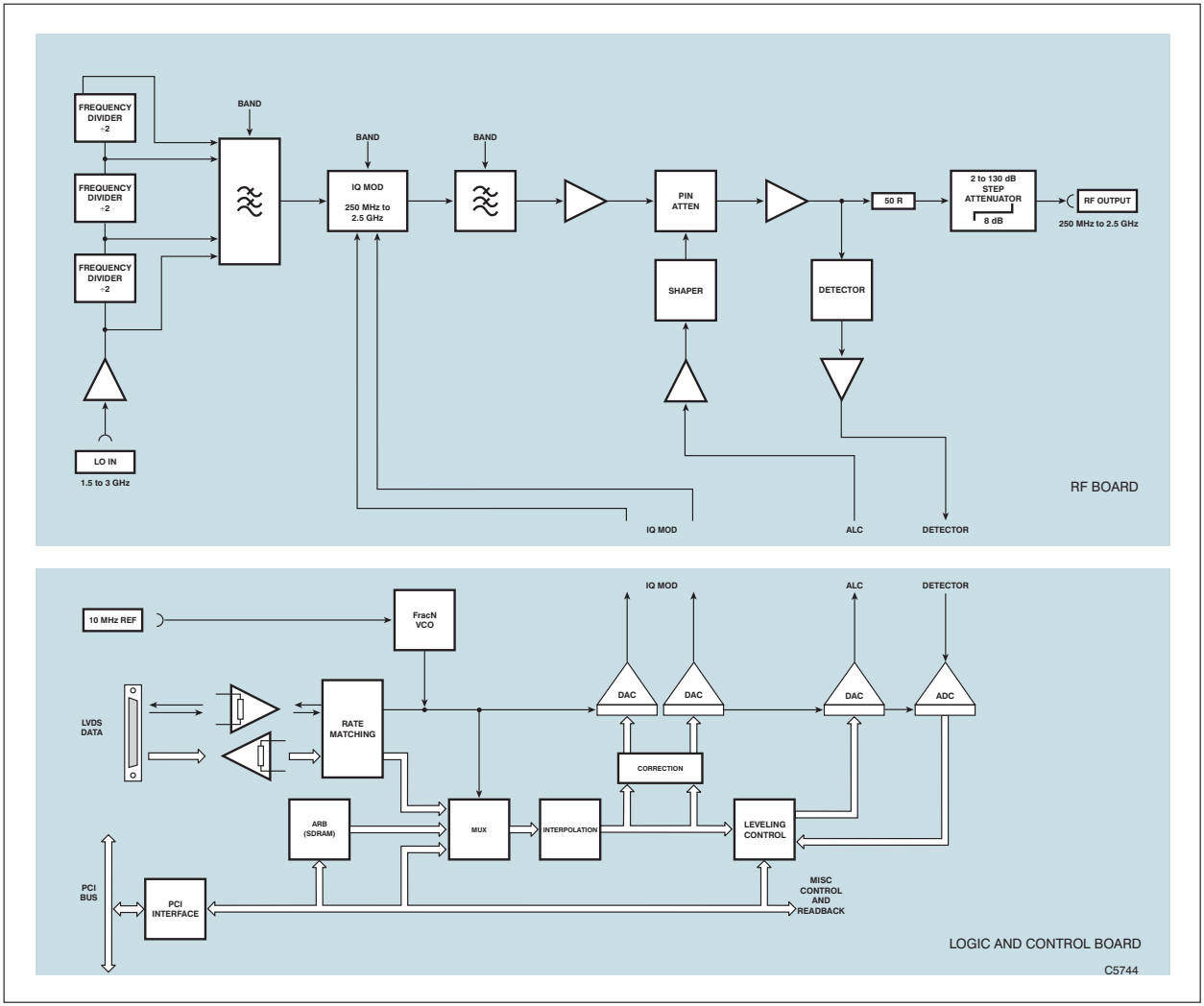


Fig. 4-1 Block schematic diagram

Chapter 5 ACCEPTANCE TESTING

Introduction

The test procedures in this chapter enable you to verify that the 3020 digital RF signal generator is meeting its specified performance.

Abbreviations

Throughout the chapter, the following abbreviations are used:

UUT	Unit Under Test
SFP	Soft Front Panel

Test procedures

Each test procedure shows you how to configure the test equipment and then describes how to perform the test. Tables are provided for recording your results. Measurements should fall within the maximum and minimum limits indicated, provided that you use the recommended test equipment and adhere to the test precautions.

The tests recommend the use of conventional ‘rack and stack’ test equipment, apart from the LO for the 3020 UUT, where an Aeroflex 3011 RF synthesizer is recommended, although a conventional signal generator may be used. Other PXI modules may be used as long as they comply with the minimum specification.

Controlling the UUT

If a separate ‘rack and stack’ signal generator is being used as an LO for the 3020, then control of the UUT is via the af3020 SFP. A column in the results tables advises the required LO frequency for the signal generator.

If a 3011 PXI RF synthesizer is being used as an LO for the 3020, then control of the 3011 and 3020 is greatly simplified by using the SigGen SFP. This controls both modules together so that the LO is set automatically to the required frequency.

***Note**: these test procedures are written assuming that you use the SigGen SFP. They may differ slightly if you use the af3020 SFP.*

Both SFPs are on the supplied CD–ROM (part no. 46886/028) as part of the common installation.

Follow the instructions provided in the 3000 Series Common Installation Guide (part no. 46882/663) to ensure that this software is correctly installed.

Each test procedure relies on the module being set to its power–up conditions. To avoid switching the instrument off and back on, reboot the module via the SFP as follows:

af3020 SFP:

- Click on **Boot**.
- Select the appropriate resource from the list.
- Click on **OK**.
- After a few seconds, the indicator turns green to show that the boot sequence has completed successfully.

SigGen SFP:

- Click on **Boot**.
- Select the appropriate AF3020: resource from the list.
- Select the appropriate LO synth: resource from the list.
- Click on **Boot Instrument**.
- After a few seconds, the indicator turns green to show that the boot sequence has completed successfully.

Note that for clarity, the PXI chassis and controller are not shown in the test equipment set–up diagrams.

Recommended test equipment

The test equipment recommended is shown below. Alternative equipment may be used provided it complies with the stated minimum specification. The minimum specification is only an indication of the required performance. With all measurements, you should ensure that the performance of the test equipment has adequate stand–off from the specification of the UUT.

Description	Minimum specification	Example	Test parameters
PXI synthesizer or signal generator	1.5 GHz to 3 GHz, 0 dBm	Aeroflex 3011, or Aeroflex 3413 or 2032	All
Power meter and sensor	1.5 GHz to 2.5 GHz	Aeroflex 6960B and 6912	RF level accuracy
Spectrum analyzer	250 MHz to 2.5 GHz RF level linearity ±0.01 dB per 10 dB WCDMA EVM and ACP measurement capability	Agilent E4445A with options: B7J Digital demod. BAF WB-CDMA license 1DS RF pre-amplifier	RF level accuracy Modulation accuracy
Oscilloscope	10 MHz	Tektronix TDS3032	10 MHz reference output

Test precautions

To ensure minimum errors and uncertainties when making measurements, it is important to observe the following precautions:

- Always use recently calibrated test equipment, with any correction figures taken into account, so as to establish a known traceable limit of performance uncertainty. This uncertainty must be allowed for in determining the accuracy of measurements.
- Ensure any user calibration routines are performed when necessary. On most power meters it is also necessary to perform an auto-zero routine.
- Use the shortest possible connecting leads.
- Allow 20 minutes for the UUT to warm up, plus any extra time for other test equipment being used.

Checking that the UUT powers up correctly

This test ensures that the 3020 powers up in a satisfactory manner and that the internal self-tests do not report any errors. This test assumes that instrument is fitted in a PXI chassis and that the supplied installation software is installed on the host controller.

- Apply power to the PXI chassis.
- Press the supply switch on the PXI chassis.

Wait for the operating system to complete its boot-up sequence.

- Double-click on the SigGen SFP icon.

The SigGen SFP now starts up. After completing its boot-up sequence, the indicator in the top right-hand corner should be red.

- Click on **Boot**.
- Select the appropriate AF3020: resource from the list.
- Select the appropriate LO synth: resource from the list.
- Click on **Boot Instrument**.

While the modules are booting, the indicator turns amber.

- After a few seconds, the indicator turns green to show that the boot sequence has completed successfully.

Carrier frequency test

This test checks correct operation of the frequency dividers used to generate frequencies down to 250 MHz.

As the frequency counter is locked to the local oscillator, the test limits are ±1 count.

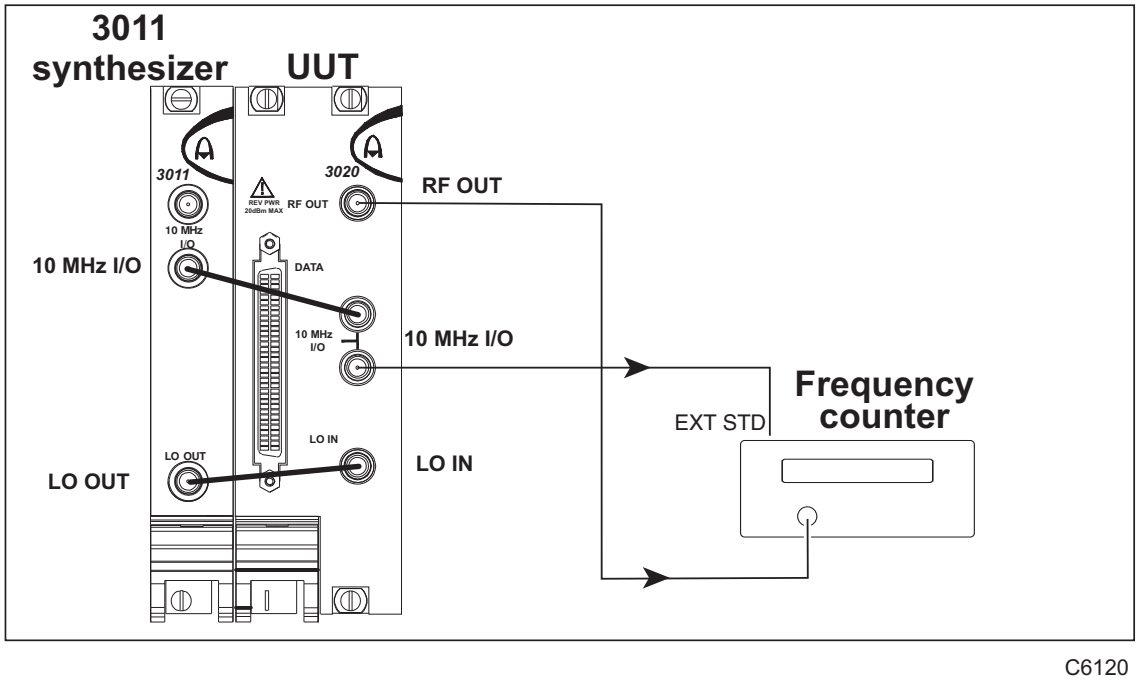


Fig. 5-1 Carrier frequency accuracy test setup

1 Connect the test equipment as shown in Fig. 5-1.

2 On the UUT set:

RF Frequency (Hz)	250000000 (250 MHz) (may be entered as 25e7)
RF Level (dBm)	0

3 Record the frequency measured by the counter against each of the UUT's RF frequencies shown in Table 5-1.

Table 5-1 Carrier frequency results

Carrier frequency (MHz)	LO frequency (MHz)	Minimum (Hz)	Result (Hz)	Maximum (Hz)
250	2000	—		—
500	2000	—		—
1000	2000	—		—
2000	2000	—		—

RF output level test

The RF level test is performed in two parts:

- The ALC flatness test measures the performance of the ALC circuitry over a range of RF levels at defined points across the frequency band.
- The attenuator test measures the performance of the output attenuator at defined points across the frequency band.

ALC flatness

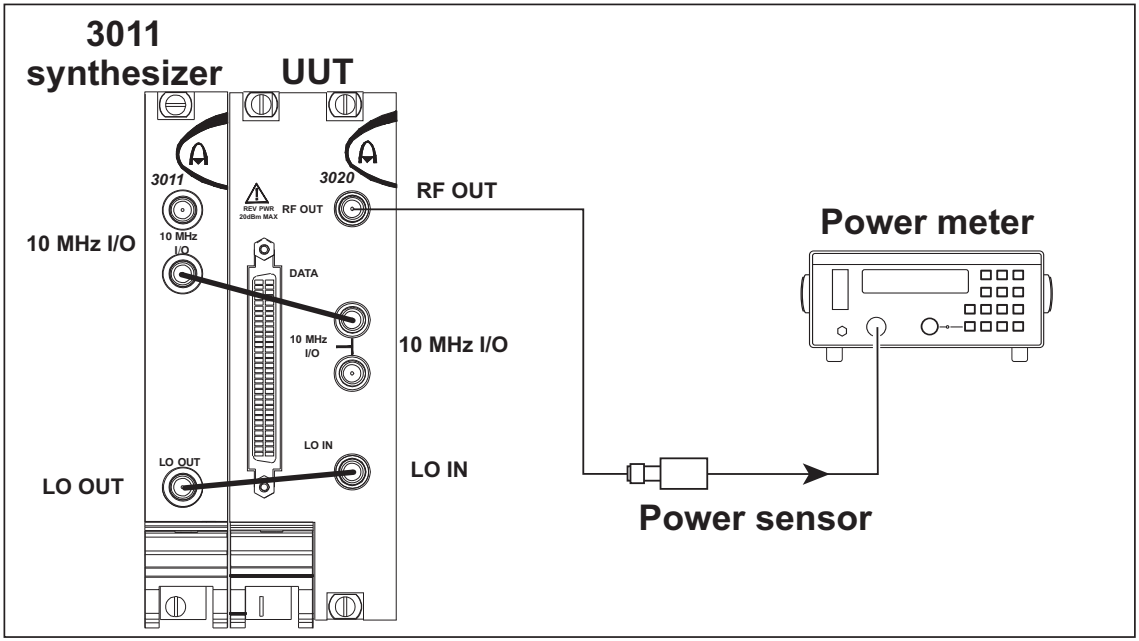


Fig. 5-2 ALC flatness test setup

1 Connect the test equipment as shown in Fig. 5-2.

2 On the UUT set:

RF Frequency (Hz)	250100000 (250.1 MHz) (may be entered as 250.1e6)
RF Level (dBm)	5

3 Set the signal generator LO and the UUT to the frequencies and levels shown in Table 5-2, recording the output level measured by the power meter.

Note: *The readings at 0 dBm taken at the frequencies indicated in bold type are used as reference values in the subsequent attenuator test.*

Table 5-2 ALC flatness results

Test frequency (MHz)	LO frequency (MHz)	RF level	Minimum (dBm)	Result (dBm)	Maximum (dBm)
250.1	**2000.8**	+5 dBm	+4.4		+5.6
		+0 dBm	**–0.6**		**+0.6**
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
375	3000	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
500.1	**2000.4**	+5 dBm	+4.4		+5.6
		+0 dBm	**–0.6**		**+0.6**
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
625	2500	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39

Test frequency (MHz)	LO frequency (MHz)	RF level	Minimum (dBm)	Result (dBm)	Maximum (dBm)
750	3000	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
875	1750	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
1000.1	**2002.2**	+5 dBm	+4.4		+5.6
		+0 dBm	**–0.6**		**+0.6**
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
1125	2250	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
1250	2500	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39

Test frequency (MHz)	LO frequency (MHz)	RF level	Minimum (dBm)	Result (dBm)	Maximum (dBm)
1375	2750	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
1500.1	**1500.1**	+5 dBm	+4.4		+5.6
		+0 dBm	**–0.6**		**+0.6**
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
1625	1625	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
1750	1750	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
1875	1875	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39

Test frequency (MHz)	LO frequency (MHz)	RF level	Minimum (dBm)	Result (dBm)	Maximum (dBm)
2000.1	**2000.1**	+5 dBm	+4.4		+5.6
		+0 dBm	**–0.6**		**+0.6**
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
2125	2125	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
2250	2250	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
2375	2375	+5 dBm	+4.4		+5.6
		+0 dBm	–0.6		+0.6
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39
2499.9	**2499.9**	+5 dBm	+4.4		+5.6
		+0 dBm	**–0.6**		**+0.6**
		–2.99 dBm	–3.59		–2.39
		–3 dBm	–3.4		–2.6
		–10.99 dBm	–11.59		–10.39

Attenuator

Perform the ALC flatness test first.

The attenuator test measures the RF level accuracy down to –113 dBm at a selection of frequencies across the frequency band. An absolute RF level measurement at 0 dBm will have already been taken during the previous ALC flatness test. With a spectrum analyzer connected, the level at 0 dBm is measured again and is correlated with that measured on the power meter. The lower levels are then measured on the spectrum analyzer relative to the measurement taken at 0 dBm.

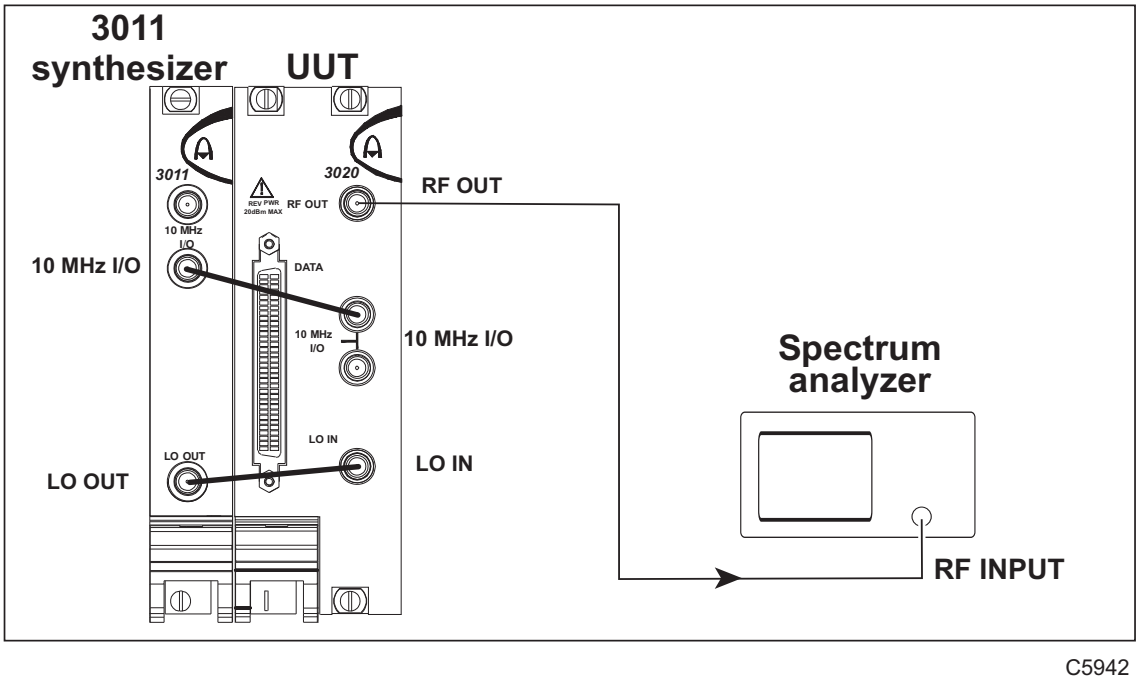


Fig. 5-3 Attenuator test setup

1 Connect the test equipment as shown in Fig. 5-3.

2 On the UUT set:

RF Frequency (Hz)	250100000 (250.1 MHz) (may be entered as 250.1e6)
RF Level (dBm)	0

3 With the spectrum analyzer set to the same frequency as the UUT, use the marker facility to measure the amplitude of the displayed signal. Using suitable span, filter and attenuation settings, record the level measured on the spectrum analyzer at each of the levels shown in Table 5-3.

4 Calculate the difference in the reading at 0 dBm to the reading taken on the power meter at the corresponding frequency in the ALC flatness test and apply this correction to the remaining measurements.

Example

The difference in the two readings at 0dBm is 0.08 dB. In this case, 0.08 dB must be added onto the spectrum analyzer reading to obtain the result.

Test frequency (MHz)	LO frequency (MHz)	RF level (dBm)	Level measured on power meter (dBm)	Level measured on spectrum analyzer (dBm)	Minimum (dBm)	Result (dBm)	Maximum (dBm)
250.1	2000.8	0	**–0.18**	–0.26	–0.6	**–0.18**	+0.6
		–3		–3.35	–3.6	–3.27	–2.4

C5973

Difference =0.08 dB

Add 0.08 dB to this measurement…

…to give this result.

5 Using Tables 5-4 to 5-8, repeat (2) to (4) above at each of the carrier frequencies indicated.

***Note**: you may need to lock the reference of the UUT to the spectrum analyzer to ensure meaningful results from a narrow measurement bandwidth at the lowest RF levels.*

Table 5-3 Attenuator results at 250.1 MHz

Test frequency (MHz)	LO frequency (MHz)	RF level (dBm)	Level measured on power meter (dBm)	Level measured on spectrum analyzer (dBm)	Minimum (dBm)	Result (dBm)	Maximum (dBm)
250.1	2000.8	0			–0.6		+0.6
		–3			–3.6		–2.4
		–8			–8.6		–7.4
		–13			–13.6		–12.4
		–18			–18.6		–17.4
		–23			–23.6		–22.4
		–28			–28.6		–27.4
		–33			–33.6		–32.4
		–38			–38.6		–37.4
		–43			–43.6		–42.4
		–48			–48.6		–47.4
		–53			–53.6		–52.4
		–58			–58.6		–57.4
		–63			–63.6		–62.4
		–68			–68.6		–67.4
		–73			–73.6		–72.4
		–78			–78.6		–77.4
		–83			–83.75		–82.25
		–88			–88.75		–87.25
		–93			–93.75		–92.25
		–98			–98.8		–97.2
		–103			–103.8		–102.2
		–108			–108.8		–107.2
		–113			–113.8		–112.2

Table 5-4 Attenuator results at 500.1 MHz

Test frequency (MHz)	LO frequency (MHz)	RF level (dBm)	Level measured on power meter (dBm)	Level measured on spectrum analyzer (dBm)	Minimum (dBm)	Result (dBm)	Maximum (dBm)
500.1	2000.4	0			–0.6		+0.6
		–3			–3.6		–2.4
		–8			–8.6		–7.4
		–13			–13.6		–12.4
		–18			–18.6		–17.4
		–23			–23.6		–22.4
		–28			–28.6		–27.4
		–33			–33.6		–32.4
		–38			–38.6		–37.4
		–43			–43.6		–42.4
		–48			–48.6		–47.4
		–53			–53.6		–52.4
		–58			–58.6		–57.4
		–63			–63.6		–62.4
		–68			–68.6		–67.4
		–73			–73.6		–72.4
		–78			–78.6		–77.4
		–83			–83.75		–82.25
		–88			–88.75		–87.25
		–93			–93.75		–92.25
		–98			–98.8		–97.2
		–103			–103.8		–102.2
		–108			–108.8		–107.2
		–113			–113.8		–112.2

Table 5-5 Attenuator results at 1000.1 MHz

Test frequency (MHz)	LO frequency (MHz)	RF level (dBm)	Level measured on power meter (dBm)	Level measured on spectrum analyzer (dBm)	Minimum (dBm)	Result (dBm)	Maximum (dBm)
1000.1	2000.2	0			–0.6		+0.6
		–3			–3.6		–2.4
		–8			–8.6		–7.4
		–13			–13.6		–12.4
		–18			–18.6		–17.4
		–23			–23.6		–22.4
		–28			–28.6		–27.4
		–33			–33.6		–32.4
		–38			–38.6		–37.4
		–43			–43.6		–42.4
		–48			–48.6		–47.4
		–53			–53.6		–52.4
		–58			–58.6		–57.4
		–63			–63.6		–62.4
		–68			–68.6		–67.4
		–73			–73.6		–72.4
		–78			–78.6		–77.4
		–83			–83.75		–82.25
		–88			–88.75		–87.25
		–93			–93.75		–92.25
		–98			–98.8		–97.2
		–103			–103.8		–102.2
		–108			–108.8		–107.2
		–113			–113.8		–112.2

Table 5-6 Attenuator results at 1500.1 MHz

Test frequency (MHz)	LO frequency (MHz)	RF level (dBm)	Level measured on power meter (dBm)	Level measured on spectrum analyzer (dBm)	Minimum (dBm)	Result (dBm)	Maximum (dBm)
1500.1	1500.1	0			–0.6		+0.6
		–3			–3.6		–2.4
		–8			–8.6		–7.4
		–13			–13.6		–12.4
		–18			–18.6		–17.4
		–23			–23.6		–22.4
		–28			–28.6		–27.4
		–33			–33.6		–32.4
		–38			–38.6		–37.4
		–43			–43.6		–42.4
		–48			–48.6		–47.4
		–53			–53.6		–52.4
		–58			–58.6		–57.4
		–63			–63.6		–62.4
		–68			–68.6		–67.4
		–73			–73.6		–72.4
		–78			–78.6		–77.4
		–83			–83.75		–82.25
		–88			–88.75		–87.25
		–93			–93.75		–92.25
		–98			–98.8		–97.2
		–103			–103.8		–102.2
		–108			–108.8		–107.2
		–113			–113.8		–112.2

Table 5-7 Attenuator results at 2000.1 MHz

Test frequency (MHz)	LO frequency (MHz)	RF level (dBm)	Level measured on power meter (dBm)	Level measured on spectrum analyzer (dBm)	Minimum (dBm)	Result (dBm)	Maximum (dBm)
2000.1	2000.1	0			–0.6		+0.6
		–3			–3.6		–2.4
		–8			–8.6		–7.4
		–13			–13.6		–12.4
		–18			–18.6		–17.4
		–23			–23.6		–22.4
		–28			–28.6		–27.4
		–33			–33.6		–32.4
		–38			–38.6		–37.4
		–43			–43.6		–42.4
		–48			–48.6		–47.4
		–53			–53.6		–52.4
		–58			–58.6		–57.4
		–63			–63.6		–62.4
		–68			–68.6		–67.4
		–73			–73.6		–72.4
		–78			–78.6		–77.4
		–83			–83.75		–82.25
		–88			–88.75		–87.25
		–93			–93.75		–92.25
		–98			–98.8		–97.2
		–103			–103.8		–102.2
		–108			–108.8		–107.2
		–113			–113.8		–112.2

Table 5-8 Attenuator results at 2499.9 MHz

Test frequency (MHz)	LO frequency (MHz)	RF level (dBm)	Level measured on power meter (dBm)	Level measured on spectrum analyzer (dBm)	Minimum (dBm)	Result (dBm)	Maximum (dBm)
2499.9	2499.9	0			–0.6		+0.6
		–3			–3.6		–2.4
		–8			–8.6		–7.4
		–13			–13.6		–12.4
		–18			–18.6		–17.4
		–23			–23.6		–22.4
		–28			–28.6		–27.4
		–33			–33.6		–32.4
		–38			–38.6		–37.4
		–43			–43.6		–42.4
		–48			–48.6		–47.4
		–53			–53.6		–52.4
		–58			–58.6		–57.4
		–63			–63.6		–62.4
		–68			–68.75		–67.25
		–73			–73.75		–72.25
		–78			–78.75		–77.25
		–83			–84		–82
		–88			–89		–87
		–93			–94		–92
		–98			–99		–97
		–103			–104		–102
		–108			–109		–107
		–113			–114		–112

Spectral purity tests

Carrier harmonics

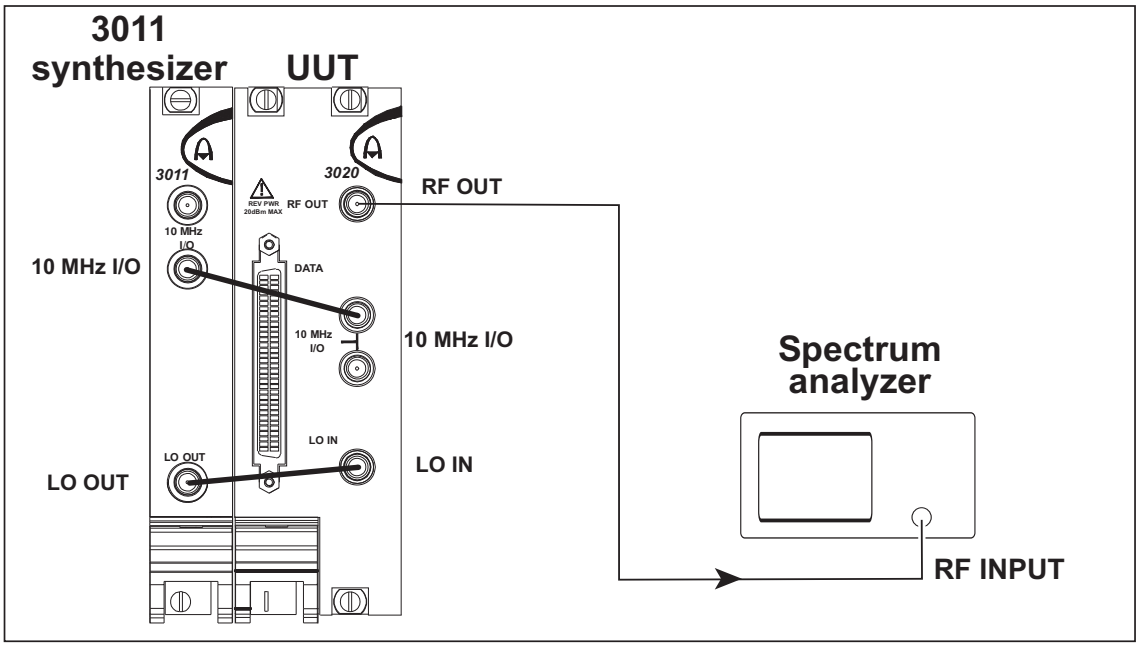


Fig. 5-4 Spectral purity test setup

1 Connect the test equipment as shown in Fig. 5-4.

2 On the UUT set:

RF Frequency (Hz)	250000000 (250 MHz) (may be entered as 25e7)
RF Level (dBm)	0

3 With the spectrum analyzer set to the same frequency as the UUT, use the marker facility to measure the amplitude of the displayed signal.

4 Using Table 5-9, set the spectrum analyzer to f * 2 and f * 3, and measure the 2nd and 3rd harmonics relative to the reading obtained in (3).

5 Repeat (2) to (4) above at each of the frequencies in Table 5-9.

Table 5-9 Carrier harmonic results at 0 dBm

Test frequency (MHz)	LO frequency (MHz)	2nd harmonic (dBc)	3rd harmonic (dBc)	Limit (dBc)
250	2000			–30
374.9	2999.2			–30
375.1	1500.4			–30
500	2000			–30
749.9	2999.6			–30
750.1	1500.2			–30
1000	2000			–30
1250	2500			–30
1499	2998			–30
1501	1501			–30
1750	1750			–30
2000	2000			–30
2250	2250			–30
2500	2500			–30

Carrier sub-harmonics

Sub-harmonic signals are generated as part of the carrier frequency generation process and are measured relative to the carrier.

1 Connect the test equipment as shown in Fig. 5-4.

2 On the UUT set:

RF Frequency (Hz)	375000001 (375.000001 MHz)
RF Level (dBm)	–2.99

3 With the spectrum analyzer set to the same frequency as the UUT, use the marker facility to measure the amplitude of the displayed signal.

4 Using Table 5-10, set the spectrum analyzer to the indicated sub-harmonic frequency and measure the sub-harmonic relative to the reading obtained in (3).

5 Repeat (2) to (4) above for each of the test frequencies shown in Table 5-10.

Table 5-10 Carrier sub–harmonic results at –2.99 dBm

Test frequency (MHz)	LO frequency (MHz)	Harmonic ratio	Sub-harmonic frequency (MHz)	Result (dBc)	Limit (dBc)
375.000001	1500.000004	1/2	187.5000005		–30
382.5	1530	1/2	191.25		–30
580	2320	1/2	290		–30
1160	2320	1/4	290		–30
1160	2320	1/2	580		–30
1500.1	1500.1	1/8	187.5125		–30
1500.1	1500.1	1/4	375.025		–30
1500.1	1500.1	1/2	750.05		–30
2000.1	2000.1	1/8	250.0125		–30
2000.1	2000.1	1/4	500.025		–30
2000.1	2000.1	1/2	1000.05		–30
2320	2320	1/8	290		–30
2320	2320	1/4	580		–30
2320	2320	1/2	1160		–30
2500	2500	1/8	312.5		–30
2500	2500	1/4	625		–30
2500	2500	1/2	1250		–30

Modulation tests

Linearity (ACPR) and EVM

This test may only be performed on a 3020 fitted with Options 100 and 102 (***IQCreator*** ® and 3G CDMA License).

A CDMA single-carrier, 64-channel, test model 1 waveform is used to modulate the carrier, and the spectrum analyzer is used to measure the ACPR.

> Using ***IQCreator*** ®
>
> The waveform is available as an example file within ***IQCreator*** ®. To generate the **.aiq* file, proceed as follows:
>
> - Click on **Modulation**, **CDMA**, **3GPP FDD (Release 5)**; select Example Settings and from the drop-down menu select: *ats_3gpp_fdd_fwd_tm1_64ch_sc0_v5pt1.iqc*
> - Click **OK**. The .iqc file will now be open.
> - To generate the waveform, click on **Generate AIQ File!** and using the current settings, click on **Next**. After the IQ values have been generated, browse for a suitable location to save the waveform and click on **Finish**.

1 Connect the test equipment as shown in Fig. 5-4.

2 On the UUT set:

RF Frequency (Hz)	2100000000 (2.1 GHz) (may be entered as 21e8)
RF Level (dBm)	0
Modulation Source	ARB

Under View Controls, click on **Arb** — the ARB File Catalogue window opens.

Click on **Add** and browse and locate *ats_3gpp_fdd_fwd_tm1_64ch_sc0_v5pt1.aiq*

Click on **Open**. The waveform filename appears in the catalog.

If there is more than one waveform in the catalog, click on the waveform name, then **Start Play**.

Click on **Close** to close the ARB File Catalogue window.

Under User Calibration, click on **IQ on Current Freq**.

3 Set the spectrum analyzer to center frequency 2.1 GHz, and select the 3GPP ACP measurement function.

4 Record the lower and upper ACP measurements, relative to the carrier, in Table 5-11.

5 Set the spectrum analyzer to measure EVM and record the measurement in Table 5-12.

Table 5-11 Linearity (ACP) results

Carrier frequency (MHz)	LO frequency (MHz)	Lower channel	Upper channel	Limit (dBc)
2100	2100			–55

Table 5-12 EVM result

Carrier frequency (MHz)	LO frequency (MHz)	EVM (%)	Limit (%)
2100	2100		1.5

Third order intermodulation distortion

The required test tone waveforms, which produce a double-sideband suppressed carrier suitable for testing intermodulation distortion (IMD), are included in SigGen SFP.

1 Connect the test equipment as shown in Fig. 5-4.

2 On the UUT set:

RF Frequency (Hz)	250000000 (250 MHz) (may be entered as 25e7)
RF Level (dBm)	0
Modulation Source	ARB

From the ARB File Catalogue:

Click on **Add** and browse and locate *ATS_tone_5MHz_i_pk.aiq.* This ARB .aiq file is in a sub-folder in the VXIPNP folder appropriate to your operating system. For example, for Windows XP you should look in C:\VXIPNP\WinNT\af3020\AIQ Files.

Click on **Open**. The waveform filename appears in the catalog.

If there is more than one waveform in the catalog, click on the waveform name, then **Start Play.**

Click on **Close** to close the ARB File Catalogue window.

Under User Calibration, click on **IQ on Current Freq**.

3 Set the spectrum analyzer to center frequency 250 MHz, 50 MHz span. Two sidebands will be visible at ±5 MHz. The IMD products will be present at ±15 MHz.

4 Record the lower and upper IMD products, relative to the adjacent sideband, in Table 5-13.

5 Repeat (2) to (4) for each of the carrier frequencies in Table 5-13.

Table 5-13 Intermodulation distortion results

Carrier frequency (MHz)	LO frequency (MHz)	Lower IMD product	Upper IMD product	Limit (dBc)
250	2000			–50
500	2000			–50
750	3000			–50
1000	2000			–50
1250	2500			–50
1500	3000			–50
1750	1750			–50
2000	2000			–50
2250	2250			–50
2500	2500			–50

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The software or part thereof may be the proprietary property of third party licensors. In such an event such third party licensors (as referenced on the package or the Order Acknowledgement) and/or Aeroflex may directly enforce the terms of this Agreement and may terminate the Agreement if the Licensee is in breach of the conditions contained herein.

11. EXPORT REGULATIONS

The Licensee undertakes that where necessary the Licensee will conform with all relevant export regulations imposed by the Governments of the United Kingdom and/or the United State of America.

12. NOTICES

Any notice to be given by the Licensee to Aeroflex shall be addressed to:

Aeroflex International Limited, Longacres House, Six Hills Way, Stevenage, SG1 2AN, UK.

13. LAW AND JURISDICTION

This Agreement shall be governed by the laws of England and shall be subject to the exclusive jurisdiction of the English courts. This agreement constitutes the whole Contract between the parties and may be changed only by memorandum signed by both parties.

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