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Racal Instruments™
3152B
VXIbus Arbitrary Waveform Generator
User Manual

Also including the 3151B, 3100M, and 3100R

Publication No. 980935 Rev. M



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FOR YOUR SAFETY

Before undertaking any troubleshooting, maintenance or exploratory procedure, read carefully the **WARNINGS** and **CAUTION** notices.



This equipment contains voltage hazardous to human life and safety, and is capable of inflicting personal injury.



If this instrument is to be powered from the AC line (mains) through an autotransformer, ensure the common connector is connected to the neutral (earth pole) of the power supply.



Before operating the unit, ensure the conductor (green wire) is connected to the ground (earth) conductor of the power outlet. Do not use a two-conductor extension cord or a three-prong/two-prong adapter. This will defeat the protective feature of the third conductor in the power cord.



Maintenance and calibration procedures sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures and heed warnings to avoid “live” circuit points.

Before operating this instrument:

1. Ensure the proper fuse is in place for the power source to operate.

2. Ensure all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If the instrument:

- fails to operate satisfactorily
- shows visible damage
- has been stored under unfavorable conditions
- has sustained stress

Do not operate until performance is checked by qualified personnel.

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CE Declaration of Conformity

We

Astronics Test Systems
4 Goodyear St
Irvine, CA 92618

declare under sole responsibility that the

3152B Arbitrary Waveform Generator
P/N 408151-xxx, 408166-xxx,
408179-xxx, 408180-xxx

conforms to the following Product Specifications:

Safety: **EN 61010-1**

EMC: **EN61000-6-3 :EN55022 Class B :2007**
EN61000-6-1 :Immunity tests (Am2) :2007

Supplementary Information:

The above specifications are met when the product is installed in an Astronics Test Systems certified enclosure, with faceplates installed over all unused slots, as applicable.

The product herewith complies with the requirements of EN61000-6-3: 2007 and EN61000-6-1:2007 (EN55024).

Irvine, CA, January 22, 2009

David Johnston, Engineering Manager

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DOCUMENT CHANGE HISTORY

Revision	Date	Description of Change
A	1/22/09	Document Control Release
B	2/16/12	ECN00034 replacing Chapter 6, Performance Checks with updated version.
C	6/20/12	ECN00423 updating 1 Meg calibration information (Chapter 7) and additional configuration information,
D	6/20/12	ECN00600 added Appendix C, 3152A/3152B Comparison.
E	3/29/13	ECN02622 added command for calibration table selection (OUTP:LOAD:CAL). Affects Appendix A, Appendix C, Chapter 5, and Chapter 7.
F	7/9/2013	ECN03073 clarified SCPI and HS commands. Revised HS command numbers for :FORMat:BORDer and FORMat:WAVE. Corrected lists of valid parameters for FREQuency:RASTer:SOURce and FUNCtion:MODe commands. Revised default values for various commands. Corrected and clarified tests in Chapter 6. Corrected and clarified descriptions of OUTPut:SYNC:SOURce and OUTPut:SYNC:WIDTh commands in Chapter 5.
G	9/24/2013	ECN03606 added instructions for installing local bus jumpers. Added reference to these instructions in each place where local bus features are mentioned. Made corrections to legacy synchronization commands.
H	10/29/2013	ECN03931 restructured Chapter 7 to provide separate instructions for Factory Calibration and Periodic Calibration. Periodic Calibration is a new section focused on the type of calibration that is performed at recommended time intervals. Added essential details about locking calibration factors. Rewrote “Updating the Firmware” section for clarity and completeness.
J	1/9/2014	ECN04265 corrected the descriptions of EXT SCLK to indicate that it is compatible with PECL and NECL amplitude levels. Specified the periodic calibration interval in Chapter 7.

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Revision	Date	Description of Change
K	5/9/14	ECN04919 revised calibration procedure in Chapter 7, PLL Adjustments for cleaner signals and improved accuracy. Revised Chapter 6, PLL Checks – Phase Offset for correct length of arbitrary waveform. Added A1 and A2 amplifier documentation, including description, commands, performance checks, and calibration procedure.
L	8/15/2014	ECN05011 revised specifications in the Function Generator Characteristics section of Appendix A.
M	11/7/2014	Clarified specifications for total harmonic distortion (THD) in Appendices A, B, and C, indicating that THD specifications are for loads >100 kΩ. In Chapter 6, clarified performance verification procedure for THD so that no 50 Ω load is applied. In Appendices B and C, corrected specifications for THD and harmonics & spurious content to match the specifications provided in Appendix A. Made corresponding changes to test limits in performance verification procedure.

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Chapter 1
Introduction

What's in This Manual

This manual contains information for operating and servicing the Racal Instruments™ 3151B, 3152B, 3100M-3152B, and 3100R-3152B VXIbus Arbitrary Waveform Generators. Generally, what is applicable to the 3152B is the same for the other three models, except where otherwise stated. Throughout this manual, we will refer to all four units as the 3152B. When there are differences in the specific models, the differences are described in detail.

More specific information on the four models is included in the section, "Carrier Configuration (Different Model Numbers)" later in this chapter.

Legacy mode information can be found in Chapters 3 and 5.

The manual is divided into functional chapters which guide you through the various operations that are necessary to install and to prepare the instrument for its intended operation. The following lists the chapters that are included in this manual:

- Chapter 1 provides general description of the instrument and identifies key controls and features. It also describes briefly all functions and features that are available for the user.
- Chapter 2 describes hardware and software installation.
- Chapter 3 provides descriptions of all functions, features, run modes and operating modes. It also describes in detail how to operate the instrument.
- Chapter 4 demonstrates the capability of ArbConnection to control the 3152B and to create and download waveforms and control tables to the working memory.
- Chapter 5 lists all of the commands that control the instrument. It also has detailed descriptions of the limits and factory default values of the programmable parameters.
- Chapters 6 and 7 contain service information that allows you to do performance tests and to calibrate the product.
- Appendix A lists the 3152B product specifications.
- Appendix B lists the specifications for the optional 3201A/3202A signal amplifier modules.
- Appendix C features tables showing the specification

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compatibilities between the 3152A and the 3152B

What's in This Chapter

This chapter contains a general and functional description of the Racal Instruments 3152B VXIbus Arbitrary Waveform Generator. It also explains the front panel connectors, operational modes, and all available features. However, some options available for the 3152B may not be installed in your specific module. A complete listing of the available options is included later in this chapter.

Conventions Used in this Manual

This manual uses the following conventions:

NOTE
A note contains information relating to the use of this product

CAUTION
A caution contains instructions to avoid damage to the instrument or the equipment connected to it.

WARNING
A warning alerts you to a potential hazard. Failure to adhere to the instructions in a warning could result in personal injury.

Introduction

The 3152B is a VXIbus Arbitrary Waveform Generator. It has a single channel, and communicates using the VXI message-based protocol. This high-performance waveform generator combines five powerful instruments in a single C-size card:

- Arbitrary Waveform Generator
- Function Generator
- Pulse Generator
- Modulation Generator
- Counter/Timer

The front panel has connectors and indicator lights, but no controls. To control the 3152B, use instrument drivers or a soft front panel from your computer.

Supplied with the 3152B is ArbConnection, a software application that controls the 3152B. ArbConnection allows you to specify, design, or edit waveforms and download them from your computer to the 3152B.

The 3152B ships in Legacy mode but can be programmed to start in either Legacy or Modern mode. See Chapters 3 and 5 for more information.

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3152B Feature Highlights

- Single width, C-size, VXIbus Module
- Provision to generate six types of waveforms: standard, arbitrary, sequenced, pulse, modulated, and half-cycle
- 250 MS/s sample clock frequency for generating arbitrary and sequenced waveforms
- Sine and square waveforms to 100 MHz, and other waveforms to over 10 MHz
- Frequency hopping and sweeping
- Modulated waveforms: AM, ASK, FM, FSK, and PSK
- 14-digit sample clock frequency setting, limited by 1 μS/s
- Extremely low phase noise
- PLL function that automatically locks to external signals
- Clock stability of 1ppm
- 16-bit vertical resolution. 10 mVp-p to 16 Vp-p into 50 Ω (20 mVp-p to 16 Vp-p into high-impedance load)
- 1 M-point memory depth. Option for 4 M-points in the 3100M-3152B and 3100R-3152B configurations
- Ultra-fast waveform downloading
- Trigger delay and period-controlled auto re-trigger
- Built-in counter/timer



Figure 1-1, Racal Instruments 3152B

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3100M/3100R Feature Highlights

- Single width, C-size, VXIbus Module
- Contains 3152B instrument card
- May contain one additional 3152B instrument card, 3101A amplifier card, or 3202A dual-channel amplifier card

3201A/3202A Feature Highlights

- Available as option for Models 3100M and 3100R
- Amplifies 3152B output (connect 3152B output to 3201A/3202A input using external cable)
- Available with impedance of 50 Ω, 75 Ω, or 600 Ω
- Outputs 0 to 20 Vp-p into matching impedance (50 Ω, 75 Ω, 600 Ω), or 40 Vp-p into high impedance
- 15 MHz bandwidth at 20 Vp-p (-3 dB)
- Provides single amplifier channel (3201A) or two amplifier channels (3202A)
- Operates as a summing amplifier, adding two input signals per channel

ArbConnection Feature Highlights

ArbConnection (provided with the 3152B) has the following features:

- Virtual control panels
- Arbitrary waveform composer
- Complex pulse composer
- Serial data and FM composers
- Detailed virtual control panels for all functions and modes
- Waveform, modulation, and pulse composers for designing, editing, and downloading complex waveforms
- Automatic detection of active instruments
- Equation editor to generate waveforms from equations
- SCPI command and response editor (simulates ATE operation)
- Translation of waveform coordinates from ASCII and other file formats
- Simplified generation of complex waveform sequences

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Figure 1-2, ArbConnection Control Panels

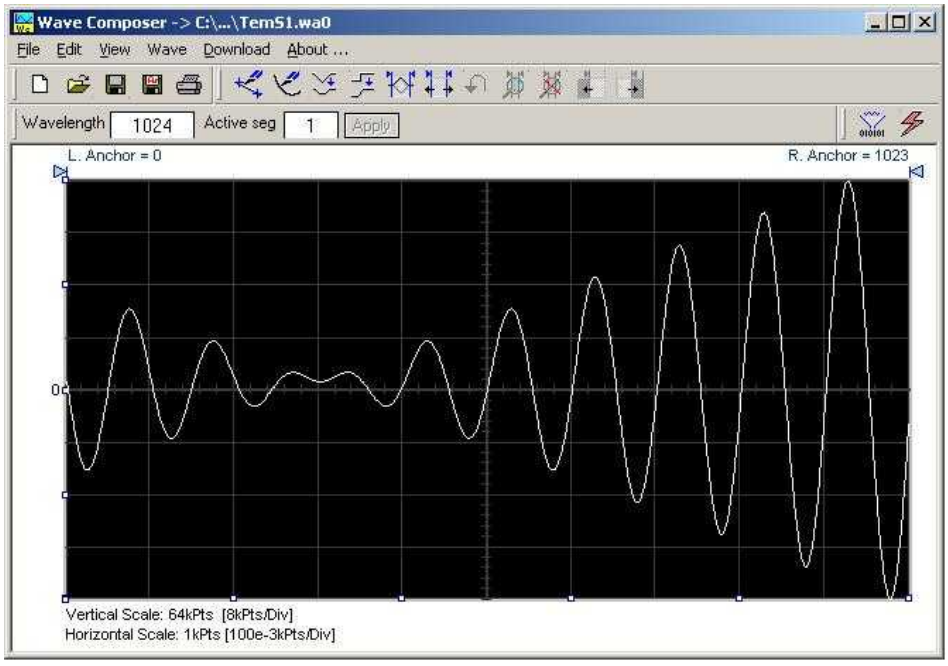


Figure 1-3, ArbConnection Wave Composer Example

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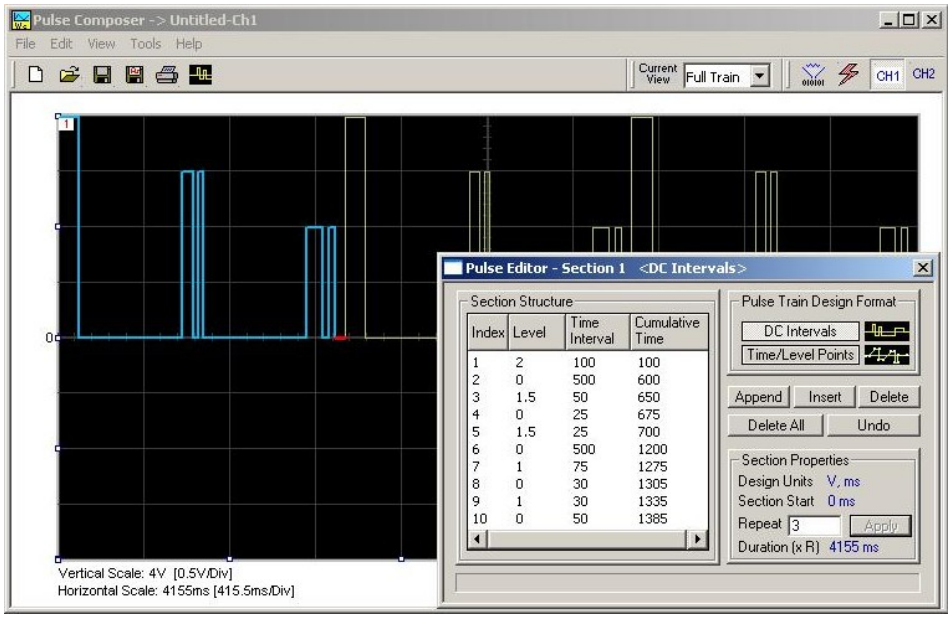


Figure 1-4, ArbConnection Pulse Composer Example

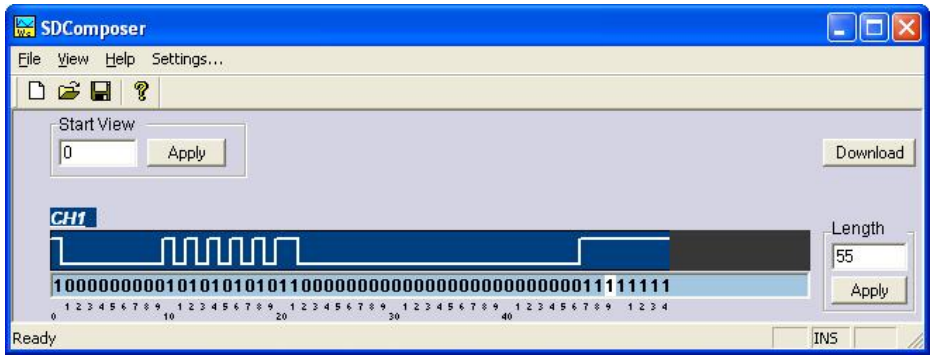


Figure 1-5, ArbConnection Serial Data Composer Example

General Description

This section describes the 3152B general features and performance, as well as output functions, run modes, and functions.

Output Waveforms

The 3152B is a digital waveform generator that creates virtually any type of waveform. Unlike conventional function and pulse generators, the 3152B creates waveforms digitally and stores them in memory. A clock generator then clocks the data from memory to a digital to analog converter (DAC) to convert the digital data to an output waveform. Since the waveform memory is volatile, its data is lost when you turn off the instrument. However, you may create as many waveforms as desired on the host computer, and quickly download them to the 3152B memory as needed.

The memory size is large enough for most applications. However,

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you may maximize the effective memory capacity by downloading specific waveforms only when they are required. For example, if one part of your ATE sequence requires a complex waveform that consumes nearly all of the waveform memory, you may delete this waveform after that portion of your sequence is completed, and then quickly download a new waveform for the next part of the sequence.

Depending upon your application, you may be able to change waveform parameters even more quickly without downloading new data. After you download a waveform, you may change the sample clock frequency, amplitude, offset, and run modes without disturbing the downloaded data.

The 3152B can divide its memory into smaller segments, and then use these segments to create complex sequences of waveforms.

The 3152B can generate, and even measure, the following functions:

- Standard waveforms. The 3152B computes these automatically from its built-in equations for sine, square, triangle, and other common waveforms.
- Arbitrary waveforms. Download these to the instrument whenever you need to change from one arbitrary waveform to another.
- Waveform sequences. The 3152B builds sequenced waveforms from memory segments that are loaded with the waveforms and are referenced in the sequence table in advance.
- Modulated signals. A direct digital synthesis (DDS) circuit creates these signals without downloading a waveform.
- Pulses. The ArbConnection controls for pulse waveforms have the look and feel of a standard pulse generator. However, after you use the controls to specify the pulse waveform, the 3152B creates it digitally in the arbitrary waveform memory.
- Half-cycle waveforms. Half-cycle waveforms are similar to standard waveforms, but a programmed delay interval separates the half cycles.
- Phase-Lock Loop (PLL) mode. This special function allows phase locking to an external signal regardless of the wave shape and frequency of that signal. While locked to the external signal, the 3152B can generate any of the above functions, with the added control that is attributed to the external signal.
- Counter/timer. The 3152B also performs counter/timer measurements.

Run Modes

The 3152B has two run modes that determine when it will output a waveform. Continuous Run is the basic mode for generating a waveform that does not stop. This mode is appropriate except

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when the application requires synchronization to external events.

In Interrupted Run mode, the output is either triggered or gated by external signals. The 3152B accepts a trigger event from the front panel connector, a backplane trigger line, or a software command from your computer.

The Run mode and triggering are discussed later in this chapter.

Frequency Control and Accuracy

An internal reference determines the frequency accuracy of the output waveform. The internal reference provides 1 PPM accuracy and stability over time and temperature. For applications that require better accuracy and stability, or just clock synchronization to external devices, the 3152B can use the CLK10 VXIbus signal or the front panel 10MHz REF IN signal (which is available only on the 3100M/R-3152B versions and on the 3151B).

Phase-Lock Loop (PLL)

By activating the Phase-Locked Loop (PLL) function, you may generate any standard or arbitrary waveform while synchronizing with an external signal, or even while tracking it as its frequency changes. This feature is not available on the 3151B model.

Signal Integrity

As technology evolves and new devices are developed each day, faster and more complex signals are needed to simulate and stimulate these new devices. Using the latest technology, the 3152B has the highest bandwidth in its class, enabling it to accurately duplicate and simulate high frequency test signals. With its outstanding sample clock generator range, 16-bit vertical resolution and its high output voltage amplifier that has an output bandwidth of over 100 MHz, one can create mathematical profiles, download the coordinates to the instrument and be assured that the waveforms are generated without compromising signal fidelity or system integrity.

Frequency Agility

The 3152B has two separate internal clock sources:

- Sample clock generator: The sample clock generator clocks the standard, arbitrary, and sequenced waveforms
- Direct digital synthesis (DDS) circuit: The DDS circuit generates amplitude and frequency related modulation throughout the entire amplitude and frequency ranges of the 3152B. This mode is useful for wideband FM, sweep, FSK, PSK, ASK, AM, and frequency hopping, as well as simultaneous sweeping of frequency, amplitude, and phase (3D modulation).

Amplitude

The output level is programmable from 20 mVp-p to 32 Vp-p into an open circuit, or 10 mVp-p to 16 Vp-p into a 50Ω load. A programmable offset shifts the output in either the positive or

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negative direction.

Remote Control

As with any other VXIbus instrument, the 3152B must be used with a host computer. All of its functions, modes, and parameters are fully programmable using one of the following three ways:

- Low-level programming. Use SCPI commands to program each individual parameter.
- ArbConnection. Use the ArbConnection virtual front panel on the computer screen, which simulates a mechanical front panel. It has push-buttons, displays, and dials to simulate the look and feel of a bench-top instrument.
- Instrument drivers. Use a high-level driver, such as, VXI*plug&play*, IVI or LabVIEW, with your own program to control the 3152B.

Carrier Configuration (Different Model Numbers)

Carrier configuration specifies how the instrument is mechanically constructed and the model number of the final instrument. Figure 1-6 shows the front panels of the various configurations. The following are available:

- **3151B** – Front panel compatible with the legacy 3151, 3151A and 3151A+, this model is exactly the same as the 3152B, with the following exceptions:
  - The Phase Modulation Input BNC is replaced by a 10 MHz Reference Input BNC.
  - The PLL ON LED is not installed
  - **idn?* response is “3151B” in instrument field
- **3152B** – Used to replace or add legacy 3152A-type instruments to your system without having to modify existing code. The 3152B is a message-based product that is substantially compatible with 3152A legacy behavior. See Table 5-1 for a summary of software compatibility and Appendix A for specification compatibility.
- **3100R-3152B** – Use this version to specify a register-based interface. This version is highly recommended for new users that seek higher speed of command parsing and execution. This version can be expanded to 3100R-3152B-3152B for a dual-channel configuration where two instruments can be used either independently or synchronized in a master-slave configuration. The 3100R carrier can accept other instruments although these are not described here.
- **3100M-3152B** – Use this version to specify a message-based interface including USB and LAN. This version is recommended for users that seek flexibility in communication with the 3152B. You may communicate with the instrument through the normal

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VXI controller but take control via the LAN port to completely bypass the backplane interface and control instrument functions and parameters from a web page using LXI capabilities. The USB port is used for memory stick I/O where waveform data can be loaded directly to arbitrary waveform memory. This feature was specifically designed for security reasons where breach of secret waveform data can endanger national security if it falls to the wrong hands. This way, the data is erased immediately as soon as the instrument is turned off but can be restored by a person holding a memory stick with data. This version can be expanded to a 3100M-3152B-3152B for dual channel configuration where two instruments can be used independently of each other or synchronized for master-slave operation. The 3100M carrier can accept other instruments as well although these are not described here.

- **3100M-3152B-3201A** – This version includes the 3152B waveform generator combined with the 3201A Signal Amplifier module. By connecting the output of the 3152B to the input of the 3201A, higher drive capability is available at the output of the 3201A.

- **3100M-3152B-3202A** – This version includes the 3152B waveform generator combined with the dual-channel 3202A Signal Amplifier module.

The description in this manual ignores specific configurations and provides details of the 3152B only. The configuration chosen can have a significant impact on the way that one programs the instrument. Register based commands are parsed and executed using an external dll (3100R) but message-based commands are parsed and executed by the internal CPU (3100M, 3151B, 3152B). The supplied drivers provide access to all functions for both versions.

Specifications

Appendix A lists the instrument specifications. Specifications apply under the following conditions:

- Output terminated into 50 Ω except where otherwise specified
- 30-minute warm up period
- Ambient temperature range of 20°C to 30°C.
- For temperatures outside the above temperature range, specifications degrade by 0.1 % per °C.

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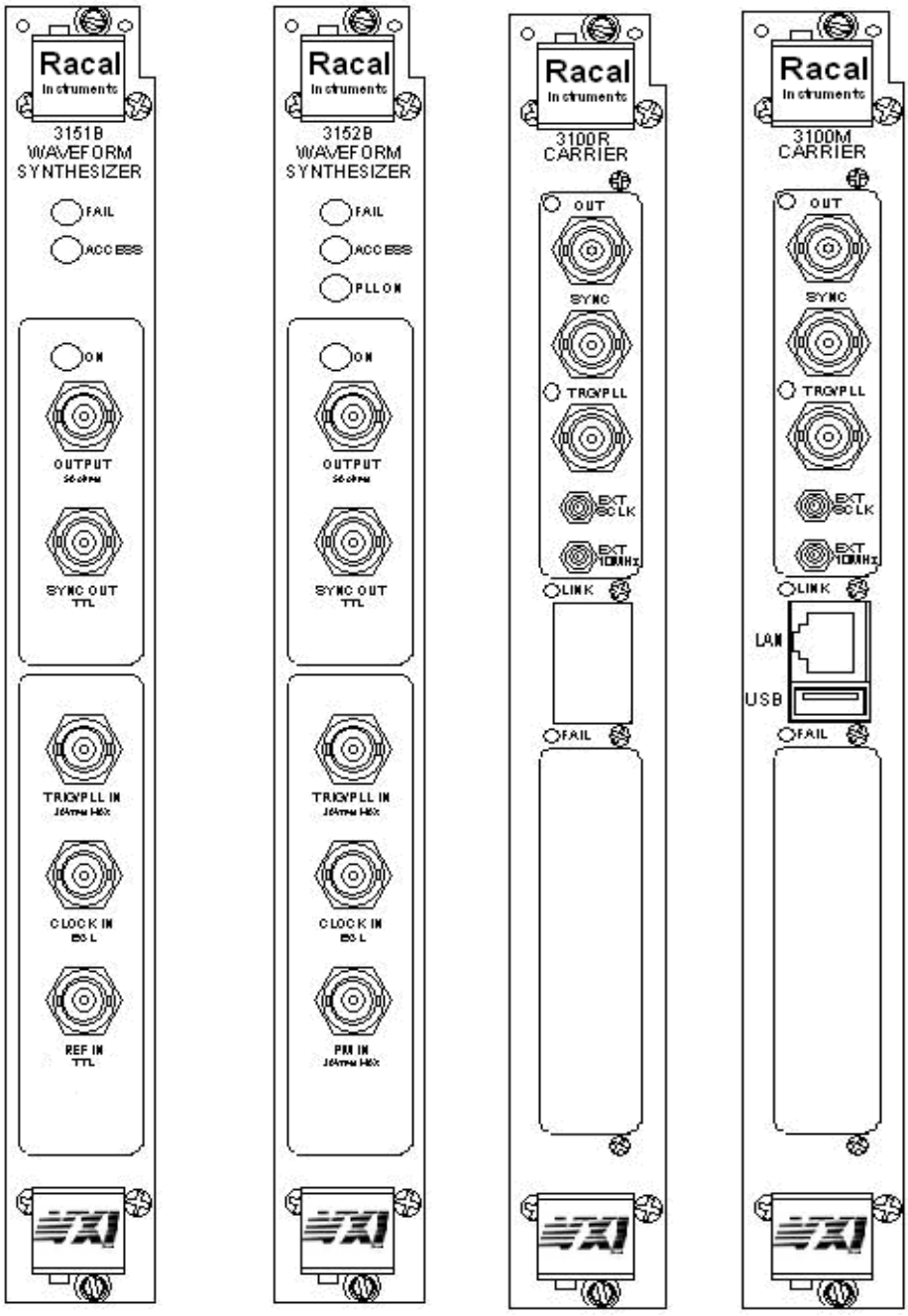


Figure 1-6, Configurations: 3151B, 3152B, 3100R-3152B, and 3100M-3152B

Safety Considerations

The 3152B has been manufactured according to international CE safety standards – EN-61010. Adjustments, maintenance, or repair of the unit while the covers are removed and power is applied must be carried out only by skilled, authorized personnel. Removal of the covers without authorization shall immediately void the warranty agreement.

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Options

The 3100M-3152B and 3100R-3152B are available in two memory configurations. Compare the option number printed on the instrument to verify which option was installed at the factory. Contact your nearest Astronics Test Systems representative if the number printed on the case does not reflect the version ordered. The list of options is given below:

-001 - 3152B - basic instrument, with 1MB RAM. This designates the standard memory size supplied with the 3152B.

-004 - 3152B - basic instrument, with 4MB RAM. This designates memory expansion to 4 meg waveform data points.

Supplied Accessories

The instrument is supplied with a CD containing the instruction manual, ArbConnection for Windows 2000/XP/NT, and VXI plug & play soft front panel and drivers.

Front Panel Connectors

The **3151B** has five BNC connectors on its front panel, marked as follows:

- OUTPUT: The main output signal
- SYNC OUT: A digital signal in sync with the main output
- TRIG/PLL IN: Trigger input
- CLOCK IN: An ECL level external sample clock input
- REF IN: TTL level 10 MHz reference input

The **3152B** has five BNC connectors on its front panel, marked as follows:

- OUTPUT: The main output signal
- SYNC OUT: A digital signal in sync with the main output
- TRIG/PLL IN: Trigger input; also used to lock the 3152B to an external signal
- CLOCK IN: An ECL level external sample clock input
- PM IN: Phase control input for use in PLL mode

The **3100R-3152B** has three BNC and two SMB connectors on its front panel, marked as follows:

- OUT (BNC): The main output signal
- SYNC (BNC): A digital signal in sync with the main output
- TRIG/PLL (BNC): Trigger input; also used to lock to an external signal
- EXT SCLK: An ECL level external sample clock input

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- EXT 10MHz: A TTL level external 10 MHz reference OR a phase control input for use in PLL mode (software selectable)

The **3100M-3152B** has the same pattern as described above for the 3100R-3152B but has the following additional functions:

- LAN (RJ-45): LAN connection for software control
- USB 2.0 (Type A): Memory stick device port for firmware upgrade or for loading external data into memory

OUTPUT (OUT)

The OUTPUT connector is the main output, and is used for fixed (pre-defined) or modulated waveforms up to 100 MHz, and for arbitrary or sequenced waveforms with up to 300 MS/s.

Output impedance is 50Ω, and the amplitude accuracy is calibrated for a connection to a 50Ω load and a load >100 kΩ. The amplitude is doubled for high-impedance loads (greater than 100 kΩ).

SYNC OUT (SYNC)

The SYNC OUT connector outputs a single TTL-level pulse for synchronizing other instruments, such as an oscilloscope, to the output waveform. The SYNC signal always appears at a fixed point relative to the waveform. The location of the SYNC signal relative to the waveform is programmable, as is the pulse width. When the sweep or any other modulation function is enabled, the SYNC connector is also useful as a marker output.

TRIG/PLL IN (TRG/PLL)

The TRIG/PLL IN connector accepts signals that stimulate the generation of output waveforms. The 3152B ignores this input when operating in Continuous mode. When placed in Trigger, Gated, or Burst mode, the trigger input is active, and the 3152B waits for the proper condition to trigger the instrument. In Trigger and Burst modes, the TRIG/PLL input is edge-sensitive, so that a signal transition will trigger the 3152B. The direction of the transition is programmable. In gated mode, the TRIG/PLL signal is level sensitive. The output waveform is enabled when the TRIG/PLL signal voltage is beyond a threshold voltage. The threshold voltage and direction are programmable within the range of -10 V to +10 V.

When the PLL function is selected, this input feeds the reference signal to the PLL circuit. The PLL input must be stable and repeatedly cross the trigger level threshold setting. Signals having a low slew rate may cause jitter because of noise. Therefore, make sure that the transition time is fast enough to minimize jitter.

The TRG/PLL IN input is also used in FSK, ASK, and PSK modes, where the output shifts between two frequencies, amplitudes, or phases. The output signal has the nominal frequency, amplitude,

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and phase when the TRG/PLL IN level is at logic 0, and a shifted frequency, amplitude, or phase when the TRG/PLL IN level is at logic 1.

EXT SCLK (EXT 10MHz)

The EXT SCLK connector accepts sample clock signals from an external source. It is AC-coupled to accommodate positive ECL (PECL) or negative ECL (NECL) amplitude level clock signals having frequencies from DC to 300 MHz. This signal replaces the internal clock generator, either for low-noise applications or for synchronization purposes. The sample clock input is active only after selecting the External Sample Clock Source option.

EXT 10MHz

This input accepts a 10MHz reference signal and is labeled as PM IN on the 3152B but can be programmed as either function. At the factory, this input is configured for TTL logic levels. It may be changed to 0 dBm, but only by qualified service personnel.

The EXT 10MHz input is available for applications requiring a more accurate, stable reference than can be attained by the 1 ppm TCXO reference built into the 3152B. The reference input is active only after selecting the External 10MHz Reference Source option.

Output Waveforms

The 3152B can generate six types of waveforms:

- Standard (Fixed)
- Arbitrary
- Sequenced
- Modulated
- Digital Pulse
- Half-cycle

Standard (FIXED) Waveforms

The 3152B must pre-load its memory before it can generate standard waveforms. On power-up, the waveform memory contains no specific data. The sine waveform, which is the default, is computed and loaded into the waveform memory as part of the reset procedure. Later, if you select another standard waveform, the 3152B computes the waveform points and loads them into the waveform memory.

Every time the user selects a new waveform, there is some delay for the processor to compute the data and download it to memory. The delay interval depends on the complexity of the waveform and the number of points the processor has to calculate. It is good practice to add sufficient delay to a test program to allow for this delay. The delay could range from a few milliseconds to a few seconds, and there are no special rules beside trial and error to

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determine the necessary delay time.

Nine standard waveform shapes are available:

- Sine
- Triangle
- Square
- Pulse/Ramp
- Sine(x)/x
- Pulse
- Gaussian Pulse
- Rising/decaying Exponential Pulse
- Noise
- DC

Each waveform has parameters for modifying it to suit your requirements.

Arbitrary (User) Waveforms

The waveform memory can store one or more arbitrary, or user-defined, waveforms. The regular 3152B configuration is supplied with 1 mega-sample (M-sample). A 4 M-sample waveform memory option is available on the 3100M/R-3152B models.

You may allocate the entire memory for a single waveform or you may divide the memory into smaller segments and load each segment with a different waveform. By dividing the memory into multiple segments, you may program the instrument to output the waveform one segment at a time, using a simple command each time you want to select a different memory segment. There are no limitations on the shape of the arbitrary waveform as long as it meets certain criteria such as minimum and maximum lengths and does not exceed the dynamic range of the DAC (65,535 counts).

Sequenced Waveforms

The sequence generator lets you link and loop segments in any order. For a simple example of a sequenced waveform, see Figures 1-7 through 1-10. The waveforms in figures 1-7 through 1-9 are placed in memory segments 1, 2, and 3, respectively. The sequence generator links and loops these waveforms in a predefined order to generate the waveform shown in Figure 1-10.

The sequence circuit is useful for generating long waveforms with repeated sections. Although the waveform only needs to be programmed once, the sequencer loops on this segment as many times as selected. When in sequenced mode, there is no time delay between linked or looped segments.

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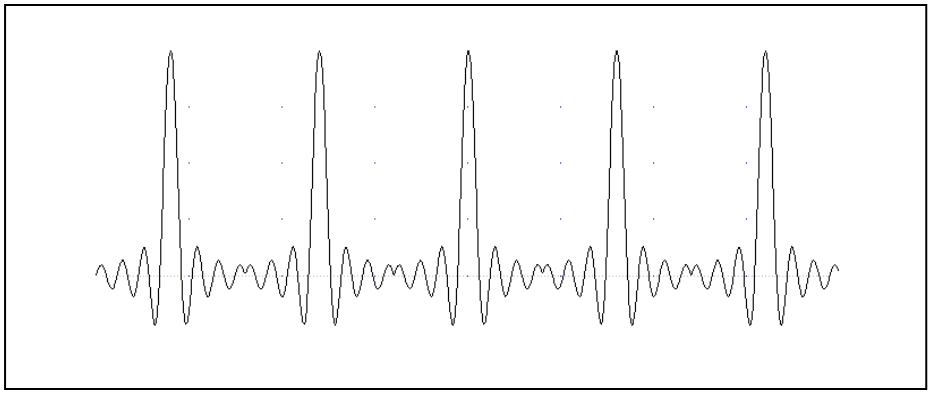


Figure 1-7, Segment 1 – Sine (x)/x Waveform

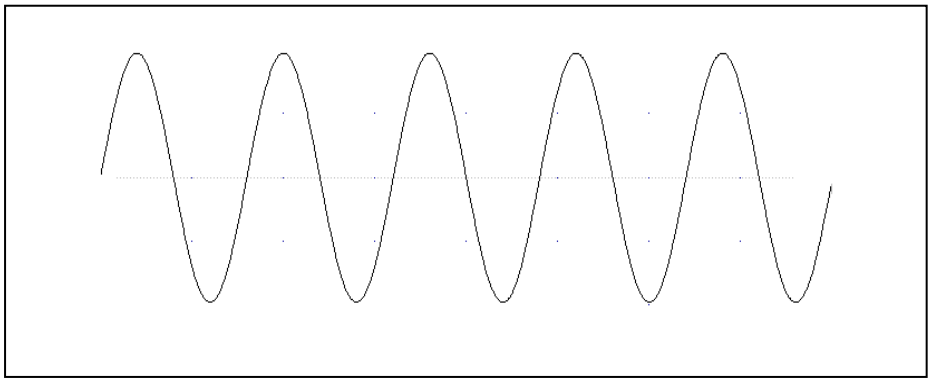


Figure 1-8, Segment 2 – Sine Waveform

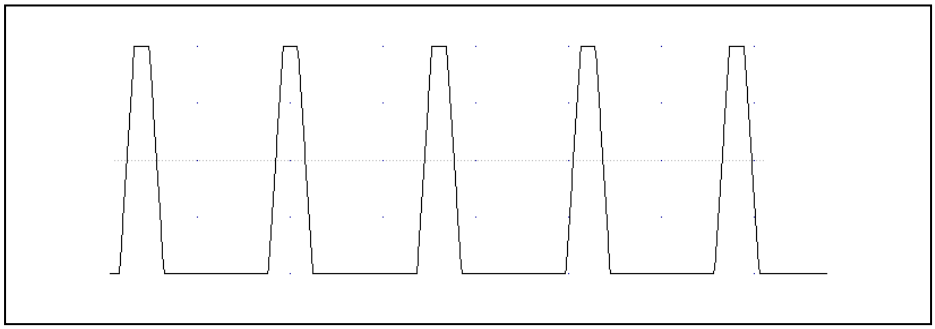


Figure 1-9, Segment 3 – Pulse Waveform

The following sequence was made of segment 2 repeated twice, segment 1 repeated four times, and segment 3 repeated two times.

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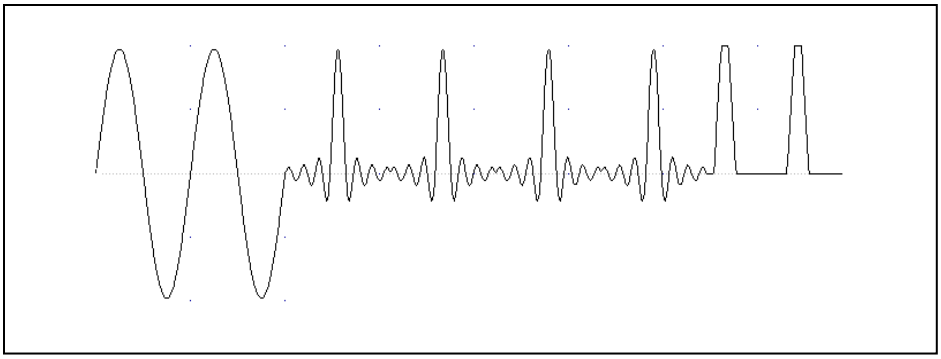


Figure 1-10, Sequenced Waveforms

Modulated Waveforms

The use of direct digital synthesis (DDS) technology makes the 3152B is agile. During operations such as sweep, FSK, FM, and other modulation modes, the 3152B quickly synthesizes the modulated waveform using the DDS circuit. The variety of modulated waveforms are described below.

Sweep

The 3152B can sweep the output frequency between minimum and maximum values that you specify. You may sweep up or down using linear or logarithmic increments. Sweep frequency is programmable from 10 Hz to 100 MHz, and sweep times can range from 1.4 μs to 40 seconds. Sweep mode is compatible with Continuous, Triggered, and Gated modes.

Sweep modes with triangle and square waveforms are computed and placed in memory as complete waveforms. This adds delay before the initial output is available while the software computes the waveform. All sine swaps use the DDS circuit, thus no computation time is required.

FM

The FM function modulates the frequency of the 3152B output waveform. You can modulate the output using built-in standard or arbitrary waveforms. FM is available in Continuous, Triggered, and Gated modes.

The 3152B generates two types of frequency modulation: standard and arbitrary. For standard modulation, the modulation waveform is selected from a built-in library of four standard waveforms: sine, triangle, square, and ramp. For arbitrary modulation, complex modulation signals are loaded into modulation waveform memory. There are 10,000 points allocated specifically for modulation waveform memory.

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AM

The AM function modulates the amplitude of the 3152B output waveform. Four standard modulating waveforms are available: sine, triangle, square, and ramp. AM can be used in Continuous, Triggered, and Gated modes. Modulation depth is programmable from 0% to 100% and up to 200% in some cases.

Frequency Hopping

The Frequency Hopping function causes the output frequency to hop through a sequence of frequencies. The amount of time the 3152B dwells on each frequency is programmable. You may opt to set the dwell time uniformly over the entire hop list.

The frequency hop table can contain up to 1,000 frequency values ranging from 10 Hz to 100 MHz.

Amplitude Hopping

The amplitude hopping function causes the output amplitude to hop through an amplitude list. The amount of time the 3152B dwells on an amplitude level is programmable for each hop. You may also set the dwell time uniformly over the entire hop list.

The amplitude hop table contains up to 5,000 different amplitude values ranging from 0 V to 16 V.

FSK

FSK (frequency shift keying) shifts the output between two frequencies. The logic level of the TRIG/PLL input determines the instantaneous frequency value. When the trigger slope is set to positive and the TRIG/PLL is false, the output is at the base frequency. When TRIG/PLL is true, the output frequency is shifted by an offset. To reverse the trigger polarity, select the negative trigger slope.

PSK

PSK (phase shift keying) shifts the phase of the output between 0° and 180°. The logic level of the TRIG/PLL determines the phase value. When the trigger slope is set to positive and the TRIG/PLL is false, the phase shift is 0°. When TRIG/PLL is true, the phase shift is 180°. To reverse the trigger polarity, select the negative trigger slope.

ASK

ASK (amplitude shift keying) shifts the output between two amplitudes. The logic level of the TRIG/PLL input determines the instantaneous amplitude value. When the trigger slope is set to positive and the TRIG/PLL is false, the output is at the base amplitude. When TRIG/PLL is true, the output amplitude is shifted by an offset. To reverse the trigger polarity, select the negative trigger slope.

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3D

The 3D function allows you to sweep the output in three dimensions at the same time: frequency, amplitude, and phase. You may operate the 3D function only from the ArbConnection utility.

Digital Pulse Waveforms

The waveform memory of the 3152B can be programmed as if it were a pulse generator. All pulse parameters are adjustable, including period, pulse width, delay, rise time, and fall time, as well as double pulse parameters. The pulse structure is limited only by the resolution of the sample clock and the number of waveform points required to create the pulse shape.

Just as with a bench-top pulse generator, pulses are limited to one or two per pulse period, and amplitude is fixed from one pulse period to another. For applications that require pulse sequences with variable amplitude profiles, use the Pulse Composer that is available in ArbConnection.

Half Cycle Waveforms

The 3152B generates three types of half-cycle waveforms: sine, triangle, and square. The frequency range is 10 mHz to 1 MHz, and the delay between half cycles is programmable from 100 ns to 20 seconds in increments of 20 ns. You may also program the starting phase of the waveforms from 0.1° to 359.9°.

Counter/Timer

The 3152B can operate as a counter/timer to measure frequency, period, averaged period, and pulse width, and to count events. As a counter/timer, it measures frequency to over 100 MHz with gate times of 100 μs to 1 s. When using a gate period of one second, it provides seven digits of resolution with an initial accuracy of 1 ppm.

General Run Modes

The 3152B may operate in one of four run modes: Continuous, Triggered, Gated, and Burst. These modes are described below. Note that the 3152B behaves differently when it generates modulated waveforms. The description below applies to standard, arbitrary, and sequenced waveforms. The Modulation mode is described later.

The 3152B responds to a variety of trigger sources: front panel triggers, the TRIG/PLL connector, VXIbus backplane trigger lines (TTLTrg0-7), and software triggers from the computer. There are also two built-in trigger generators. One repeats itself at pre-programmed intervals from 100 ns to 20 seconds. The other has a programmable delay. The re-trigger delay is measured from the end of a signal to the start of the next signal. You may program the re-trigger delay from 100 ns to 20 seconds, in increments of 20 ns.

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Continuous Mode

In Continuous mode, the 3152B generates the selected waveform continuously at the selected frequency, amplitude, and offset. The generator will begin waveform generation as soon as the waveform and its parameters have been programmed, and will stop only when turned off or placed in one of the interrupted run modes.

Triggered Mode

In Triggered mode, you may program the trigger circuit to respond to positive or negative transitions of the trigger input signal. When triggered, the generator outputs one waveform cycle, and then remains idle at an amplitude level equal to the voltage of the first point of the waveform. You may set the instrument to receive triggers from the front panel connector, backplane, or the trigger command in your software.

A Re-trigger circuit requires only one trigger event, after which it automatically generates a series of triggers. In this case, the re-trigger delay parameter determines the time between waveform cycles.

The trigger signal, whether it comes from the front panel, VXIbus trigger line, or a software command, has to pass through electrical circuits. These circuits cause a small delay known as system delay. This delay determines the amount of time it will take from a valid trigger edge to the moment that the output reacts. System delay cannot be eliminated completely, and must be accounted for when using a trigger signal.

Gated Mode

In Gated mode, the 3152B circuits will generate an output waveform as long as a gating signal enables it. Two gated modes are available:

Level: The output is enabled only while the trigger signal is at the selected logic level (high or low).

Transition (Edge): The gate opens on the first transition and closes on a subsequent transition. The trigger polarity (rising edge or falling edge) is programmable).

Regardless of the selected gating mode, the generator always completes the waveform at the end of the gate and then idles at a DC level.

Burst Mode

The Burst mode is an extension of the Triggered mode where the generator is programmed to output a pre-determined number of waveforms. The sources to trigger a burst are the same as for the Triggered mode.

Trigger Sources

The 3152B responds to a variety of trigger sources such as the TRIG/PLL connector, backplane trigger lines (TTLTrg0-7), and a software trigger. There are also two built-in, self generating trigger

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generators. One repeats itself at pre-programmed intervals from 100 μs to 20 seconds. The other has a programmable delay time. The re-trigger delay is measured from the end of the signal to the start of the next signal and programmed from 100 ns to 20 seconds with a resolution of 20 ns.

Modulation Run Modes

As previously mentioned, the 3152B has four run modes: Continuous, Triggered, Gated, and Burst. However, the 3152B behaves differently when generating modulated waveforms.

While the modulated and non-modulated run modes are similar, the modulated run mode offers two start options for the output signal during idle. Idle is the period of time before the output is triggered or gated to generate a modulated waveform.

The first option is where the 3152B, before receiving a trigger event, outputs continuous, non-modulated waveforms. When the trigger or gate occurs, the 3152B outputs the modulated waveform. When that waveform has completed, the instrument resumes outputting non-modulated waveforms.

The second option is where the 3152B, before receiving a trigger or gate, outputs a DC level. When triggered or gated, the 3152B outputs the modulated waveform. When that waveform has completed, the instrument resumes outputting a DC level.

Synchronization of Multiple 3152B Modules

A single or dual waveform generator in a single slot, no matter how advanced, may become a limiting factor for applications requiring multiple simultaneous waveforms.

Various techniques exist to synchronize the outputs of multiple waveform generators, but none are simple because real synchronization requires sharing of the reference and sample clocks, as well as signals that control the starting phase of the waveform. The 3152B can use the VXIbus Local Bus (LBUS0-7) to synchronize adjacent modules. The Local Bus lines are short and can tolerate high-frequency signals, but modules must be placed in the VXIbus chassis in a fixed master/slave configuration, and local bus jumpers must be installed. Details are provided in Chapter 2 in the Local Bus Configuration section.

Alternatively, the ECLTrg0 and ECLTrg1 lines may be used to synchronize multiple modules if position independence or legacy 3152A compatibility is required.

In either case, the slave instrument(s) are locked to the frequency and starting phase of the master module. After lock has been achieved, the starting phase of the slave modules may be shifted with respect to the master module to create a multi-phase system. The starting phase is programmable from 0° to 360°.

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PLL Synchronization

PLL synchronization is another technique for synchronizing multiple waveform generators. In this case, synchronization is not between pairs of 3152B modules, but between the 3152B and any external device that generates signals stable enough to satisfy the PLL input requirements. When placed in this mode, the 3152B measures the profile of the input signal and determine whether or not it is valid. Then, the built-in counter/timer circuit measures the frequency of the signal and centers its lock-in range on this frequency. The 3152B thus locks automatically onto the frequency of the external signal. Note that there is no need for manual initiation or operator intervention for the PLL function to find and lock onto an external reference. The PLL range is 500 Hz to 10 MHz.

After phase locking has been established, the start phase of the 3152B waveform can be shifted with respect to the start phase of the external reference within the range of -180° to +180°, with phase increments as low as 0.01° (fine phase control). The reference signal is applied to the front-panel TRIG/PLL connector. In this way, the same reference can be applied to multiple modules to generate multi-phase signal patterns. The TRIG/PLL input has a programmable trigger level and programmable slope.

Phase Modulation

When the 3152B is placed in PLL mode, there are two ways to control the phase offset. The first way is to modify the phase offset setting using SCPI commands. This method is quite accurate, and allows phase offset adjustments in increments of 0.01°.

The second way is to apply a voltage to the EXT 10MHz input (or the PM IN port if it is a 3152B with legacy-compatible pinout). This changes the start phase of the synthesizer, proportional to the voltage level at the phase modulation input. An input voltage of 1 V modifies the phase by 20°. The phase changes between -180° and 180° as the applied voltage goes from -9 V to 9 V. The instrument responds to AC changes or the EXT 10MHz port (or PM IN port) throughout the frequency range of DC to 10 kHz, but the time to lock depends on the lock frequency and the number of waveform samples.

Filters

The 3152B has two elliptic filters (60 MHz and 120 MHz) and two Bessel filters (25 MHz and 50 MHz). You may switch these filters in to reduce harmonics or high frequency spurs.

Access to the elliptic filters is disabled while the 3152B is generating standard sine waveforms because these filters are used automatically to construct optimal sine waveforms.

Output State

For safety reasons, the 3152B powers up with its output turned off. In fact, the output circuit is disconnected from the output connector using a mechanical relay, which eliminates erroneous and uncontrolled transitions that may occur during power-up. This

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protects equipment that remains connected to the output when the mains power fails or the system is powered down.

Mechanical relays have a settling time of about 2 ms. Therefore, when writing software, allow enough time for the relay to close before using the signal at the output connector.

Programming the 3152B

The 3152B has no front panel control; therefore, you must use a computer to communicate with the instrument. There are a number of ways to do this including the use of an appropriate software driver on the host computer. The specifics of communication are discussed in later chapters.

An alternative to a driver is to use the SCPI (Standard Commands for Programmable Instruments) language. Chapter 5 explains the details of SCPI programming.

The ArbConnection software application is supplied with the 3152B. ArbConnection provides a user interface that allows you to control the 3152B interactively. Chapter 4 provides detailed instructions for using ArbConnection.

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Chapter 2
Installation

Preparation for Use

Preparation for use includes selecting the required logical address, configuring the Local Bus (if required), and installing the module in a VXIbus chassis.

Logical Address Selection

The VXIbus Chassis Resource Manager identifies a module in the system by the module's address. VXIbus logical addresses can range from 0 to 255. However, logical address 0 is reserved for the Resource Manager. Addresses 1 to 254 are reserved for VXIbus modules. Logical address 255 permits the Resource Manager to dynamically configure the module logical address.

To change the 3152B logical address, use the 8-segment DIP switch (S1) accessible from the side of the module near the rear of the case. Figure 2-1 shows the logical address switch. The switch segments are marked with numbers 1 to 8. Each switch segment represents a binary digit of the 8-bit binary logical address. The segment marked "1" represents the least-significant digit. A switch is active (equal to 1) when it is moved downward to the "ON" position.

Astronics Test Systems ships the 3152B with the logical address set to 2 as shown in Figure 2-1.

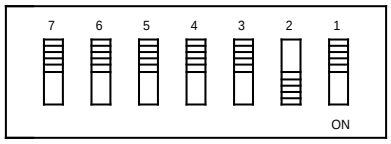


Figure 2-1, Switch S1 (Set to Logical Address 2)

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Local Bus Configuration

A 3152B can synchronize (phase lock) with other 3152B modules installed in the same VXI chassis. One of the synchronization methods uses the VXI Local Bus lines (LBUS0-LBUS7). The Local Bus has advantages of high bandwidth and the capability to synchronize any quantity of modules in the same chassis.

To use the Local Bus, the modules to be synchronized must be configured as instructed below, and must be operated in Modern Mode (not Legacy Mode).

NOTE
Originally, configuration of Model 3152B for Local Bus operation was performed at the factory. In September 2013, a feature was added to allow the user to configure the 3152B. If you need to configure a 3152B module for Local Bus operation, and it does not have the side-panel access openings shown in Figure 2-2, contact Customer Support. Contact information is provided in the Warranty Statement at the front of this manual.

When synchronizing (phase locking) a group of modules, they must be installed in a contiguous group of slots in the VXIbus chassis. The reference module (master) that the others will synchronize to must be immediately to the left of the other modules (slaves) in the group.

To enable use of the Local Bus, you must install Local Bus jumpers (supplied with 3152B) into each module. Figure 2-2 shows the installation locations for the jumpers, which you will install onto the internal printed circuit board through the openings in the side panel. Each jumper slides onto two header pins, connecting them together. It may be helpful to use needle-nose pliers to install the jumpers.

The specific jumpers required for each 3152B depend on its position within the synchronized group:

1. The first module on the left (master) requires jumpers LK15 and LK16. Do not install LK13 or LK14 on this module.
2. The last module on the right requires jumpers LK13 and LK14. Do not install LK15 or LK16.
3. If there are modules between the first and last modules, they each require jumpers LK13, LK14, LK15, and LK16.

As mentioned above, the 3152B must be in Modern Mode (not Legacy Mode) to use the Local Bus for synchronizing modules. To place the 3152B in Modern Mode, send the following SCPI command:

FORMat:INSTrument MODern

You may abbreviate the command by omitting all lower-case characters. When power is cycled, the 3152B defaults to Legacy Mode, even if it was in Modern Mode while power was being turned off.

Commands used for controlling local bus synchronization are detailed

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in Chapter 5 in the Instrument & Output Control Commands section (see INSTrument:COUPle commands).

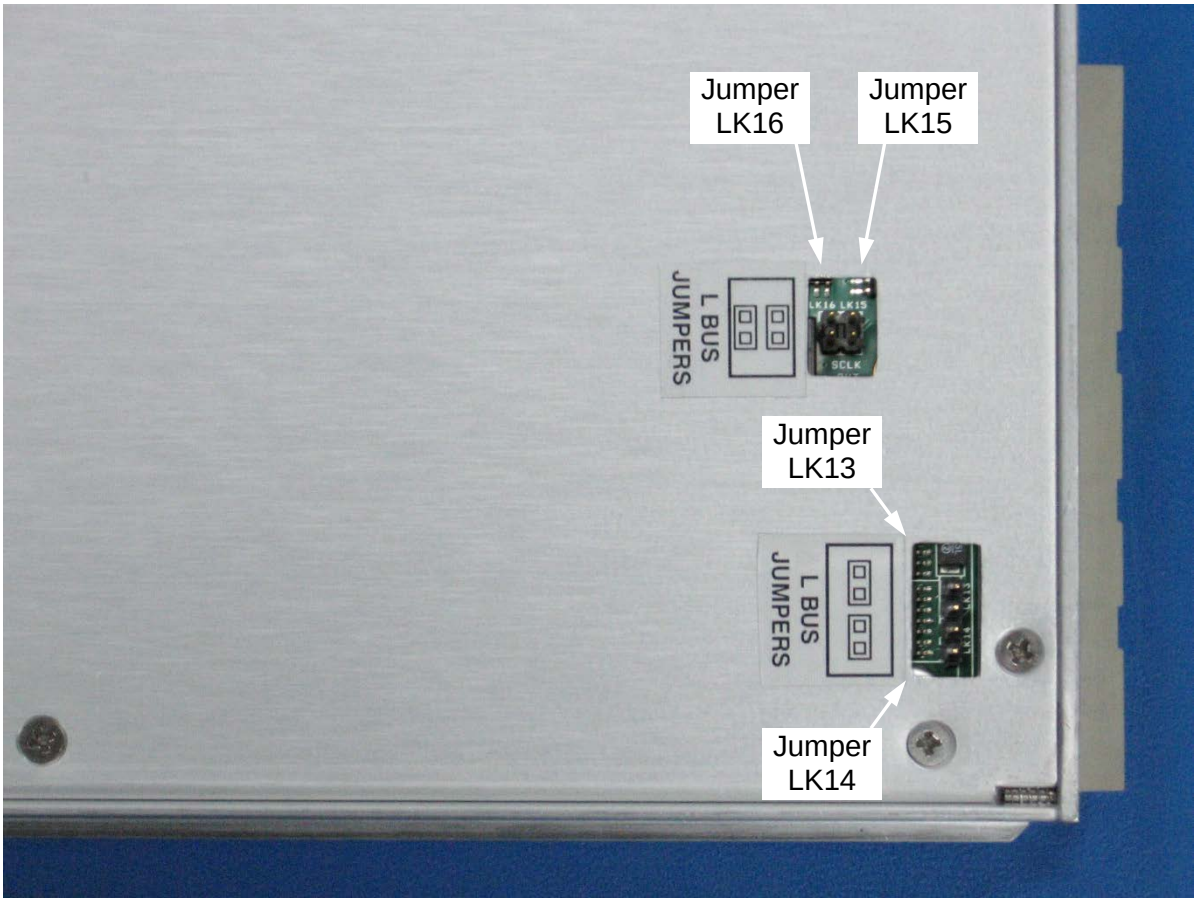


Figure 2-2, Local Bus (LBUS) Jumper Locations

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Installation

If the 3152B is not configured to use the Local Bus, you may install it into any empty slot in the VXIbus chassis except slot 0. If the 3152B is configured for Local Bus operation, then take care to comply with the configuration rules from the previous section.

When inserting the instrument into the mainframe, gently rock it back and forth to seat the connectors into the backplane receptacle. The ejectors will be at right angles to the front panel when the instrument is properly seated into the backplane. Use the captive screws above and below the card ejector handles to secure the instrument into the chassis.

Controlling the Instrument from a Remote Device

In general, the 3152B is controlled from a remote device using the VXIbus slot 0 controller. In addition, when configured in a 3100M carrier, there is an additional front panel LAN connector that allows communication with a web page (LXI specification) and USB port. This allows you to transfer data directly to the waveform memory.

To communicate with the 3152B you may either write your own software or use one of the soft front panel programs that allows access to all instrument modes, functions, and parameters. If you wish to use ArbConnection, insert the supplied CD and follow the instructions on the screen to install the program. You may also use the soft panels that are supplied with the VXIplug&play drivers on the same CD. 3100M-3152B users that intend to control the instrument from a web page must program the LAN parameters before it can be used on the network. Information on how to program the LAN parameters is given below. Note that as long as the instrument is powered on, the LAN parameters will not change. For a new LAN setting to take effect, turn the power off and then back on.

Installing Software Utilities

The 3152B is supplied with a CD containing ArbConnection and the VXIplug&play driver, and possibly an IVI compatible driver for use with the Ethernet interface. It also includes the user manual. You should store the CD in a safe place in case you need to restore damaged files or load the software onto different computers. The latest User Manual, drivers, and firmware are available for download from our web site: http://www.astronicstestsystems.com/support/downloads.

ArbConnection lets you control instrument functions and features from a remote computer. It also lets you generate and edit arbitrary waveforms, sequence tables, and modulated signals, and then download these to the 3152B.

You may use ArbConnection to control the 3152B without writing software. However, for maximum flexibility, you may control the 3152B at a low level using SCPI commands in your own software. Note that for register-based models, SCPI commands need to be directed to a DLL instead of to the VISA library. In either case, you may use SCPI commands through ArbConnection's command editor without programming.

Chapter 4 provides installation and operating instructions for

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ArbConnection.

Connecting to a LAN Network

The 3100M-3152B has a front panel connector that allows connection to a local area network system. This LAN port has three purposes:

- Download waveform data directly from an external computer without using the VXIbus controller.
- Control the 3152B in a system that does not have a VXIbus slot 0 controller.
- Use Ethernet to control VXIbus modules adjacent to the 3152B using VXIbus local bus lines (for modules designed to interface with the 3152B in this way).

The programming section of this manual lists the default settings. Additional descriptions of LAN settings are given below.

Direct connection between a single host computer and a single device is also possible, but you must use a special cable that has its transmit and receive lines crossed. If your site is already wired, connect the 3152B via twisted pair Ethernet cable. Take care that you use twisted pair wires designed for 10/100 BaseT network use (phone cables will not work). Refer interconnection issues to your network administrator. After you connect the 3152B to the LAN port, proceed to the LAN Configuration section in this chapter for instructions how to set up LAN parameters.

LAN Configuration

There are several parameters that you may have to set to establish network communications with a LAN interface. Primarily you'll need to establish an IP address. You may need to contact your network administrator for help in establishing communications with the LAN interface. To change LAN configuration, you'll need to use some LAN commands that are listed in the programming reference. The programmed parameters will be updated with the new setting only after you turn the VXI chassis off and on once.

Note there are some LAN parameters cannot be accessed or modified; These are: Physical Address and Host Name. These parameters are set in the factory and are unique for this product. The only parameters that can be modified are the IP Address, the Subnet mask and the Default gateway. Correct setting of these parameters is essential for correct interfacing with the LAN network.

Description of the LAN settings is given in the following. Information how to modify the LAN setting is given in the programming section of this manual.



Note

Configuring your LAN setting does not automatically select the LAN as your active remote interface.

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There are three LAN parameters that can be modified and adjusted specifically to match your network setting; These are described below. Consult your network administrator for the setting that will best suit your application.

- **IP address** - The unique, computer-readable address of a device on your network. An IP address typically is represented as four decimal numbers separated by periods (for example, 192.160.0.233). Refer to the next section - Choosing a Static IP Address.
- **Subnet mask** - A code that helps the network device determine whether another device is on the same network or a different network.
- **Gateway IP** - The IP address of a device that acts as a gateway, which is a connection between two networks. If your network does not have a gateway, set this parameter to 0.0.0.0.

Choosing a Static IP Address

For a Network Administered by a Network Administrator

If you are adding the Ethernet device to an existing Ethernet network, you must choose IP addresses carefully. Contact your network administrator to obtain an appropriate static IP address for your Ethernet device. Also have the network administrator assign the proper subnet mask and gateway IP.

For a Network without a Network Administrator

If you are assembling your own small Ethernet network, you can choose your own IP addresses. The format of the IP addresses is determined by the subnet mask. You should use the same subnet mask as the computer you are using with your Ethernet device. If your subnet mask is 255.255.255.0, the first three numbers in every IP address on the network must be the same. If your subnet mask is 255.255.0.0, only the first two numbers in the IP addresses on the network must match.

For either subnet mask, numbers between 1 and 254 are valid choices for the last number of the IP address. Numbers between 0 and 255 are valid for the third number of the IP address, but this number must be the same as other devices on your network if your subnet mask is 255.255.255.0.

Table 2-1 shows examples of valid and invalid IP addresses for a network using subnet mask 255.255.255.0. All valid IP addresses contain the same first three numbers. The IP addresses in this table are for example purposes only. If you are setting up your own network, you probably do not have a gateway, so you should set these values to 0.0.0.0.

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Table 2-1, Valid and Invalid IP Addresses for Subnet Mask 255.255.255.0

IP Address	Comment
123.234.45.211	Valid.
123.234.45.213	Valid. The first three numbers match the previous IP address. The fourth number must be a unique number in the range of 1 to 254.
123.202.45.214	Invalid. Second number does not match the previous IP addresses. The first three numbers must match on all IP addresses with subnet mask 255.255.255.0.
123.234.45.0	Invalid. The first three numbers are valid but the fourth number cannot be 0.
123.234.45.255	Invalid. The first three numbers are valid but the fourth number cannot be 255.



TIP

To find out the network settings for your computer, perform the following steps:

- **For Windows 98/Me/2000/XP**

  1. **Open a DOS prompt.**
  2. **Type IPCONFIG.**
  3. **Press <Enter>.**

If you need more information, you can run ipconfig with the /all option by typing IPCONFIG /all at the DOS prompt. This shows you all of the settings for the computer. Make sure you use the settings for the LAN adapter you are using to communicate with the LAN device.

- **For Windows 95**

  1. **Open a DOS prompt.**
  2. **Type WINIPCFG.**
  3. **Press <Enter>.**

Select the Ethernet adapters you are using to communicate with the *Ethernet device* from the drop-down list.

Connecting to the USB Port

The 3100M-3152B has a front panel USB connector that allows connection to a USB memory device. This USB port has only one purpose, to allow the downloading of waveform data directly from a USB memory device without going through the VXI controller. The waveform data has to be stored on the USB memory device in a special format. The negotiation between the USB memory device and the instrument is automatic. The application program can then select the loaded memory segment for use in an application.

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Chapter 3
Operation

Overview

This chapter explains how to operate the 3152B. Unlike a bench-top instrument, the 3152B requires a computer to turn on functions, change parameters, and configure various operating modes. Two software applications are available to control the instrument: VXI*plug&play* soft front panels (SFPs) and ArbConnection. For the experienced programmer, VXI*plug&play* drivers and a set of SCPI commands are available.

Legacy to Modern Mode

When operation is converted from Legacy to Modern mode (and vice-versa), the instrument automatically issues an internal hardware reset command which modifies its settings to factory defaults. The power-on and reset defaults for Legacy Mode are as follows:

Model	Default
3151B	Legacy
3152B	Legacy
3100M-3152B	Modern
3100R-3152B	Modern

Using the Reset command to restore factory defaults, however, has no effect on the selection of Legacy or Modern mode. If you switched to one mode or another, the only way to restore the original default is either by using an appropriate command or by cycling power.

Example 1, Model 3152B, default instrument format is Legacy

- *form:inst mod* modifies the commands set from Legacy to Modern, *rst is automatically forced and the 3152B parameters are modified to accept the defaults of the Modern mode.
- **rst* restores factory defaults for Modern operation.
- After shut-down, the 3152B powers up again in Legacy

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configuration.

Example 2, Model 3100M/R-3152B, default instrument format is Modern

- *form:inst leg* modifies the commands set from Modern to Legacy, *rst is automatically forced and the 3152B parameters are modified to accept the defaults of the Legacy mode.
- **rst* restores factory defaults for Legacy operation.

Output Termination

Output signals should be properly terminated to minimize signal reflections or power loss due to an impedance mismatch. For the best performance, use 50 Ω coaxial cables for the OUTPUT and SYNC OUT outputs, and terminate the receiving end of each cable with a 50 Ω load.

Load impedance accuracy affects the accuracy of the waveform amplitude and DC offset levels. These output levels will not match the amplitude and offset settings when using loads other than 50 Ω. To correct for a load that is greater than 50 Ω, program the actual load impedance and the 3152B will automatically adjust the output level to compensate. Use the following command:

outp:load <value>

where <value> is the load impedance in ohms. The default at power-up is 50 Ω.

Correction is not available for loads less than 50 Ω.

If the loads are high impedance (1 MΩ or greater), use the above command with the actual impedance value, and then use the following command to achieve maximum accuracy:

outp:load:cal 1M

This activates a separate set of calibration constants for accurately driving into a high-impedance load. If, after using this command, you wish to drive a 50 Ω load, use the following command to revert back to the calibration constants for a 50 Ω load:

outp:load:cal 50

The default at power-up is 50 Ω.

If you are using high-impedance loads with legacy 3152A software that does not include the *outp:load <value>* command, you may still benefit from the high-impedance calibration table by sending the *outp:load:cal 1M* command outside of your software. You might send this command before initializing your software, or use a software wrapper to insert this command before driving high-impedance loads. If you use this command, the output level will still

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be double the programmed value, just as it was when running the software with the 3152A, but the accuracy will be improved.

Input/Output Protection

The 3152B provides protection for its internal circuitry at the input and output connectors. Appendix A specifies the level of protection for each input or output connector.

Power On/Reset Defaults

At power-up or as a result of a software reset, the 3152B changes all settings to their default values. Chapter 4 lists all settings and their default values, as well as their maximum and minimum allowable values.

It is good practice to reset the instrument between sequence events to make sure that parameters that were programmed for previous tests will not accidently interfere with future tests. Use the following common command to reset the instrument to its default state:

**rst*

Turning the Output On

For safety, the “OUTPUT” connector of the 3152B defaults to the “Off” state when the unit is first powered up or receives a software reset. To avoid the production of random signals at the output connector, keep the output in the “Off” state while setting up the instrument.

The output signal is connected to the “OUTPUT” connector through a mechanical relay. When writing software to control the 3152B, provide a 2 ms delay to make sure that the signal output is stable before you proceed with the next step of the test. Use the following commands to turn the output on and off.

outp 1	Turns the output on
outp 0	Turns the output off

The 3152B defaults to a 1 MHz, 5 Vp-p sine wave when you apply power or reset the unit. If you turn the output on before changing any settings, the output defaults to a sine wave signal.

Turning the SYNC Output On

For safety, the “SYNC OUT” connector of the 3152B defaults to the “Off” state when the unit is first powered up or receives a software reset. To avoid the production of random signals at the output connector, keep the SYNC output in the “Off” state while setting up the instrument.

The SYNC output signal is hard-wired to the output connector and,

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therefore, the output impedance remains low regardless of whether the output is on or off. Use the following command to turn the SYNC output on and off:

outp 1	Turns the SYNC output on
outp 0	Turns the SYNC output off

When you apply power or reset the 3152B, the SYNC output defaults to a single pulse that has a fixed width of four sample clock periods.

Selecting the SYNC Source

The main purpose of the SYNC output is to produce a pulse that other devices may synchronize with. The width of the “SYNC” signal might be too narrow for slower devices. The pulse width, and several other parameters, may be programmed using the following commands:

outp:sync:sour bit	Provides a signal that is synchronized with an external trigger event when the 3152B is placed in one of its interrupted modes. Generates a narrow sync signal every time the segment is generated. The sync position along the waveform can be programmed using the OUTP:SYNC:POS command. OUTP:SYNC:POS is used to set both the TRIGger point and the SYNC point. The BIT signal is recommended for use in continuous mode.
outp:sync:sour lcom	Generates a sync signal in SEQuence mode only once when the selected segment appears for the first time in the sequence. The identity of the segment can be programmed using the TRAC:SEL command. The sync position along the selected waveform can be programmed using the OUTP:SYNC:POS command. The LCOM signal is recommended for use in Sequenced mode.
outp:sync:sour ssyn	Generates a sync signal at intervals that are synchronized with the internal clock generator. This option is useful to minimize jitter when using an oscilloscope. The SSYNc signal is recommended for use in Triggered mode.
outp:sync:sour hcl	Generates a trigger signal of the same period as the output waveform, but a 50% duty cycle. This option is useful for synchronizing two-point waveforms on an oscilloscope (sine and square waveforms above 10 MHz).

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outp:sync:sour puls	Generates a pulse each time a segment waveform is generated. The pulse width is specified in points using the OUTP:SYNC:WIDTh command. This command is a useful alternative to the BIT sync source, especially when the bit pulse is too narrow. It is also helpful when using the 3152B to emulate the sync pulse of another instrument that it is replacing in a test system.
outp:sync:sour zero	Generates a SYNC signal which remains low when the main output level is below 0 V and shifts to high when the output signal becomes greater than 0 V.

Changing the SYNC Position and Width

The “SYNC” signal must be wide enough for other devices to detect, but not so wide that it adversely affects timing in faster applications. To accommodate a wide variety of situations, the SYNC pulse width is programmable.

The programmed start point for the SYNC signal is in effect for all of the SYNC types except ZERO and HCL. The SYNC width parameter is in effect only when the pulse type is selected. Use the following procedure to program SYNC position and width.

outp:sync:sour puls	Selects pulse as the sync source. In this mode, you may also program the position of the sync pulse.
outp:sync:pos<value>	Sets the position of the sync pulse relative to the active segment. The position is programmed in units of waveform points.
outp:sync:wid<value>	Sets the width of the sync pulse. The width is in units of waveform points. Note that the position (in points) plus the width (in points) shall not exceed the number of points in the segment.

Example: Generating a Simple Waveform

This example assumes that you have set up the chassis and run the Resource Manager.

Connect two cables, one from the OUTPUT connector and the other from the “SYNC” connector, to an oscilloscope. Set up the oscilloscope to trigger from the SYNC signal. Use the following sequence of commands to set up the 3152B:

**rst*	Restore factory defaults (Table 5-1 provides a complete listing of defaults)

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outp 1	Enable output relay to turn output on
volt <value>	Set up the amplitude level
volt:offs <value>	Set up the offset level

Set up your oscilloscope to observe that the 3152B generates a sine waveform with the following properties:

- Frequency: 1 MHz
- Offset: 0 V
- Amplitude: 5 V

The output of the 3152B is calibrated for signals applied to a 50 Ω load. If your amplitude is twice as high as expected, then the 3152B output may not be properly terminated. In this case, either add a 50 Ω termination to the cabling or change your oscilloscope settings so that its input uses the built-in 50 Ω input termination. Also, note the interaction between amplitude and the offset as described below.

Amplitude-Offset Interaction

Amplitude and offset may be programmed freely as long as the following relationship is observed:

$$\frac{Amplitude}{2} + |Offset| \leq 16Vp-p \text{ (-8V to +8V peaks)}$$

Amplitude-offset combinations outside the above limits will generate "settings conflict" errors.

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Selecting an Output Function

The 3152B has four basic output function types. Use the following commands to select the waveform type:

func:mode fix	The 3152B outputs the standard waveform currently selected by the FUNC:SHAP command (default sine, 1 MHz, 5Vp-p).
func:mode user	The 3152B outputs the arbitrary waveform currently selected by the TRAC:SEL command (default trace is 1).
func:mode seq	Selects the Sequenced Waveform function. Waveform segments must be downloaded to the instrument before it can sequenced generate waveforms. In addition, the SEQ:DEF command must be used to define the sequence.

When programming a waveform function, you must consider the run mode, since combinations of waveform types that are legal in one mode may not be legal in a different mode. For example, arbitrary and sequenced waveforms that do not conflict in Continuous mode may conflict in Burst mode.

Selecting a Run Mode

The 3152B offers five run modes:

- Continuous
- Triggered
- Re-triggered
- Gated
- Burst

In Continuous mode, the 3152B repeats the selected waveform continuously. The other four modes are known as *interrupted*, that is, the output does not generate waveforms until an event initiates a single- or multiple-output cycle.

Interrupted modes require a single trigger or multiple triggers to initiate output cycles. Trigger events come from various inputs, such as VXIbus backplane trigger lines or the front-panel connector. Information on selecting a run mode and trigger source is given in the following paragraphs.

Use the following commands to select run modes:

init:cont on	Selects Continuous mode. This is the default state of the instrument. Use this command to return to Continuous run mode from any other interrupted mode.
init:cont off	De-selects Continuous mode. If you did

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not previously select a specific interrupted mode, the generator will automatically be placed in Triggered mode.

Continuous Run Mode

Upon power-up, the 3152B defaults to Continuous mode and automatically starts generating waveforms which appear at the output connector as the output relay is turned on. Use “init:cont on” to return to Continuous mode from any interrupted mode.

Triggered Run Mode

In Triggered mode, the output remains at a specific DC level until a trigger event initiates a single output cycle (see “Selecting the Trigger Source” for details about trigger parameters).

Each time a transition occurs at the trigger input, the 3152B generates one complete output cycle. At the end of the waveform cycle, the output assumes a DC level that is equal to the amplitude of the first point of the waveform.

If you have not invoked any interrupted modes since applying power to the 3152B, you may use the following command to turn off Continuous mode and default to Triggered mode:

init:cont off	Turns off Continuous mode, changing to an interrupted mode. If you have not selected a specific interrupted run mode since power-up, the generator will default to Triggered mode.

If you have used other interrupted modes since power-up, then send the following command sequence to guarantee a change to Triggered mode:

init:cont off	Turns Continuous mode off in case this was the most recent run mode.
trig:retr off	Turns Retriggered mode off in case this was the most recent interrupted run mode.
trig:gated off	Turns Gated mode off in case this was the most recent interrupted run mode.
trig:burs off	Turns Burst mode off in case this was the most recent interrupted run mode.

Re-Triggered Run Mode

Re-triggered mode is a special case of Triggered mode where, after a valid trigger event, the generator automatically self-issues triggers separated by a programmable delay. The delay interval is measured from the end point of the waveform to the start point of the next waveform cycle. Use the following commands to place the instrument in re-triggered mode and to program the delay between

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events:

init:cont off	Turns Continuous mode off, changing to an interrupted mode. If you have not selected a specific interrupted run mode since power-up, the generator will automatically be placed in Triggered mode.
trig:retr 1	Turns on Re-triggered mode.
trig:retr:del <value>	Sets the re-trigger delay time. The re-trigger delay is measured from the last point of the waveform cycle to the first point of the next waveform cycle.
<trigger event>	Starts the re-trigger generator. You may select the source of trigger events from a number of inputs, such as software trigger, front-panel input, or VXIbus backplane trigger lines.

The waveform will continue to re-trigger unless you change the run mode or turn off power. Use the following commands to restore continuous run mode:

trig:retr 0	This turns off Re-triggered mode. The generator will revert to the Triggered run mode.
init:cont on	This removes the 3152B from interrupted run mode and reverts to Continuous mode.

Gated Run Mode

In Gated mode, the output remains at a specific DC level until a valid event opens the gate and waveform output begins. At the end of the last output cycle, the output assumes a DC level equal to the amplitude of the last point of the waveform.

Only triggers from hardware sources can open or close the gate. Use VXIbus backplane trigger lines or the front-panel trigger input as the gating control.

You may set trigger detection for either a rising or falling edge, or a high or low level.

There are two selectable modes for opening the gate:

- Transition (edge): A transition in the same direction as the programmed slope toggles the gate open or closed.
- Level: The gate remains closed as long as the trigger signal is at the selected logic state (high or low), based on the trigger level setting. The gate opens when the trigger signal exceeds the trigger level setting.

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Use the following commands to turn the gate function on and to select the conditions for opening the gate:

init:cont off	Selects the interrupted run mode. If you did not select a specific interrupted run mode since power-up, the generator will automatically be placed in Triggered mode.
trig:gate 1	Turns the Gated mode on.
trig:gate lev	Makes the gate level-sensitive. The gate opens based on whether the gating signal is high or low (selectable threshold and direction).
trig:gate tran	Makes the input transition-sensitive. The gate opens on the first transition in the selected direction, and closes on the next transition in the same direction.
<gate event>	This event controls Gated mode. You may select the source of the gate events from a number of inputs, including the front-panel or VXIbus backplane trigger line.

The gating sequence continues unless you change the run mode or turn off power. Use the following commands to restore Continuous mode:

trig:gate 0	Turns off Gated mode. The generator reverts to Triggered mode.
init:cont on	Places the 3152B into Continuous mode.

Burst Run Mode

Burst mode is similar to Triggered mode except that only one trigger signal is needed to generate a counted number of output cycles. In Burst mode, the output remains at a specific DC level until a valid trigger event initiates a burst of output waveforms. Any trigger source can initiate a burst. If a hardware trigger source is selected, the edge sensitivity can be programmed for either the rising or falling edge of the input signal.

Each time a transition at the trigger input occurs, the 3152B generates a counted burst of output waveforms. At the end of the burst, the output assumes a DC level equal to the amplitude of the first point of the waveform. The burst counter is programmable from 1 to 1 M counts.

The 3152B can also operate in conjunction with Re-triggered mode, creating a continuous sequence of delayed burst cycles. Use the following commands to place the instrument in Burst mode and to program the burst counter:

init:cont off	Selects the interrupted run mode. If you

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have not selected a specific interrupted run mode since power-up, the generator will automatically be placed in triggered run mode.

trig:burs 1	Turns the Burst mode on.
trig:burs:coun <value>	Sets the burst counter. After a legal trigger event, the instrument will generate the counted number of waveforms, and then resume idling at a DC level.
<burst event>	This starts the burst generator. You may select the source of the burst event from a number of inputs including software trigger, front-panel input, or VXIbus backplane trigger line.

The counted burst sequence will continue as long as legal trigger events are present at the trigger input. Use the following commands to restore Continuous mode:

trig:burs 0	This turns off Burst mode. The generator reverts to Triggered run mode.
init:cont on	This removes the 3152B from an interrupted run mode and reverts to Continuous run mode.

Selecting the Trigger Source

Interrupted run modes require trigger signals, of which there are three types:

- External trigger. For synchronizing with external events, connect the external trigger signal to one of the trigger inputs.
- Internal trigger generator. For applications not requiring synchronization to external signals, the 3152B has an internal trigger generator with a free-running clock. This clock is asynchronous to the sample clock generator.
- Software trigger. Your software may generate an interrupt condition by executing a trigger command.

You may select (arm) only one trigger source at a time. The 3152B responds only to the selected trigger source, and ignores other sources. Use one of the following commands to select a trigger source:

trig:sour ext	This selects the front-panel TRIG IN connector as the active source for trigger events.
trig:sour int	This selects the internal trigger generator as the active source for trigger events.
trig:tim <value>	This sets the period of the built-in trigger generator. Unlike the Re-trigger run mode, the internal trigger period defines actual trigger events. Therefore, the period of the

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internal trigger generator must be larger than the period of the waveform.

trig:sour ttlt<n,1> This selects and activates one or more of the VXIbus backplane triggers (TTLTrg0 through TTLTrg7) as the active source for trigger events. If more than one input is activated, the instrument will accept trigger events from all active trigger lines. Note that if one of the lines is designated as an output, it cannot be used as an active source at the same time.

trig:sour bus This selects the software trigger as the active source for trigger events.

Selecting the Trigger Level

The Trigger Level command sets the threshold level for the trigger input connector only. The trigger level is adjustable from -10 V to +10 V using the following command:

Trig:lev <value> This programs the trigger level threshold for signals that are applied to the front-panel TRIG IN connector.

The default value is 1.6 V which is appropriate for TTL signals.

Selecting the Trigger Slope

The Trigger Slope command selects between positive- and negative-edge triggering. The inputs that will be affected by this command are: Front-panel TRIG IN connector, TTLTrg lines 0 through 7, and ECLTrg line 0. Transitions must cross the trigger level threshold to trigger a response. Use the following commands to select slope sensitivity for trigger events:

trig:slop pos TTLTrg lines: This sets the 3152B to respond to negative-going transitions only (direction is reversed for TTLTrg lines).

All other inputs: This sets the 3152B to respond to positive-going transitions only.

trig:slop neg TTLTrg lines: This sets the 3152B to respond to positive-going transitions only (direction is reversed for TTLTrg lines).

All other inputs: This sets the 3152B to respond to negative-going transitions only.

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Using Trigger Delay

The trigger delay value designates the time that will elapse from a trigger event to the start of the waveform at the output connector. The trigger delay adds to the system delay time (see the definition of System Delay in Appendix A). Therefore, when delaying the trigger, always consider the added factor of the system delay.

Use the following command to turn on trigger delay and to program the delay time value:

trig:del <value>	This command is available for compatibility with legacy 3152A code. A value of 0 provides no trigger delay, and values in the range of 10 to 2M set delays in units of sample clock periods.
trig:del:stat 1	This command turns on the trigger delay function. When turned on, the minimum delay time is 100 ns plus system delay.
trig:de:stat 0	This command turns off the trigger delay function. When turned off, the minimum delay time is equal to the system delay.
trig:del:tim <value>	This sets the delay in units of time (an alternative to the legacy compatible method above which uses units of sample clock points). You may set the delay time in the range of 100 ns to 20 seconds in increments of 20 ns.

Activating the Backplane TTLTrg Lines

The 3152B is programmable to drive or receive triggers on the VXIbus backplane trigger lines (TTLTrg0 through TTLTrg7). It is important to manage the trigger lines so that only one VXI instrument drives any given line.

The signals through the TTLTrg lines are always TTL.

Use the following commands to program the backplane trigger lines.

outp:ttlt<n> 1	This command defines a specific TTLTrg line as an output. The SYNC signal is then applied to the active TTLTrg output and the front-panel SYNC OUT connector. The argument <n> designates the required TTLTrg line, and can take values from 0 through 7.
outp:ttlt<n> 0	This command removes the output definition from a specific TTLTrg line and permits re-definition of this line as an input.

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Example: Generating Standard Waveforms

Previous paragraphs provided sinusoidal waveform examples, showing how to set amplitude and offset. This section expands on that capability, covering all nine standard waveforms in the 3152B internal library: sine, triangle, square, pulse, ramp, Gaussian pulses, exponential pulses, DC, and noise.

The following command sequence example demonstrates how to select a standard ramp waveform with an amplitude of 1Vp-p, an offset of zero, a rise time of 10% of the ramp period, and a fall time of 10% of the ramp period:

**rst*	Restores factory defaults.
outp 1	Activates the hardware connection to the front panel OUTPUT connector and turns the output on.
func:mode fix	Selects the built-in library of standard waveforms.
func:shap ramp	Selects the ramp from the built-in library as the active waveform.
ramp:tran 10	Programs the ramp leading edge rise time in units of percent (referenced to the ramp period).
ramp:tran:tra 10	Programs the ramp trailing edge fall time in units of percent (referenced to the ramp period).
volt 1	Sets the amplitude level to 1Vp-p.
volt:offs 0	Sets the offset level to zero.

Similar sequences could select different standard waveforms and program their parameters. See Chapter 5 for programming references for the complete range of standard waveforms.

Using the Apply Command

The Apply command provides shortcuts for setting up a waveform and its parameters without programming each parameter individually. This also selects the waveform as the active signal at the output connector. It does not, however, eliminate the need for turning on the output. You may use the Apply command on a waveform from the built-in library or on waveform segments that are pre-loaded to the waveform memory. Sequenced and modulated waveforms do not use the Apply command.

The following example uses the Apply command to specify a square wave at the end of the programming sequence:

**rst*	Restores factory defaults.
appl:squ 10.7e6,2,1,30	Selects the standard square wave as the active function, and simultaneously

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	sets the frequency to 10.7 MHz (10.7e6), amplitude to 2 V, offset to 1 V, and duty cycle to 30%.
outp 1	Turns on the output.

The above is an example of a full utilization of the Apply command, including the frequency, amplitude, offset, and duty cycle parameters for a standard square wave. You may use the Apply command in a similar manner for other standard or arbitrary waveforms.

You may use the Apply command on a partial set of the available parameters of a waveform. To leave out a parameter, place no characters between the corresponding comma separators. For example, you may specify the frequency and duty cycle of a square wave while leaving the amplitude and offset at the default values, as follows:

**rst*	Restores factory defaults.
appl:squ 12.7e6,,,45	Selects the standard square wave as the active function, and simultaneously sets the frequency to 12.7 MHz, leaves the amplitude at the default value, leaves offset at the default value, and sets the duty cycle to 45%.
outp 1	Turns on the output.

In a similar manner, you may use the Apply command with other standard waveforms to set some parameters while leaving others at their default values.

Generating Standard Waveforms

Each standard waveform is built into the 3152B in a lookup table or equation. Ten standard function shapes are available:

- Sine
- Triangle
- Square
- Pulse
- Ramp
- Sinc
- Exponential Decaying Pulse
- Gaussian Pulse
- Noise
- DC

Every time you select a standard function, the 3152B retrieves the data points from a lookup table or calculates them from equations, and then places them into waveform memory.

Use the following commands to select one of the standard

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waveform shapes:

func:shap sin	Selects the sine waveform
func:shap tri	Selects the triangle waveform
func:shap squ	Selects the square waveform
func:shap puls	Selects the pulse waveform
func:shap ramp	Selects the ramp waveform
func:shap sinc	Selects the sinc waveform
func:shap gaus	Selects the Gaussian waveform
func:shap exp	Selects the exponential waveform
func:shap nois	Selects the noise waveform
func:shap dc	Selects the DC waveform

After you select a waveform shape, you may specify the waveform parameters. Chapter 5 explains the commands available for specifying parameters of standard waveforms.



Note

The number of points used for defining a standard waveform depends upon the programmed frequency. Therefore, some parameter changes may not have any effect on the waveform because the number of points do not provide enough resolution to show the difference.

The number of waveform points varies, depending upon the output frequency. The reason for this variation is that even standard waveforms are in a manner similar to that of arbitrary waveforms, except that the 3152B stores standard waveforms in a permanent internal library for immediate use. At low frequencies, the number of points for each standard waveform is 1,000. Therefore, waveform modifications are possible in increments of 1/1,000 of the total waveform. For example, if you want to modify the duty cycle of a square waveform, the resolution for the duty cycle is 0.1%.

At higher frequencies, the number of points used for generating waveforms decreases according to the following relationship:

Output Frequency = Sample Clock Frequency / Waveform Points

Since the maximum sample clock frequency is 250 MS/s, the only way to increase frequency is by reducing the number of waveform points (when the standard waveform frequency is > 250 kHz). The reduced number of points available at higher frequencies decreases timing resolution for the standard waveforms. For example, for a 25 MHz square wave, only ten points per period are available. Therefore, duty cycle resolution is decreased to 10% increments.

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Standard Waveform Parameters

The built-in library of standard waveforms provides basic waveform shapes. First select the basic shape, and then specify the waveform parameters to create the finished waveform to fit your requirements. For each standard waveform shape, you may adjust the frequency, amplitude, and offset. Some wave shapes have additional parameters available. For example, you may set the starting phase for a sine wave, or the rise and fall time for a ramp waveform.

The following example demonstrates how to select a standard pulse waveform and set its parameters:

**rst*	Restores factory defaults.
func:mode fix	Sets the output function to the standard built-in library of waveforms. This is also the default function mode so if you are using the reset command, there is no need to re-select this function.
func:shap puls	Selects the pulse waveform.
puls:del 0	Sets the delay value to 0 s.
puls:wid 20	Sets the pulse width to 20% of the waveform period.
puls:tran 3	Sets the rise time (leading edge) to 3%, expressed as a percentage of the waveform period.
puls:tran:tra 5	Sets the fall time (trailing edge) to 5% of the waveform period.
freq 5e3	Sets the frequency of the pulse waveform to 5 kHz (5e3 Hz).
outp 1	Turns the output on.

You may use similar command sequences to program other waveforms and their parameters. Table 5-1 lists the complete set of commands for setting waveform parameters.

Using the Apply Command

The Apply command is a shortcut for setting up standard waveforms and their parameters without having to program each parameter individually. This also selects the waveform as the active signal at the output connector. It does not, however, eliminate the need for turning on the output. You may use the Apply command on a waveform from the built-in library or on waveform segments that are pre-loaded with arbitrary waveforms. Sequenced and modulated waveforms are not supported by the Apply command.

The following example uses the Apply command to specify a square wave at the end of the programming sequence:

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**rst*	Restores factory defaults.
appl:squ 10.7e6,2,1,30	Selects the standard square wave as the active function, and simultaneously sets the frequency to 10.7 MHz (10.7e6), amplitude to 2 V, offset to 1 V, and duty cycle to 30%.
outp 1	Turns on the output.

The above is an example of a full utilization of the Apply command, including the frequency, amplitude, offset, and duty cycle parameters for a standard square wave. You may use the Apply command in a similar manner for other standard or arbitrary waveforms.

You may use the Apply command on a partial set of the available parameters of a waveform. To leave out a parameter, place no characters between the corresponding comma separators. For example, you may specify the frequency and duty cycle of a square wave while leaving the amplitude and offset at the default values, as follows:

**rst*	Restores factory defaults.
appl:squ 12.7e6,,,45	Selects the standard square wave as the active function, and simultaneously sets the frequency to 12.7 MHz, leaves the amplitude at the default value, leaves offset at the default value, and sets the duty cycle to 45%.
outp 1	Turns on the output.

In a similar manner, you may use the Apply command with other standard waveforms to set some parameters while leaving others at their default values.

Generating Arbitrary Waveforms

Before the 3152B can generate arbitrary waveforms, you must first download them to its waveform memory. This section describes the arbitrary waveform function and explains how to download waveforms.

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What Are Arbitrary Waveforms?

Arbitrary waveforms are generated from digital data points which are stored in memory. Each data point (waveform sample) has a vertical resolution of 16 bits (65,536 levels). Another way to express this is that each sample has an amplitude resolution of one part in 65,536. For legacy emulation, 12 bit waveform data is converted into 16 bit data with a four position shift.

The standard 3152B has a waveform memory capacity of 1 M points (4 M is available as an option in some configurations). Each point has a unique address. The address of the first point is zero, and the address of the last point depends upon the waveform memory size. If a waveform does not require the entire waveform memory, then you may divide the memory into smaller segments, each of which may store a separate waveform.

When the instrument is set to output arbitrary waveforms, the clock samples the data points one at a time, starting with address 0 and continuing to the last data point of the waveform. The rate at which each sample is retrieved is defined as the sample clock rate. The 3152B provides programmable sample clock rates from 100 mS/s to 250 MS/s.

Unlike waveforms contained in the built-in library, arbitrary waveforms must first be downloaded into waveform memory. One of the easiest ways to calculate the waveform samples is to use ArbConnection. It provides an on-screen editor, called Wave Composer, for creating and editing waveforms. Figure 3 -1 shows a complex waveform from the Wave Composer editor. Chapter 4 provides instructions for using ArbConnection and its Wave Composer editor.

Managing Arbitrary Waveform Memory

You may divide the 3152B waveform memory into segments, and use each segment to contain a separate waveform. This is useful in applications that require multiple waveforms and can benefit from changing quickly from one waveform to another.

The memory can be partitioned into as many as 16k segments (with up to 16,384 different waveforms), but the higher the number of segments, the smaller the number of sample points that are available to each.

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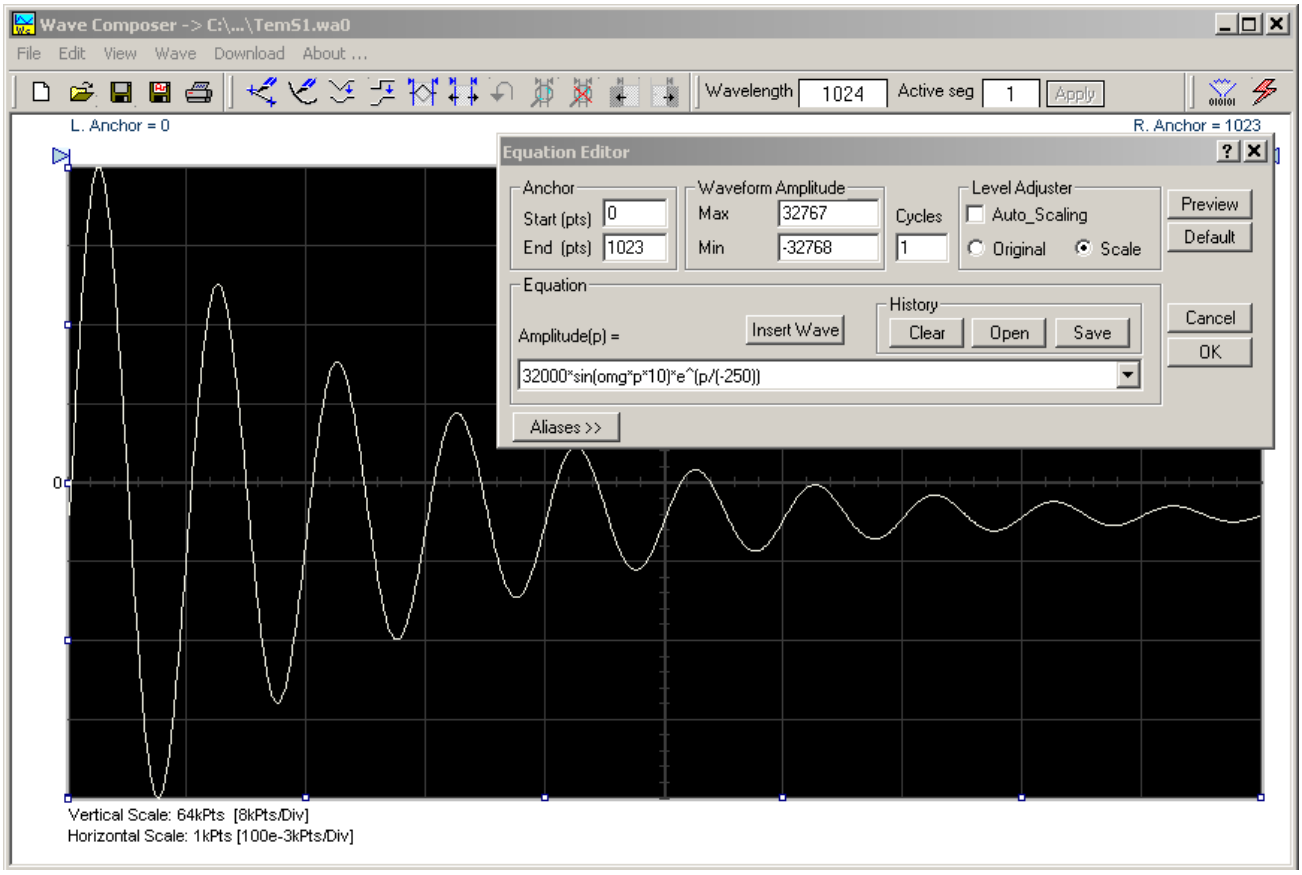


Figure 3-1, ArbConnection Example of a Complex Waveform

Memory Management Commands

Creating Memory Segments

Segments are defined using the following command:

trac:def 1,2000 — Defines segment #1 as having 2,000 sample points. Any waveform downloaded to this segment must have exactly 2,000 data points.

This command has two variables: segment number and segment size. Note that numbers, not names, are assigned to segments. Segment numbers range from 1 through 16,384. You may define the segments in any order. For example, you may define segment #3, then segment #1, and then later define segment #2. You may not change the size of a segment once you have defined it.

You cannot query the segment definition parameters, so make sure you keep track of them if you intend to partition the memory into many segments.

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You may use the above command to create as many segments as required. However, if you have many segments, it is more efficient to combine all segments into a single waveform, and then create a memory partition table for the individual waveform segments. To do this, use the following command:

segm <array>	Downloads the entire memory partition table to the instrument in one operation.

Chapter 5 provides details on the use of this command.

Deleting Memory Segments

To delete a waveform memory segment, use the following command:

trac:del <value>	Deletes a segment (specified by <value>) from the available segment list but does not erase the contents of the segment.

Note that if you delete a segment, the memory portion that belonged to this segment is no longer accessible. The next segment defined is placed at the end of the partition table. If you delete the last segment that you defined, then the next downloaded data will overwrite the memory of the deleted segment. If you delete segments often, large portions of the memory will become inaccessible. Therefore, it is suggested that you periodically clear the entire memory and reload the waveforms that you intend to use. To delete the entire memory partition table use the following command:

trac:del:all	Removes the entire partition table, allowing definition of a new segment table.



Tip

The *trac:del:all* command deletes the partition table but leaves the data in the arbitrary memory intact. Therefore, if you made a mistake and want to restore the segments, just re-load the partition table. The waveform memory is overwritten. Every time you download new waveform data, the waveform memory data for that segment is overwritten.

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Loading Arbitrary Waveforms

The easiest way to download waveforms to the 3152B is with ArbConnection. Using this application, you may define, create, and download memory segments to the 3152B.

For maximum flexibility, you may download waveforms to the 3152B from your own program. The following example shows how to clear the partition table and set up three memory segments of 4,000, 1,000, and 64 sample points:

First, clear the entire memory partition table to eliminate any fragmented segments. Use the delete command as follows:

trac:del:all	Removes the entire partition table and allows you to define new segments.

Next, define the waveform memory segments by specifying each segment number and its length:

trac:def 1,4000	Defines the length of segment #1 to be 4,000 sample points. Waveforms downloaded to this segment must have exactly 4,000 sample points.
trac:def 2,1000	Defines the length of segment #2 to be 1,000. Waveforms downloaded to this segment must have exactly 1,000 sample points.
trac:def 3,64	Defines the length of segment #3 to be 64. Waveforms downloaded to this segment must have exactly 1,000 sample points.

This completes the setup for the three memory segments.

Alternatively, you may use the following command to create the entire partition table at once:

segm <array>	Downloads the entire memory partition table to the instrument in one operation.

Once you have defined the waveform memory segments, the next step is to specify the active segment. This sets up the following conditions:

1) The next time you download data to the 3152B, it will go to the active segment (the 3152B will accept downloaded data only if a segment is designated as active).
2) The waveform contained in the active segment will appear at the output the next time you turn on the output.
3) The SYNC output is associated with the active segment. This is not important in arbitrary mode, but in sequenced mode, the segments may be arranged in any order. Therefore, the location of the sync signal is important because it may appear at the

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middle of the sequence and not with the first segment.

Use the following command to select an active segment:

trac:sel <n>	Selects the active segment <n>. Waveform data is downloaded only to this active segment. If you plan to partition the entire table with the "segm <array>" command, select segment #1 as the active segment.

The next step transfers waveform data to the active segment. Use the following command:

trac# <data_array>	Downloads waveform sample data to the active segment. If you condensed all waveforms to a single waveform, then you may use the "segm <array>" command to partition the memory into segments in one operation. See Chapter 5 for information on preparing and downloading waveform sample data.

Selecting 12-bit or 16-bit Waveform Resolution

The 3152B handles waveform data in 16-bit words. In most cases this high resolution is an advantage because it minimizes quantization noise and enhances signal integrity. However, some applications, such as those using the older 3152A instrument, use only 12-bit data. For compatibility, The 3152B automatically converts 12-bit data from legacy applications without the need to re-write the application program or data files.

The default data resolution for the 3151B and 3152B is 12 bits. Other configurations, such as 3100M-3152B and 3100R-3152B, default to 16 bits. Regardless of the model number, you may set the waveform resolution to either 12 bits or 16 bits using the following commands:

form:wave:res 12bit	Sets the resolution to 12 bits. Instructions for preparing the 12-bit data are given in Chapter 5.
form:wave:res 16bit	Sets the resolution to 16 bits. Instructions for preparing the 16-bit data are given in Chapter 5.

Selecting Code Compatibility with the Legacy 3152A

For applications written for the legacy 3152A, you may use The 3152B in Legacy Compatibility mode. Legacy Compatibility mode, when enabled, affects the performance specifications in the following ways:

- Maximum sample clock frequency is reduced to 100 MS/s

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[3152B can reach 250 MS/s].

- Waveform interlace is changed to 2 (waveform size must divide by 2)

- Vertical resolution of arbitrary waveforms is 12 bits (3152B has 16-bit resolution).

The 3152B has Legacy Compatibility mode enabled by default. For Models 3100M and 3100R, Legacy Compatibility mode is disabled by default (the full 3152B specifications apply).

For any of the above products, you may enable or disable Legacy Compatibility mode by using the following commands:

form:inst leg	Enables Legacy Compatibility mode by downgrading specific specifications to approximate those of Model 3152A.
form:inst mod	Disables Legacy Compatibility mode. The full 3152B performance specifications apply.

Changing the Sample Clock Frequency

Users should be careful not to confuse waveform frequency with sample clock frequency. For the 3152B, the term “waveform frequency” is valid for standard waveforms only, and controls the waveform frequency at the output connector. Waveform frequency is measured in units of Hertz (Hz).

On the other hand, the term “sample clock frequency” is associated with arbitrary and sequenced waveforms only, and defines the frequency at which the clock generator accesses the waveform sample points. Sample clock frequency is measured in units of samples per second (S/s).

The following equation computes the frequency of an arbitrary waveform at the output connector:

Frequency = (Sample Clock Freq.) / (Number of Data Points)

For example, using a sample clock frequency of 80 MS/s with a 1,000-point waveform will generate an 80kHz waveform at the output connector.

The following command sets the sample clock frequency for arbitrary and sequenced waveforms:

freq:rast <*value*>	Set sample clock frequency in units of samples per second

Sampling clock frequency can be in the range of 100 mS/s to 300 MS/s.

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The number of points in the waveform must be an integer multiple of four. For example, you may use a waveform length of 25,804 throughout the entire range, but if you increase the number of points by two, then the 3152B will generate an error.

Note that for compatibility with older code that was used with Model 3152A, you may select the Legacy Format mode, where the limits for the sample clock change to 100 MS/s, but the waveform size can be an integer multiple of two.

Using the External Sample Clock Input

The internal sample clock generator has a high dynamic range that allows the creation of a wide variety of waveforms and frequencies. With its top frequency of nearly 300 MHz, it must use dividers to create lower frequencies. Such dividers can increase phase noise and jitter. Some applications require better stability and phase noise, making a single-tone sample clock source the most desired source.

The 3152B does not have a single-tone sample clock source, but it provides a front-panel input, SCLK IN, that can accept a clock from an external source. When this input is in use, the internal clock generator is disabled, and the 3152B waveforms are clocked at a rate defined by the external signal. Using an external clock source can improve phase noise and jitter to approximately 20 dB/Hz at 10 kHz offset from the carrier.

Apply the external sample clock signal to the front panel SCLK IN connector. Make sure your signal level has either positive ECL (PECL) or negative ECL (NECL) amplitude levels. The input automatically accommodates either.

The following commands select the source of the sample clock input:

freq:rast:sour int	This is the default selection, where the 3152B self-generates its sample clock signal. All other inputs are disabled.
freq:rast:sour ext	This selects the front panel SCLK IN connector as the source of the sample clock signal.
freq:rast:sour eclt0	This selects the backplane ECLTrg0 line as the sample clock source. This is a special mode that allows synchronization between adjacent 3152B modules. Note that the VXI specifications limit the ECLTrg0 frequency to 62.5 MHz. Backplane synchronization is covered in a separate section.

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Generating Sequenced Waveforms

Sequences are comprised of waveform segments that reside in the waveform memory. The sequence generator lets you link and loop segments in a user-defined order. To avoid unexpected results, it is essential that waveform segments are pre-loaded into waveform memory before a sequence table is used.

To create a waveform sequence, you will create a sequence table that provides instructions to the sequencer for assembling the waveform from the segments in the waveform memory. Figure 3-2 shows an example of a sequence table created using ArbConnection. The sequence table has five fields for each step:

Link – This defines the step number. The sequence will advance through the links in the same order in which they are entered. There are no pauses or transitions between links.

Seg – This defines the waveform segment number that will be linked to form the next part of the sequence. The order of waveform segments in waveform memory is irrelevent. You may link them in any order.

Loops – This defines the number of times the segment will repeat itself before advancing to the next link, or step. The number of loops may range from 1 through 1,048,576.

Adv – Defines the advance bit, which tells the generator whether to move to the next link immediately or to hold and wait for a trigger event before moving to the next link. The various advance modes are discussed in more detail in another section.

Sync – This specifies the link on which you want to place a synchronization bit. The SYNC output must be switched to the Bit source option to enable the use of this feature. The Normal SYNC output is LCOM, where the output goes high at the beginning of the sequence and returns to low at the end of the sequence.

The following paragraphs describe the commands that create, delete, update, and modify sequence tables.

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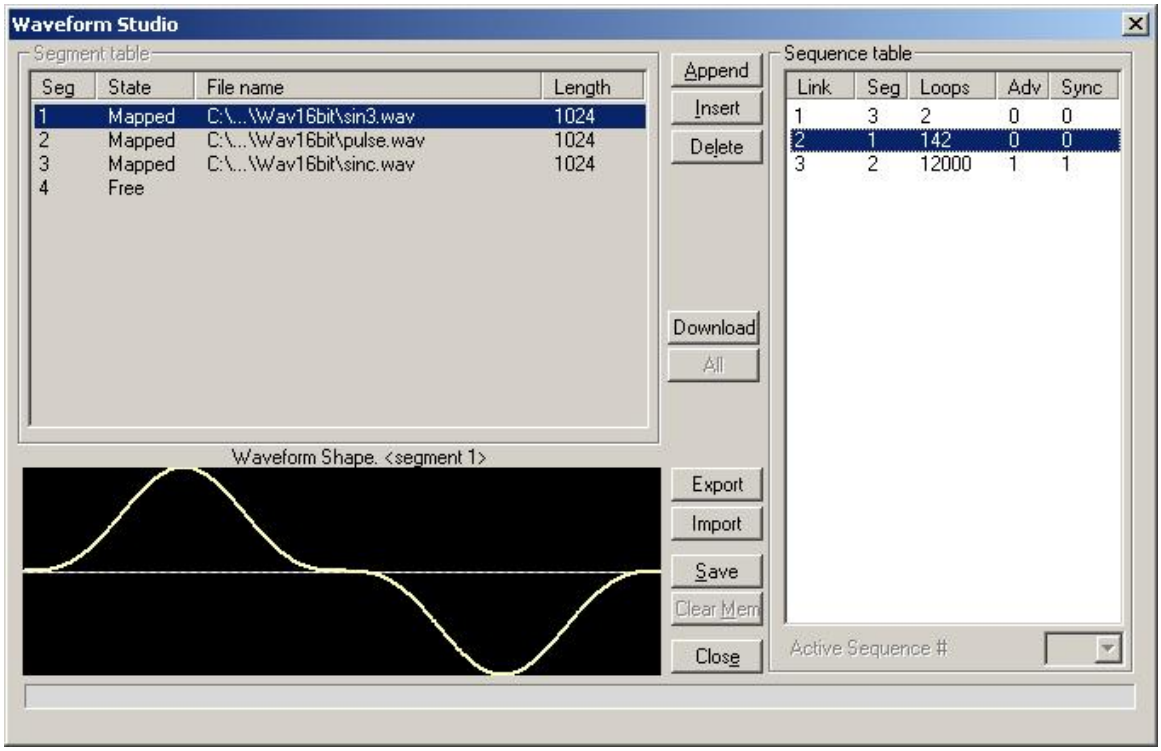

Waveform Studio
Segment table
Seg
State
File name
Length
1 Mapped C:\...\Wav16bit\sin3.wav 1024
2 Mapped C:\...\Wav16bit\pulse.wav 1024
3 Mapped C:\...\Wav16bit\sinc.wav 1024
4 Free
Append
Insert
Delete
Download
All
Waveform Shape. <segment 1>
Export
Import
Save
Clear Mem
Close
Sequence table
Link
Seg
Loops
Adv
Sync
1 3 2 0 0
2 1 142 0 0
3 2 12000 1 1
Active Sequence #

Figure 3-2, Sequence Table Created in ArbConnection

Sequence Commands

The following is an overview of how to define and program a sequence of arbitrary waveforms.

A sequence is made of a series of links. A link can stand on its own or link to another step. It is possible to have only one link in a sequence, but the output will be a continuous waveform. If only one link is specified and the 3152B is placed in Triggered advance mode, then the output will behave as it would in Burst mode, where the repeat number replaces the burst count parameter.

The easiest way to create a sequence table is with ArbConnection. Using this application you can define, create, and download waveform segments to the waveform memory without using low level commands. You may also use Waveform Studio to develop sequences.

Use the following commands to write sequence tables:

seq:sel <1..10> The 3152B can store ten separate sequences, and this command selects the active sequence. Once selected, the active sequence is generated at the output connector. Note that by selecting an active sequence, you do not automatically change the output to sequenced mode.

seq:def 1,1,10,0,1 This command defines a link. The

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parameters are (from left to right) link number, segment number, loop counter, advance flag, and sync flag. These parameters are explained in the Generating Sequenced Waveforms section.

Using the Sequence Define command repetitively, you may program a complete definition of your sequence. When entering a large number of links, efficiency can be improved by using an alternate syntax which allows a table of sequence definitions to be downloaded directly.

Use the following command to program a complete table from an array:

seq:data#<array> This will program the entire sequence table without programming individual links.

The sequence generator steps through the link list in descending order. In Continuous Run mode, the sequence repeats automatically after the last step has been completed. When the generator is in Triggered mode, the output stops at the last point of the last waveform in the sequence. In Gated mode, the sequence always completes after the gate stop signal.

To remove a link from the sequence table, use the following command:

seq:del <n> This deletes a link from a sequence table, where <n> is the step number to be removed.

To delete the entire sequence table, use the following command:

seq:del:all This deletes the entire sequence table.



CAUTION

The *seq:del:all* command erases the entire sequence table. There is no undo operation available for this command.

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Controlling the Sequence Advance Modes

Use the following commands to control how the sequence advances through the sequence links:

seq:adv auto This specifies continuous advance, where the generator steps continuously to the end of the sequence table and then repeats the sequence from the beginning. For example, if a sequence is made of three segments, 1, 2, and 3, and AUTO mode is used, the sequence will proceed: 1, 2, 3, 1, 2, 3, 1, 2, 3…, with the duration of the loop depending upon the loop counter specified in the sequence table.

seq:adv trig This specifies that the 3152B idles between links until it senses a valid trigger event. This mode is available only when the 3152B is in Triggered Run mode. An attempt to select this mode when the 3152B is in Continuous Run mode will generate a settings conflict error. After a trigger, the generator output resumes until it is once again between links. Then, the output level idles at a DC level equal to the last point of the last generated waveform. If loops (repeats) were programmed, the segment is repeated n times automatically before it begins idling. After execution of all of the programmed loops, the sequencer steps to the next segment in the sequence upon receipt of the next valid trigger event.

seq:adv step This Stepped Advance mode specifies that the sequence advances to the next link only when a valid trigger event has been received. In this mode, the 3152B generates the first segment continuously until a trigger signal advances the sequence to the next segment. If repeats are specified in the sequence table, they are ignored in Stepped Advance mode. Note that this mode requires that the run mode be set to Continuous.

seq:adv mix In this mode, advancing to the next link is controlled by the Advance bit in the link definition. “0” will cause the link to advance automatically to the next link. “1” will cause the link to repeat itself continuously until a valid trigger event has been received, and then the generator will begin executing the next link. Note that this mode requires that the run mode be set to Continuous.

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Generating Modulated Waveforms

The modulation generator is a separate instrument within the 3152B. Based on DDS technology, it has a wide dynamic range and high linearity throughout the modulation range.

The 3152B can modulate in the frequency, amplitude, and phase domains. When the modulation output is selected but modulation is turned off, the instrument generates a continuous wave (CW) signal, or steady-state sine wave. The following commands control the modulation of the carrier wave:

mod:type off This disables modulation so that the output generates a CW signal. CW is the sine waveform that is being modulated. When placed in Modulation Off, the sine waveform is continuously generated from the main output. In this mode, sine waveforms can be generated from 100 μHz to 100 MHz. Modulation off operates in Continuous Mode only. The CW settings do not automatically change when you switch from one modulation function to another.

mod:type am This selects amplitude modulation (AM). The modulating signal is internal, and the following parameters control the AM scheme: modulation shape, modulation frequency, and modulation depth.

mod:type fm This selects frequency modulation (FM). The modulating signal is internal, and the following parameters control the FM scheme: modulation shape, modulation frequency, and marker placement.

mod:type swe This selects sweep modulation. The modulating signal is internal, and the following parameters control the sweep: start and stop frequency, sweep time and direction, sweep spacing, and marker placement.

mod:type fsk This selects frequency shift keying (FSK). The shift sequence is created in a data table that can hold up to 4,000 frequency shift steps. The following parameters control FSK modulation: shifted frequency, baud, shift data array, and marker placement.

mod:type ask This selects amplitude shift keying (ASK) modulation. The shift sequence is created in a data table that can hold up to 1,000 amplitude-shift steps. The following parameters control ASK modulation: shifted amplitude, baud, shift data array, and marker placement.

mod:type psk This selects the phase shift keying (PSK). The shift sequence is created in a data table that can hold up to 4,000 shift steps. The following

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parameters control PSK modulation: shifted phase, baud, shift data array, and marker placement.

mod:type fhop This selects the frequency hop modulation. The frequency hop sequence is created in a data table that can hold up to 5,000 frequency hops. The following parameters control frequency hop modulation: dwell mode, dwell time, frequency data list, and marker placement.

mod:type ahop This selects the amplitude hop modulation. The amplitude hop sequence is created in a data table that can hold up to 5,000 amplitude hops. The following parameters control amplitude hop modulation: dwell mode, dwell time, amplitude data list, and marker placement.

mod:type 3d This selects 3D modulation. This is a special mode that modulates frequency, amplitude, and phase simultaneously. You may set the modulation profile externally through applications such as ArbConnection.

Modulation Parameters

The previous section details the modulation schemes and lists the parameters that control the modulating signals. A complete listing of the modulation control parameters is given in the Programming Reference in this manual.

To program the sweep parameters, use the following commands:

swe:star <value> Set the starting frequency for the sweep.

swe:stop <value> Set the ending frequency for the sweep.

swe:time <value> Set the amount of time that will elapse from the start to the end of the sweep.

swe:dir up Set the sweep direction to “up” (from the start frequency to the stop frequency).

swe:dir down Set the sweep direction to “down” (from the stop frequency to the start frequency).

swe:spac lin Select linear sweep steps, where the generator steps the frequency through the sweep range in linear increments.

swe:spac log Select logarithmic sweep steps, where the generator steps the frequency through the sweep range in logarithmic increments.

swe:mark <value> Define marker position. The marker will generate a pulse at the SYNC output when the marker frequency setting is crossed.

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Controlling the Carrier Frequency

In general, when you select a modulation scheme, the waveform being modulated (the carrier) is always a sine wave. When you select the modulation function but set the modulation type to “Off”, the output generates an un-modulated, continuous waveform (CW) signal. The frequency setting of the carrier in modulation mode is not the same as for standard waveform mode and must be programmed separately. Use the following command to program the carrier frequency:

mod:carr <value> Set the CW frequency in units of Hz. The same value will be used for all modulation functions.

Controlling the Carrier Base Line

As explained above, the Advanced Trigger mode allows the 3152B output to “idle” when it has finished a waveform segment and is waiting for the next trigger event. The output signal during this time is called the *baseline*.

The 3152B offers two options for the base line:

1) Carrier (un-modulated, CW carrier)
2) DC Level

Use the following command to control the carrier base line:

mod:carr:bas carr Selects continuous wave (CW) when the modulated function idles between trigger events.

mod:carr:bas dc Selects continuous DC level when the modulated function idles between trigger events.

Using the Digital Pulse Generator

The digital pulse generator function provides a way to set up pulse trains and associated parameters in units of time.

The pulse train is built in the same memory that stores arbitrary waveforms. Therefore, changing from arbitrary to digital pulse mode, and vise-versa, may overwrite arbitrary waveforms that were previously downloaded. Use the command below to select the digital pulse function:

func:mod dpul Selects the digital pulse function. If you have not changed parameters, then the output will generate a single pulse with the following default settings: 10 ms period, 0-5 V amplitude, 10 ms high time, 1 ms rise time, and 1 ms fall time.

From this point, you may change one or more of the pulse parameters while the signal is being output. Since the pulse is

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generated digitally, the pulse shape will be computed again each time you change a parameter. This may be visible as a glitch on the pulse train as the new waveform is loaded into the waveform memory.

You can adjust the pulse characteristics only if all of its parameters can be adjusted both in the time and amplitude domain. The 3152B provides the necessary controls to do that. However, note that the pulse is generated digitally, and therefore has some limitations to observe. These limitations are discussed later in this chapter.

Below is a list of commands that control pulse parameters.

dpul:per <value>	Defines the repetition rate of the pulse. The period is programmable, starting at 80 ns.
dpul:high <value>	Sets the high time, which is defined as the amount of time the signal is at the high point. This is not the same as pulse width which is measured at 50% of the amplitude level. The high time is measured at the top of the pulse.
dpul:del <value>	Sets the delay time. The delay defines the time the pulse is delayed from its starting point to the first transition. The delay time is computed as part of the pulse period. Therefore, if you do not plan to have a delayed pulse, set the delay value to 0 s.
dpul:rise <value>	Sets the rise time, defined as the time it takes for the pulse to transition from its low level to its high level. This should not be confused with the common measure of rise time from 10% to 90% of amplitude. Rise time, as set by this command, is computed as part of the pulse period and therefore, if you do not plan to have linear transitions, change its value to 0 s.
dpul:fall <value>	Sets the fall time, defined as the time it takes for the pulse to transition from its high level to its low level. This should not be confused with the common measure of fall time from 90% to 10% of amplitude. Fall time, as set by this command, is computed as part of the pulse period and therefore, if you do not plan to have linear transitions, change its value to 0 s.
dpu:lev:high <value>	Sets the high amplitude level, which is the top amplitude level of the pulse. The value must be at least 16 mV larger than the low level setting and must not exceed +16 V.
dpu:lev:low <value>	Sets the low amplitude level, which is the bottom amplitude level of the pulse. The

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value must be at least 16 mV smaller than the low level setting and must not be below -16 V.

There are other parameters that control double pulses, pulse polarity, and others. Refer to the programming section of this manual for a complete listing of the digital pulse commands.

Pulse Design Limitations

Since the 3152B creates pulses digitally, there are inherent limitations to these pulses:

1. Step size determines resolution and period.
The 3152B creates pulses digitally using a sample clock generator that clocks memory points. The rate of the sample clock defines the incremental resolution. For example, suppose you wish to generate pulses at a 100 ms pulse rate with 1 ms high time and the rest of the period low. In this case, you could select a 1 kS/s or 10 kS/s clock rate because this is fast enough to generate a high signal of 1 ms using just 100 to 1,000 memory points. However, if you wanted to define much smaller pulse widths at larger pulse rates, then the number of required points would increase as a function of the period. The limitation is set by the availability of waveform memory.

2. Sum of pulse parameters cannot exceed the period.
The 3152B will automatically check to determine whether the sum of all timing components exceeds the period. Always start your pulse design by assigning the correct pulse period, and then work your way down the parameters list.

3. Only single-pulse and double-pulse trains can be designed.
The 3152B allows generation of single or double pulse patterns having fixed high and low amplitude values. If you need to design complex trains of pulse waveforms, you may do so using the Pulse Composer in ArbConnection. The pulse composer allows creation of complex pulse trains with varying amplitude, shape, and number of pulses.

Generating Half Cycle Waveforms

The Half-Cycle function is a special case of standard waveforms, except that the waveforms are generated a half cycle at a time and displaced by a programmable delay time. In continuous mode, the half cycles are generated continuously. In triggered mode, one half at a time is generated only after a valid trigger event is received. There are three half-cycle waveforms that can be generated: Sine, Triangle, and Square. Use the commands below to select the half-cycle function and program the parameters.

func:mod half Selects the half-cycle function. If you have not changed parameters, then the output will

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generate half-cycle sine waveforms where the halves are separated by 1 μs delay intervals.

From this point you can change one or more of the half cycle parameters just as they would be programmed for the standard waveform generator. Use the following commands to select one of the half cycle waveforms:

half:shap sin	Selects the sine waveform to be generated using the half cycle function.
half:shap tri	Selects the triangular waveform to be generated using the half cycle function.
half:shap squ	Selects the square waveform to be generated using the half cycle function.

After you select the function and waveform, you may program other parameters to adjust the waveform specifically for your application. You may adjust the start phase for the sine and triangular waveforms, or the duty cycle for the square waveform, and you may program the amount of delay between the half cycles.

Chapter 5 contains programming references that will allow you to program all of the half cycle parameters.

Using the Counter/Timer

You may use the 3152B as a counter/timer instrument. When using this function, you may select the measurement function, gate time, and trigger level, and then hold the measurement until you require a reading. The reading is then taken and passed to the host computer for processing.

The 3152B cannot perform as a counter/timer and generate waveforms at the same time. When placed in counter/timer mode, all waveform patterns are purged from the waveform memory, and the 3152B can be used only for measurements.

The counter/timer function provides a means of measuring frequency and timing characteristics of external signals. Use the commands given below to select the counter/timer mode and set up a measurement function.

func:mod coun	Selects the Counter/Timer allowing frequency and time measurements on external signals.

Once you have selected the Counter/Timer mode, you may select the specific measurement function. Available functions include:

- Frequency
- Period
- Period averaged

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- Pulse Width
- Totalize (counts the number of trigger events)

Use one of the following commands to select the measurement function:

coun:func freq	Selects the frequency measurement function. The 3152B takes readings continuously and places them in the output queue, waiting for a read operation to clear the queue for the next reading.
coun:func per	Selects the period measurement function.
coun:func aper	Selects the averaged period measurement function.
coun:func puls	Selects the pulse width measurement function.
coun:func tot	Selects the totalize function. The counter will detect and count all trigger events from the trigger input.

You may adjust the gate time and display mode. If you want to take continuous counter readings, use the default display mode as follows:

coun:disp:mod norm	Enables continuous measurements and read cycles.
coun:disp:mod hold	Stops the measurement cycle and performs a single measurement when triggered by a read operation. The next measurement cycle may be performed after you clear the counter buffer using the following command:
coun:res	Resets the counter, clears the output queue, and arms the counter for its next measurement event.

Chapter 5 contains programming references that will allow you to program all of the counter/timer parameters.

Counter/Timer Limitations

A summary of counter/timer limitations is given below.

1. Measurement speed

The rate at which the counter performs its measurements depends upon the display mode setting. The Normal setting simulates the display of a bench-top instrument, where the user sees the result of each measurement as it completes. The display time is roughly 300 ms, allowing enough time to check the result after each gate time cycle. The maximum rate is three measurements per second when using low-period gate times. The Hold display mode allows one reading at a time. The reading starts when the input senses a

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valid trigger signal, and ends after the gate has closed. Processing time for the reading and the display is roughly 100 ms. In this mode, the counter can take a maximum of ten readings per second.

2. Gate time period must be higher than the signal period
The gate must open for an interval that allows enough transitions to pass through the counter gate. If the gate time is too short to measure a signal, the gate will open, but no results can be obtained.

3. Auxiliary functions disable waveform generation
When the Counter/Timer mode is selected, all operations of the waveform generator are stopped, and the waveform memory is purged.

Synchronizing through the Local Bus

Use the following commands to set up and control synchronization (phase locking) of two modules through the Local Bus:

inst:coup:path lbus	This sets the coupling (synchronization) path to the Local Bus (LBUS). This command must be sent to the master module and the slave module(s).
inst:coup:mode mast	Send this command to the 3152B that will be the master module to which other modules will be phase-locked.
inst:coup:mode slav	Send this command to the slave module(s) that will be phase locked to the master module.
inst:coup:stat on	Send this command to the master module, and then to the slave module. It enables coupling (phase locking).

Example:

The following procedure sets up a 3152B module as the master, sets up another 3152B module as the slave, and monitors the outputs of both modules to observe that they are phase locked.

1. Install Local Bus jumpers on both 3152B modules (refer to Chapter 2, in the Local Bus Configuration section).

2. Install the two modules into adjacent slots in a VXI chassis. The 3152B on the left will be the master, and the 3152B on the right will be the slave.

3. Turn on power to the VXI chassis.

4. Connect the output connector of the left module (master) to channel 1 of the oscilloscope.

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5. Connect the output connector of the right module (slave) to channel 2 of the oscilloscope.

6. Send the following commands to the left module (the master):

   inst:coup:mode mast
   inst:coup:path lbus
   inst:coup:stat on
   outp on

   This configures the module as a master, selects the Local Bus (LBUS) as the coupling path, turns coupling on, and then turns on the output. At this point, the oscilloscope (channel 1) will show that the master module is generating a waveform. Since the frequency and amplitude were not commanded, the waveform will have the default amplitude ($5V_{P-P}$) and the default frequency (1MHz). The master module is also sending the synchronization signals onto the LBUS.

7. Send the following command sequence to the right module (slave):

   inst:coup:path lbus
   inst:coup:mode slav
   inst:coup:stat on
   outp on

   This selects LBUS as the coupling path for phase locking, sets up the module as a slave to be phase-locked to the master, turns coupling on (enables phase locking), and then turns on the output.

After the above steps have been performed, channel 2 on the oscilloscope will show that the slave module is generating the default waveform: a $5V_{p-p}$ sine wave. By comparing the displays of channels 1 and 2 on the oscilloscope, it is verified that the two 3152B units are in-phase.

Using the 3201A/3202A Signal Amplifier

The 3201A and 3202A Signal Amplifiers, available in Models 3100M and 3100R, provide amplification for driving up to 20 Vp-p into loads as low as 50 Ω. These amplifiers do not generate waveforms themselves, but simply amplify low-voltage signals from the 3152B module. They provide a fixed gain of 10.

Use a coaxial cable to connect the 3152B output to one of the 3201A/3202A amplifier inputs. The 3201A/3202A will then route the amplified signal and route it to the 3201A/3202A output connector.

Models 3201A and 3202A may be used as summing amplifiers.

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Each channel has two input connectors, and sums the two signals before amplifying.

Connecting the 3202A/3202A Signal Amplifier

3201A Single-channel Amplifier: Use an external coaxial cable to connect the 3152B output to the 3201A input. You may use either of the two 3201A input connectors: BNC or SMB. If you connect signals to both connectors, then the 3201A/3202A will amplify the sum of the signals. If you are amplifying only one signal, leave the unused connector open (unconnected).

3202A Dual-channel Amplifier: Use an external coaxial cable to connect the 3152B output to either of the two 3202A channels. Use either the BNC or SMB connector for Channel 1. Use either of the two SMB connectors for Channel 2. If you connect signals to both connectors of the same channel, then the 3201A/3202A will amplify the sum of the signals. Leave all unused connectors open (unconnected).

Controlling the 3201A/3202A Output

The 3201A/3202A amplifies its input signals and provides the result at its output connector at all times. There are no commands or different states for the 3201A/3202A.

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Chapter 4
ArbConnection

What's in This Chapter

This chapter explains how to install, invoke, and use the ArbConnection application. It provides instructions for programming instrument controls and parameters, creating waveforms, and downloading waveforms to the 3152B.

What is ArbConnection

ArbConnection is a utility program that aids in controlling the 3152B from a remote computer. It provides three types of functions:

- Front panel control. Through a simulated front panel, you can control the 3152B in much the same manner as a bench-top instrument.
- Waveform generation and editing. Using drawing tools and equations, you may define and edit arbitrary waveforms.
- Downloading. After you define a waveform, you may download it to the waveform memory on the 3152B.

System Requirements

To use ArbConnection, you need the following:

1. Computer, Pentium III or better
2. Windows 2000/XP/Vista, or higher
3. Screen resolution of at least 1024 x 768 pixels
4. Pointing device, mouse, or trackball
5. National Instruments VISA, version 2.6 or higher, or equivalent

Installing ArbConnection

Before you install ArbConnection, make sure that there is at least 10 megabytes of available space on your hard disk.

Installation of ArbConnection requires the visa32.dll runtime engine. You may download the latest version of this file from National Instruments' web site, **www.ni.com.**

After downloading this file, move it to your Windows system folder. Then run the "setup.exe" file on the ArbConnection installation CD. The installation program installs ArbConnection on a logical drive of your choice (the default is drive C:). It automatically creates a new

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folder and copies the files that are required to run the program. Then it creates a workgroup and icons to start ArbConnection.

Startup & Communication Options

Invoke ArbConnection by double-clicking the icon on the desktop. If you cannot find the icon on your desktop, click on Start -> Programs -> ArbConnection. The “Startup & Communication Options” dialog box displays as shown in Figure 4-1.

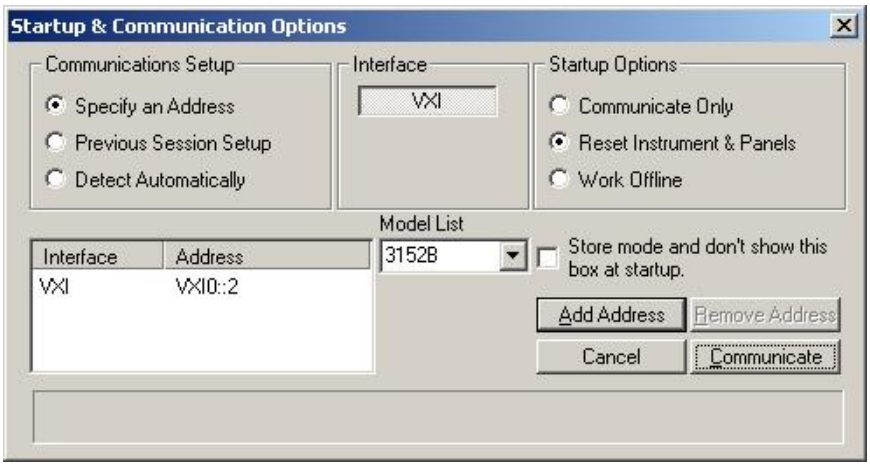


Figure 4-1, Startup & Communication Options Dialog Box

If desired, you may check the “Store mode and don’t show…” box to prevent this dialog box from displaying every time you invoke ArbConnection.

The purpose of this dialog box is to configure the program to communicate properly with the 3152B. For example, if you are using a GPIB device that has address 4, you may click “Specify an Address” and then enter the required address. Then, ArbConnection will automatically use the specified address each time it starts up.

If you choose not to have this dialog box displayed automatically at startup, you may still access and change the options from the System command, at the top of the ArbConnection window.

Make your selection and then click “Communicate.” The “Startup & Communication Options” dialog box will close, and the main window displays.

ArbConnection Features

ArbConnection provides complete control over all features of the 3152B. Using ArbConnection, you may set up the 3152B to generate waveforms from sources such as the built-in library of standard waveforms, arbitrary waveforms from user-downloaded coordinates, modulated waveforms, and digital patterns. You may also access these features through software utilities such as VXI*Plug&Play* drivers and soft front panels.

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Main Window

The main window includes a standard Windows menu bar at the top (Figure 4-2). It provides access to operations such as loading and saving files, setting viewing options, and configuring the 3152B.

The Link bar is immediately below the menu bar. The Link bar provides direct access to instruments that are active on the interface bus. ArbConnection can control a number of instruments, such as the Model 3152B, simultaneously. If you connect an instrument while ArbConnection is running, ArbConnection automatically detects the instrument and adds its name and associated address to the drop-down list in the Link bar. If you run ArbConnection in offline mode, the Link bar will show "3152B, Offline."

The Panels toolbar is shown in Figure 4-3. By clicking the buttons on the Panels toolbar, you may access the corresponding virtual control panels (detailed later in this chapter). When you launch ArbConnection, the Output panel is initially open.



Figure 4-2, ArbConnection Menu and Link Bar

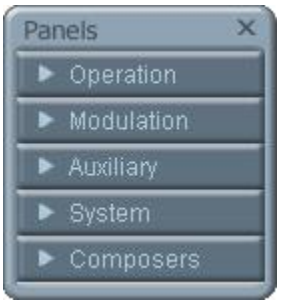


Figure 4-3, Main Panels Toolbar

Control Panels

Each control panel replicates the look and feel of a bench-top instrument's front panel. Refer to the Output panel in Figure 4-5. Other panels are similar, so the following description of the Output panel serves as guide for controlling the rest of the panels.

Looking at Figure 4-5, identify the following controls and indicators:

- Pushbuttons
- LEDs
- Radio buttons
- Dial
- Digital display

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The functions of these are as follows:

Pushbuttons – Clicking the mouse on a pushbutton toggles an option on and off. For example, clicking the State button in the Output section turns the 3152B output on. To help indicate this, the button then appears as though pushed in, and a red bar at the center of the button appears to be illuminated. Clicking the Output button a second time turns off the output, and then the button no longer appears pushed in or illuminated.

LEDs –LEDs indicate which of the parameters are displayed on the digital display. A red LED indicates that the parameter name next to this LED is selected. Only one LED can be "on" at a time.



HINT

To turn on an LED, click on the LED or on the text next to it. The selected parameter is then indicated by a darker LED shade.

Radio Buttons – Radio buttons are used for changing operating modes, or selecting between mode options. One of the radio buttons is always "on", with a red dot in its center to indicate its state. These are referred to as "radio buttons" because only one can be on at a time, as with a radio that has preset buttons.

Dial – The dial is a tool for adjusting a number in the display area. To use the dial, point to it with the mouse and then press and hold the left mouse button. While holding the mouse button down, move the mouse in a clockwise circle to increase the displayed number, or counterclockwise to decrease the number. The dial modifies digits at the cursor position, and allows modification within the legal range of the displayed parameter. Once you have reached the end of the range, further dial movement has no effect on the display. You may also change the display reading without the dial by using the [↑], or [↓] keys, or by simply typing the desired number using the computer keyboard.



NOTE

After you change the displayed number, the 3152B will be updated with the new parameter only after you click on the Modify/Execute knob.

Digital Display – The digital display is a tool for displaying various 3152B parameters, just as on a physical control panel.



Note

The normal color of a displayed number is dark blue. If you modify the number, its color changes to a lighter

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shade of blue, indicating that the 3152B has not been updated yet with the new value. Clicking on the Modify/Execute knob will update the instrument and restore the color of the digital readout to dark blue, indicating that the actual 3152B setting now matches the displayed number.

Also note that the digital readout has an auto-detect mechanism for high and low limits. You cannot exceed the limits when using the dial, but you may if you use the keypad. If you enter a number that exceeds the limits, ArbConnection will not let you update the instrument with the setting until you correct it.



Figure 4-4, Operation Panel Selection

The Operation Panels

The Operation panels provide control over the basic operation of the 3152B. From these panels, you may select the output function and run mode, turn the output on and off, and adjust parameters for various functions. There are five panels in this group:

- Output
- Run Mode
- Standard
- Arbitrary/Sequence
- Half Cycle

The Output panel is always visible because this is the panel that controls operating functions, run modes and sets the outputs on and off. You may hide or show other panels by clicking the appropriate item under “Operation” (Figure 4-4).

The Operation panels are detailed in the next section.

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Output

ArbConnection displays the Output panel, shown in Figure 4-5, automatically. The buttons and LEDs are arranged in the following groups:

- General Parameters. These controls adjust amplitude and offset.
- Wave Mode. This group lets you select the waveform mode.
- Run Mode. These controls are for selecting the Continuous mode or one of the interrupted modes (Trigger, Gated, or Burst).
- PLL. These controls enable and disable phase locking, and select the source signal.
- Sync Output. This group enables and disables the sync signals on the VXIbus backplane and front panel, selects the sync qualifier, and allows you to adjust the sync pulse position and width relative to the waveform.
- Output. These controls are for turning the output signal on and off, and for selecting the load impedance.



Figure 4-5, Output Panel

When you click on a button, the 3152B responds immediately. When you change a numeric parameter on the display, the 3152B does not respond until you click on the Modify/Execute knob to update the instrument.

Some controls in this panel also appear in other panels. When you change a parameter in this panel, the other panels are updated automatically.

The functional groups listed above are explained in detail below.

General Parameters

The General Parameters group contains two parameters: Amplitude and Offset.

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To access a parameter, click on its name. The LED next to the parameter then changes to “on” and the display shows the current value. You may use the dial, keyboard, or [↑] and [↓] keys to adjust the value. After you change the value, click on the Modify/Execute knob to update the 3152B.

Wave Mode

The Wave Mode group is used for selecting which of the available waveforms will be generated at the output connector. The 3152B provides five types of waveforms: Standard, Arbitrary, Sequenced, Modulated, and Half Cycle. Click one of these buttons to select the waveform type. The default function type is Standard. If you want to change the Standard waveform parameters, you may select Standard from the Panels bar.

Run Mode

Using the controls in the Run Mode group, you may select Continuous mode or one of the interrupted modes (Triggered, Gated, or Burst). There is no additional panel for Continuous mode, but if you click one of the other run mode options, then you may adjust the trigger parameters from the Trigger panel.

PLL

The PLL group is used for turning the PLL function on, selecting the reference source, and for adjusting the PLL offset.

SYNC Output

SYNC Output group has buttons that control the state of the SYNC output and the position and width of the sync pulse relative to the waveform. It also has buttons to control the VXIbus backplane TTLTrg0-7 and ECLTrg1 outputs and the sync validation source. Click on the State buttons to toggle the outputs on and off.

The operation of the SYNC output is explained in Chapter 3. Note that the position parameter affects the output only when placed in BIT, LCOM, or Pulse mode, and the width affects the output only when Pulse mode is selected.

Output

The Output Control group controls the state of the main output only. Click on the State buttons to toggle the outputs on and off.

The load impedance button allows you to calibrate the output amplitude to compensate for the actual load impedance value. The default impedance is 50 Ω, and the output level is adjusted in reference to this value. If the actual load impedance is higher than 50 Ω, make sure the impedance setting matches the actual load impedance.

Run Mode

To work with the Run Mode Control Panel (Figure 4-6), click on the Run Mode button on the Panels toolbar. Note that when you invoke the Run Mode Control Panel, the trigger mode does not change. To change the run mode, use the Output panel. The trigger parameters and settings in the Run Mode Control Panel take effect only if you

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have selected an appropriate run mode.

The Run Mode Control Panel has its controls divided into the following groups:

Trigger Modifier
The Trigger Modifier group provides control over the retrigger interval and delay time.

To change the trigger delay or the re-trigger interval, click on one of these parameters. The digital display then shows the current value, which you may adjust using the dial, keyboard, or the [↑] and [↓] keys. After you adjust the value, click on the Modify/Execute knob to update the 3152B.



Figure 4-6, Run Mode Control Panel

Trigger Source
The 3152B accepts triggers from a number of sources: Bus, VXI Backplane (TTL Trigger 0 through 7 and ECL Trigger 1), External, and Internal. The VXI backplane trigger lines can synchronize operation with other devices residing in the VXIbus chassis.

The various trigger source options are:

Bus – Disables all trigger inputs and allows software triggers only.

External – Enables the front panel trigger input and disables all other sources.

Internal – Enables an internal, non-synchronized trigger generator, but will not allow triggers from any other sources.

TTLT0-7 – Enables one or more backplane trigger lines. Note that the 3152B can receive triggers from more than one TTLTrg line, but will not accept triggers from bus, external, or internal trigger sources.

ECLT1 – Enables the ECLTrg1 input and will allow trigger events from this backplane line.

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Trigger Parameters

Gated Mode: There are two modes that define how the 3152B will gate. The standard mode is Level, in which a selectable level (high or low) on the trigger signal enables the output. The other mode is Transition, in which each transition toggles the gate on or off. The level or transition direction is programmable using the Slope options.

Slope: If you click on “Pos”, the instrument triggers on the positive-going (rising) edge of the trigger signal. Similarly, if you click on “Neg”, the instrument will trigger on the negative-going (falling) edge of the trigger signal. Note that this affects only the signals that are accepted from the front panel trigger input.

Burst: Programs the burst counter for burst mode. Once triggered, the 3152B outputs a series of output waveforms that ends when the burst counter reaches the specified count.

Timer: The Timer button lets you set the trigger period of the free-running internal trigger generator. The internal trigger timer is programmed in units of seconds. Note that the internal trigger generator function is available in Pulse mode only. Other output functions use the re-trigger generator, which has a meaning different from that of the internal trigger period. Information on the Re-trigger mode is given in Chapter 3.

Trigger Level: Programs the trigger level parameter. Depending on the slope setting, the 3152B will be triggered to output waveforms when the trigger level threshold has been crossed.

Manual Trigger

The TRIG button operates only in conjunction with the BUS mode. Press the TRIG button to trigger the instrument as if an external trigger has been applied.

Standard

The Standard Waveforms Panel (Figure 4-7), is accessible after you click on the Standard button in the Panels bar. The Standard Waveform Panel groups allow adjustment of channel control, parameters, 10 MHz reference, and waveforms. The functional groups in the Standard Waveforms panel are described below.

General Parameters

The General Parameters group has controls for Amplitude and Offset. The values you set in this panel may be duplicated on other panels, so whenever you change amplitude and offset in the Parameters group, the other panels update automatically.

To access the required parameter, click on the parameter name. The indicator next to the required parameter highlights. The digital display then shows the value associated with the highlighted indicator. Use the dial, keyboard, or the [↑] [↓} keys to adjust the reading to the required setting. After you modify the reading, click on the Modify/Execute knob to update the 3152B with the new reading.

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Figure 4-7, Standard Waveforms Panel

Waveforms

The Waveforms group provides access to a library of built-in standard waveforms. The library includes Sine, Triangle, Square, Pulse Ramp, Sinc, Exponential, Gaussian, and DC waveforms. Each waveform has one or more parameters to adjust the required characteristics of the output. For example, phase start can be adjusted for the sine and triangle waveforms, and duty-cycle can be adjusted for the square waveform. For the pulse waveform, you may adjust the rise and fall time, as well as the width and delay. Parameters associated with each waveform are automatically displayed when you select the waveform.

Note that by clicking a button in this group, you immediately update the 3152B output with this waveform shape.

Parameters

The parameters group contains buttons that control the output frequency and the 10 MHz reference source.

The Frequency control lets you set the output frequency of the selected waveform shape. When this control is selected and highlighted, you may modify it using the dial, keyboard, or [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, click on the Modify/Execute knob to update the 3152B with the new value.

10 MHz Ref – The 10 MHz group contains buttons that control the source of the 10 MHz reference for standard waveforms. The 10 MHz clock is the reference that feeds the sample clock and the DDS clock, and therefore determines accuracy and stability. The internal 10 MHz source has 1 PPM stability over the operating temperature range, and a time stability of 1 PPM per year). The accuracy of the internal source is adjustable, but will shift with time and temperature.

When better accuracy or stability is required, or when clock synchronization to other devices is necessary, you may select

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another source. The 10 MHz source options are:

- Internal: from the built in source
- External: applied to the front panel 10 MHz input connector
- CLK10: Available on the VXI backplane. The CLK10 source has the least accuracy and stability of the three options, but is useful for synchronization with other VXI modules.

Arbitrary/Sequence

To access the Arbitrary/Sequence panel, click the Operation button on the Panels bar (Figure 4-8). Then click the Arbitrary/Sequence button that drops down below the Operation button. The Arbitrary/Sequence panel will then open).

Note that if you invoke the Arbitrary/Sequence Panel from the Panels menu, the 3152B will not change its output type. On the other hand, if you select the Arbitrary or Sequenced option from the Main Panel, the 3152B will immediately change its output to the selected waveform type.

The functional groups in the Arbitrary Waveforms Panel are described below.

General Parameters

The General Parameters group contains two parameters: Amplitude and Offset. The values in this group may be duplicated on other panels. When you change amplitude or offset in the Parameters group, the other panels are updated automatically.

Sync Type

The available two types of synchronization are Bit and LCOM.

SCLK

The SCLK (Sample Clock) controls let you select the source of the sample clock and set the sample clock frequency. The sample clock setting affects the 3152B in Arbitrary mode only. It is programmed in units of samples per second (S/s), and will affect the instrument only when it is programmed to output arbitrary or sequenced waveforms. The SCLK parameter has no effect on the frequency of standard waveforms.

The three switches in the SCLK group set the sample clock input to Internal, External, or ECLT0. The default is Internal. When you select External, make sure an appropriate signal is connected to the external sample clock connector on the rear panel. The ECLT0 source is a backplane signal that allows ECL level signals to travel to all VXI modules.

Click on the SCLK button to access the SCLK parameter. The value that is associated with the highlighted indicator appears on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the SCLK setting. After you modify the setting, click on the Modify/Execute knob to update the 3152B with the new reading.

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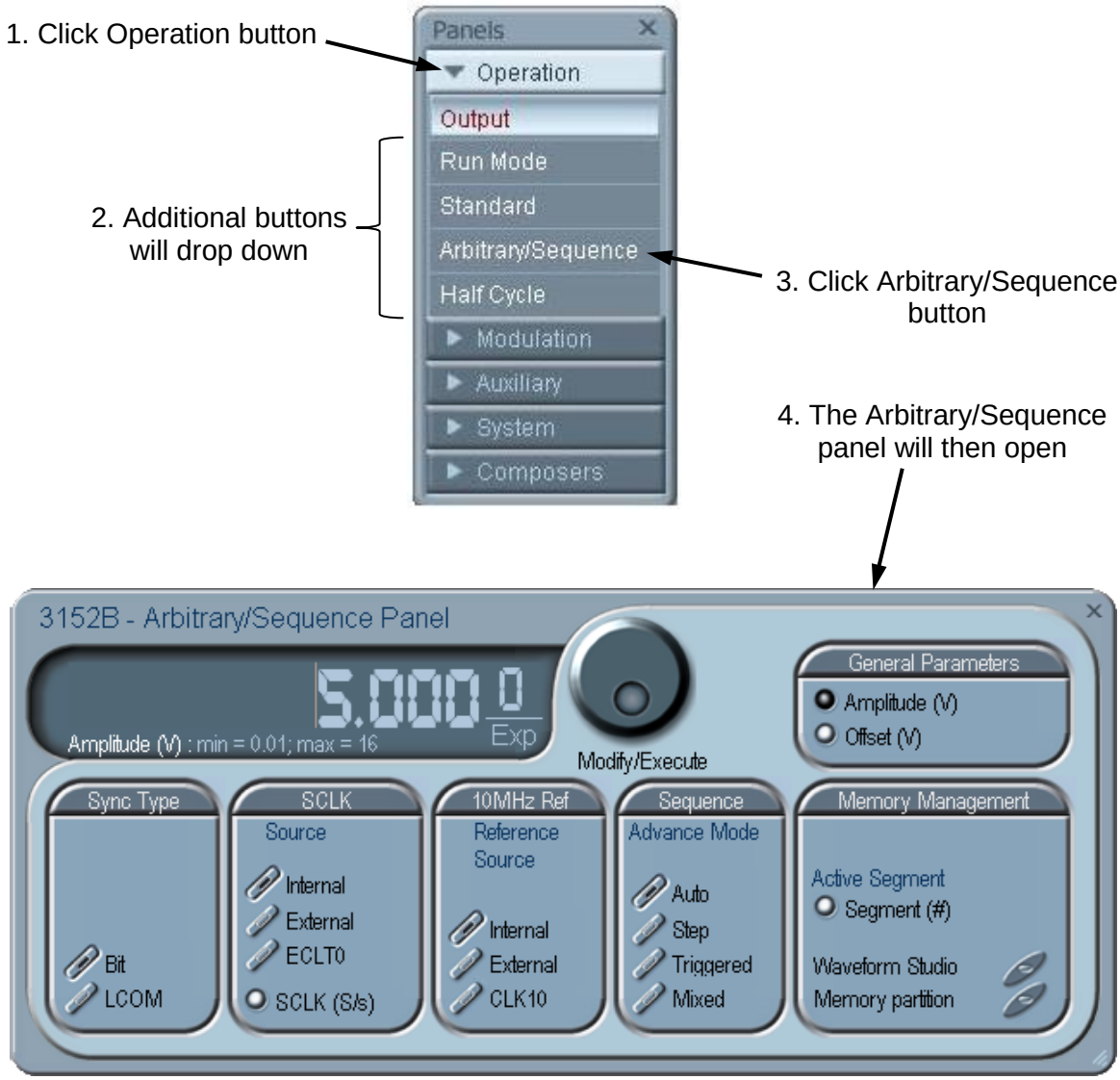


Figure 4-8, Arbitrary/Sequence Panel

10MHz Ref

The 10 MHz Ref group contains buttons that select the source of the 10 MHz reference for standard waveform. The 10 MHz clock is the reference that feeds the sample clock and the DDS clock, and therefore determines accuracy and stability. The internal 10 MHz source has 1 PPM stability over the operating temperature range, and time stability of 1 PPM per year. The accuracy of the internal source is adjustable, but will shift with time and ambient temperature.

When better accuracy or stability is required, or when clock synchronization to other devices is necessary, you may select another source. The 10 MHz source options are:

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- Internal: from the built in source
- External: applied to the front panel 10 MHz input connector
- CLK10: Available on the VXI backplane. The CLK10 source has the least accuracy and stability of the three options, but is useful for synchronization with other VXI modules.

Sequence

The Sequence Advance Mode group provides control over advanced modes for the sequence generator. Advanced options include Auto, Stepped, Single, and Mixed. Refer to Chapter 3 for details about these advanced modes.

Memory Management

The Memory Management group contains three parameters: Segment, Waveform Studio, and Memory Partition.

The Segment parameter provides access to the active segment for each channel. To access the required segment, click on Segment (#). The adjacent indicator is then highlighted and the digital display shows the current segment number. You may use the dial, keyboard, or the [↑] [↓} keys to select a different segment. After you modify the setting, click on the Modify/Execute knob to update the 3152B with the new setting.

The Waveform Partition button opens a screen as shown in Figure 4-9. The Waveform Studio button opens the screen shown in Figure 4-10. Instructions for using these screens are given in the following paragraphs.

Using the Memory Partition Table

Refer to Chapter 3 for more information about waveform memory and segment control. In general, the 3152B generates arbitrary waveforms, but they must first be downloaded from the host computer to the 3152B waveform memory.

You do not have to use the entire memory when you download a waveform. Model 3152B allows memory segmentation, so that up to 16 k smaller waveforms may be stored in this memory.

There are two ways to divide the waveform memory into segments:

- Define a segment and load it with waveform data, define the next segment and load with data, etc.
- In ArbConnection, make up one long waveform that contains many smaller segments, download it to the instrument in one operation, and then download a memory partition table that splits the entire waveform memory into the required segment sizes.

To use ArbConnection to download one long waveform and then segment it into smaller sections, follow this procedure:

- Click Memory Partition. The dialog box shown in Figure 4-9 appears.

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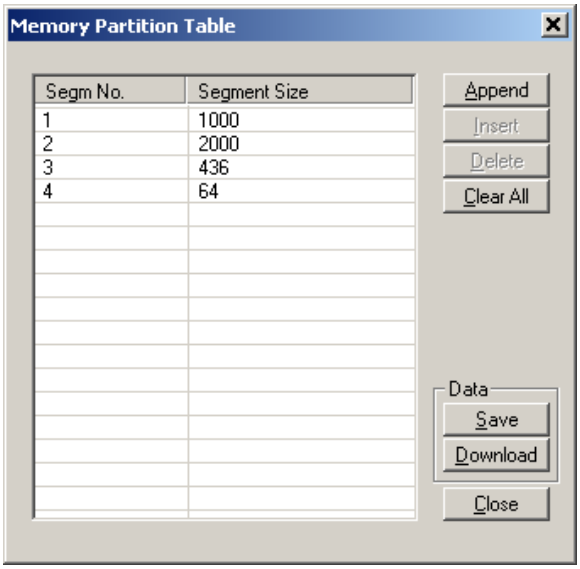


Figure 4-9, Memory Partition Table

The two main fields in the segment table are “Segm No.” (segment number) and “Segment Size”. “Segm No.” is an index field that can have values from 1 to 16 k. The segment size is always associated with the segment number. You may program any segment size from 16 (10 in legacy mode) to the capacity of the memory.

Click on the Append button to add a segment at the end of the segment list. If you click a segment, it will highlight, and the Append button becomes an Insert button. Use the Insert button to insert a segment before the highlighted segment. Use Delete button to delete the highlighted segment.

The Clear All button removes all segments from the table and lets you start a new segment table.

Click on the Close button discard of the contents of the dialog box without saving your last actions, and to remove the Segment Table from the screen.

The Save button saves the current session so that you may continue to configure the Memory Partition table from the same point later on. The Download button updates the 3152B with the present segment table settings.

TIP

The Memory Partition table does not download waveforms. Use the memory partition table only if you have merged multiple waveforms into one. The purpose of the partition table is to divides the memory contents into separate segments, each containing a waveform. If you download waveforms using Waveform Studio, then the memory is already segmented for the waveforms,

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and there is no need to use the memory partition table.

Using Waveform Studio

Waveform Studio (Figure 4-10), provides access to waveforms that are already stored as files in the host computer. You may download waveforms from such files to various segments in the 3152B waveform memory, and later use them as individual waveforms or combine them into complex sequences.

Waveform Studio has a Segment Table section and a Sequence Table section, as described below.

Segment Table

Using the segment table, you may list and download waveform files that are stored on the host computer. For each waveform, the table shows the segment number, associated file name, length, and download status. You may also download waveforms to memory segments using Wave Composer or individual function calls, but Waveform Studio makes the process easy by combining multiple and complex commands into one simple dialog box.

To access the segment table, click anywhere in the Segment Table area. It will then turn white.

The Segment Table area is divided into three parts: the table area, the waveform shape area, and control buttons. When you click one of the waveforms, the Waveform Shape window displays it.

The Segment Table has four fields:

The “Seg” field contains numbers from 1 through 2,048, designating the programmed memory segment. Note that memory segments are numbered from 1 to 16 k.

The State field shows the current status of the memory segment. It can be *Free*, if no file has yet been assigned to this segment number, or *Mapped*, if file name has been assigned to the segment but the Download button has not been used yet to move the file to the 3152B memory, or *Loaded*, if the process has been completed by pressing either the Download button or the All (download all) button.

The File field is an edit field that lets you browse and select file names to be applied to a specific memory segment. To change or add file name, point and click on the File name field and either type your path or browse to the file location and let Windows find the right path.

The Length field displays the length of the selected memory segment. Memory segments size may be programmed from 16 to the maximum size of your installed memory. Note that the length field is not accessible and shown for reference purpose only.

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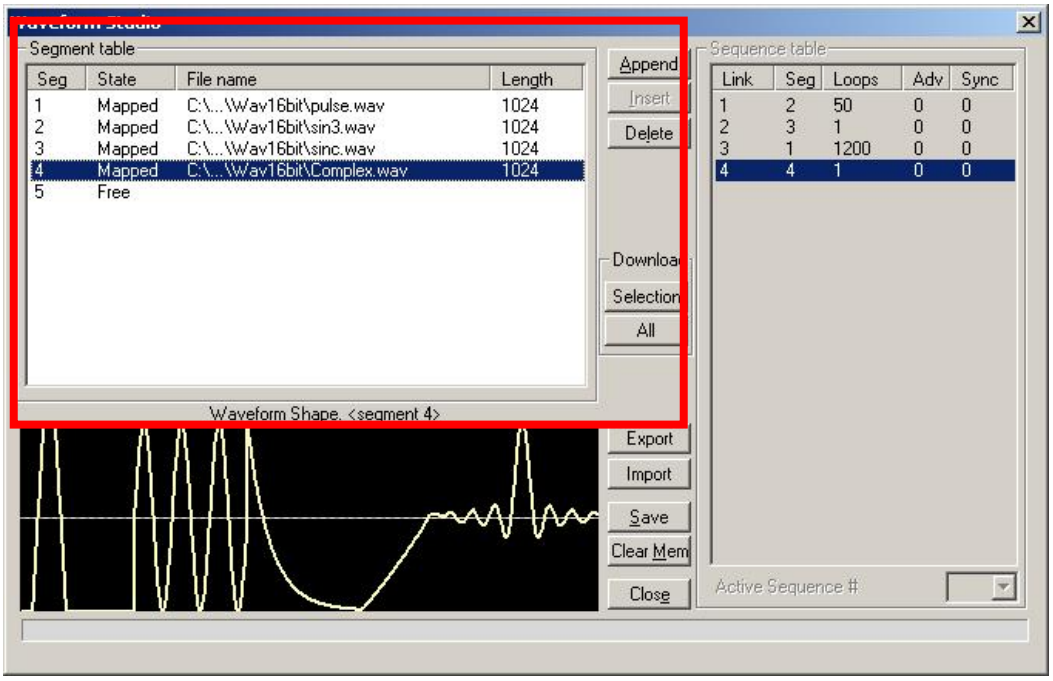

Segment table
Seg State File name Length
1 Mapped C:\...\Wav16bit\pulse.wav 1024
2 Mapped C:\...\Wav16bit\sin3.wav 1024
3 Mapped C:\...\Wav16bit\sinc.wav 1024
4 Mapped C:\...\Wav16bit\Complex.wav 1024
5 Free
Waveform Shape, <segment 4>
Append
Insert
Delete
Download
Selection
All
Export
Import
Save
Clear Mem
Close
Sequence table
Link Seg Loops Adv Sync
1 2 50 0 0
2 3 1 0 0
3 1 1200 0 0
4 4 1 0 0
Active Sequence #

Figure 4-10, Waveform Studio

TIP

Point and click on one of the segments to show its shape in the Waveform Shape window.

Description of the various buttons in the Segment Table is given below.

Append – adds segment number at the end of the table

Insert – adds a segment above a highlighted segment line

Delete – removes a highlighted segment

(Download) Selection – downloads a highlighted segment only to the 3152B memory

(Download) All – downloads the complete table to the 3152B memory

Export – This allows exportation of Waveform Studio settings to another session

Import – This allows importation of Waveform Studio settings from another session

Save – saves current table settings

Clear Mem – wipes out the entire memory and clears the table for fresh settings

Close – removes the Waveform Studio from the screen. If you have not saved your work, the table setting will be lost.

Sequence Table

As was explained in the above, the waveform memory can be

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divided into smaller segments and up to 16 k segments can be defined and used as individual arbitrary waveforms. Having a limited size of waveform memory can, for some applications, pose a limitation however, if sections of the waveform are repetitive, one may use the sequence generator to take these segments and replay them as part of the complete waveform without losing valuable memory space and without scarifying waveform coherence and integrity. The tool for combining repetitive and multiple segments in one long waveform is called Sequence Generator and ArbConnection has a special dialog box where sequences are designed. This tool is called – Sequence Table.

Using the Sequence table you can use waveforms that you already downloaded to the 3152B from the Segment table, link and loop in random order to create one long and complex waveform that combines the individual memory segments.

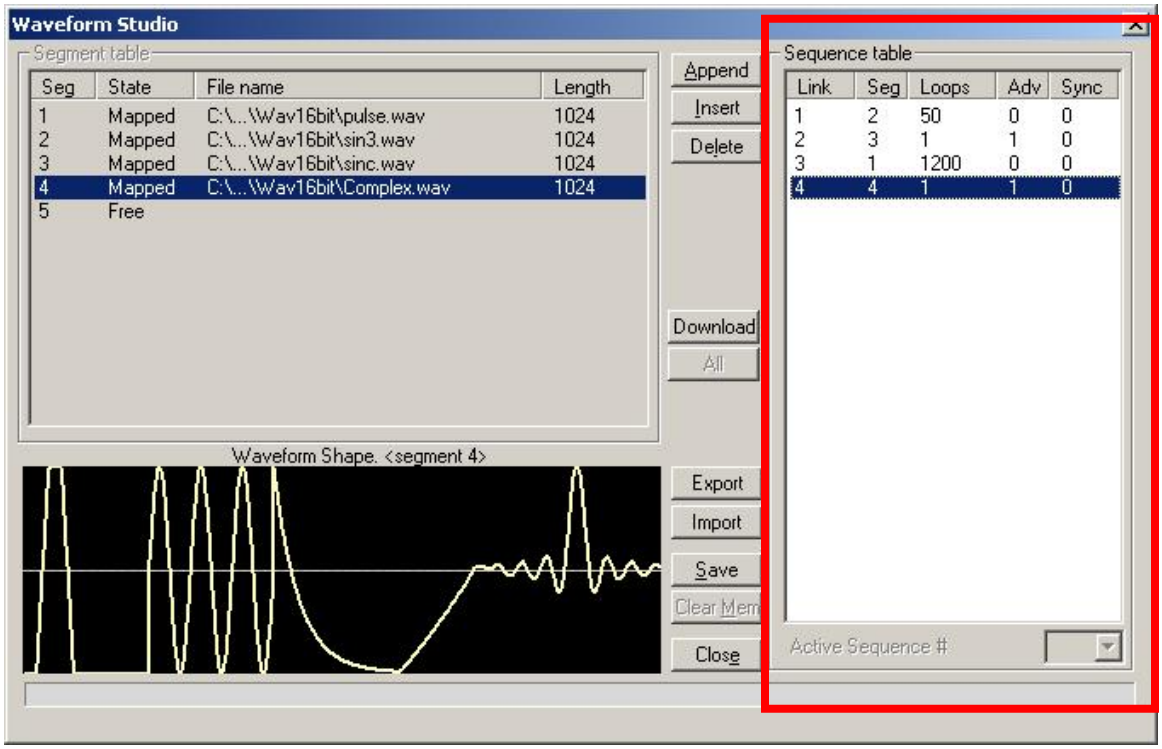

Waveform Studio
Segment table
Seg
State
File name
Length
1 Mapped C:\...\Wav16bit\pulse.wav 1024
2 Mapped C:\...\Wav16bit\sin3.wav 1024
3 Mapped C:\...\Wav16bit\sinc.wav 1024
4 Mapped C:\...\Wav16bit\Complex.wav 1024
5 Free
Append
Insert
Delete
Download
All
Waveform Shape. <segment 4>
Export
Import
Save
Clear Mem
Close
Sequence table
Link
Seg
Loops
Adv
Sync
1 2 50 0 0
2 3 1 1 0
3 1 1200 0 0
4 4 1 1 0
Active Sequence #

Figure 4-11, Sequence Table Example

The Sequence Table is highlighted in Figure 4-11. To access the Sequence table, click anywhere on the Sequence Table area. If it was not yet, it will turn white as opposed to the Segment Table area that turns gray.

There are five major elements that you should consider while programming a sequence table. They are: Link, Seg, Loops, Adv and Sync. These terms are explained below.

Link - This parameter defines an index array for the sequence generator. When generating sequences, the instrument steps though the links in descending order therefore, make sure that you

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enter your waveform segments in exactly the order you would like them at the output.

Seg - This parameter associates waveform segments with links. You can use different segments for different links or you can use the same segment for a number of links. There are no limitations to how you associate links to segments except that you cannot program assign segments to the sequence table that were not defined previously.

Loops – This parameter define how many times the segment will loop for the selected link. For example, if you program 2, the waveform will cycle twice through the same segment before transitioning to the next link.

Adv – This parameter flags the advance mode for the a givensegment. This flag is active when the advance mode is Stepped. When set to 0, the sequence will advance through the list automatically until a segment that is flagged 1 is encountered. When 1 is encountered, the generator will idle on this segment until an external trigger is applied. Learn more about the sequence advance modes in Chapter 3.

Figure 4-11 shows an example of a 4-step sequence of which the first waveform is made of segment 2, which will loop 50 times; segment 3, looping once; segment 1, looping 1200 times and segment 4, looping once. The Adv bits on links 2 and 4 are set to 1 and therefore, external triggers are required for the sequencer to step through these links.

Sync – This parameter flags if a bit marker will occur on the selected segment. Normal sync output is LCOM for the sequence mode however, if you want to use shortened and/or multiple sync pulses, change the sync output selection in the Arbitrary/Sequence Panel to BIT and the output will generate a pulse every time the sequence steps through a segment that has been flagged.

The control buttons on the left of the Sequence Table have the same functionality as for the Segment Table.

Use the **Append** key to add a step at the end of the sequence list. Use the **Insert** key to insert a step at the cursor location. The **Delete** key is used for deleting a step at the cursor position.

Click on the **Close** to discard of the contents of the dialog box without saving your last actions and to remove the sequence Table from the screen but click on the **Save** key if you want just to save your work before you close the dialog box.

The **Download** key has double action, it will download the sequence table to the instrument and will save the contents of your table so the next time you open this table, it will have the same contents as you saved in your previous session.

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Half Cycle

The Half Cycle panel contains controls that select the half cycle functions and adjust the half cycle parameters. To access the Arbitrary/Sequence panel, click the Operation button on the Panels bar (Figure 4-12). Then click the Half Cycle button that drops down below the Operation button. The half cycle panel will then open.

The half cycle functions are generated with variable and controllable delay between the halves. If triggered mode, one half at a time is generated as a result of a trigger signal regardless of the programmed delay value. The half cycle functions have different limitations compared to the standard functions; these are listed in Appendix A. The half cycle panel and the various parameters that control these functions are described below.

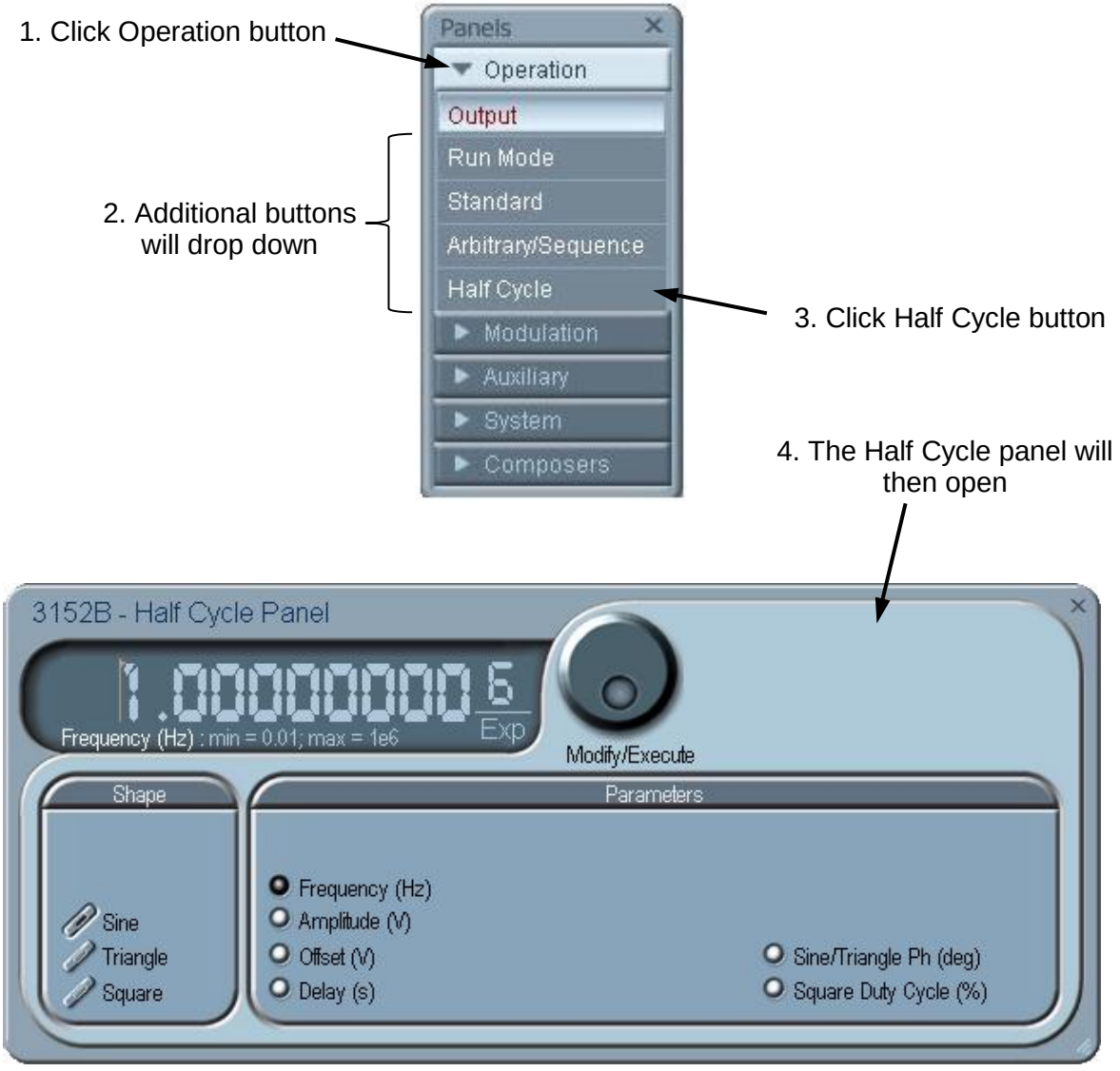


Figure 4-12, Half Cycle Panel

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State
The State button turns on and off the half cycle waveforms function. The half cycle function can also be selected from the Output panel.

Shape
The Shape group has controls that select the shape of the half cycle function.

Parameters
The Parameters group has controls for programming the frequency, amplitude, offset, delay, phase, and duty cycle. Each channel can have an independent set of these parameters.

The Modulation Panels

The five Modulation functions are accessed by clicking the Modulation header (Figure 4-13) and then one of the modulation panels that appear below it. These panels provide access to all modulation functions and their respective parameters. The modulation functions that are available on these panels are: FM (frequency modulation), AM (amplitude modulation), Sweep, ASK (amplitude shift keying), FSK (frequency shift keying) and PSK (phase shift keying) and Amplitude and Frequency Hopping.

When modulation run modes other than continuous are selected, there are two options that control the idle state between triggers: 1) Carrier baseline and 2) DC baseline. When the first option is selected, the instrument generates the un-modulated carrier frequency (CW) until a valid signal is applied. When the second option is selected, the instrument generates a DC level signal until stimulated to generate a modulation cycle. The modulation options, their associated parameters, and the various run mode options are described separately for each of the panels below.



Figure 4-13, Modulation Panels

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FM

The FM panel (Figure 4-14) contains parameters for controlling the amplitude modulation function. To turn the FM function on and off, click on the FM button in the State group. The various groups in the FM panel are described below.

State
The State button turns the FM function on and off.

FM Parameters
This group contains parameters that allow complete control over the FM function. These are:

CW Frequency – The CW Frequency is the frequency of the pre-modulation carrier waveform. In case the modulating waveform is one of the built-in standard waveforms, the modulation will be symmetrical about the CW frequency setting.

Baseline – The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a DC level, meaning that in between triggers, the output resides on a DC level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

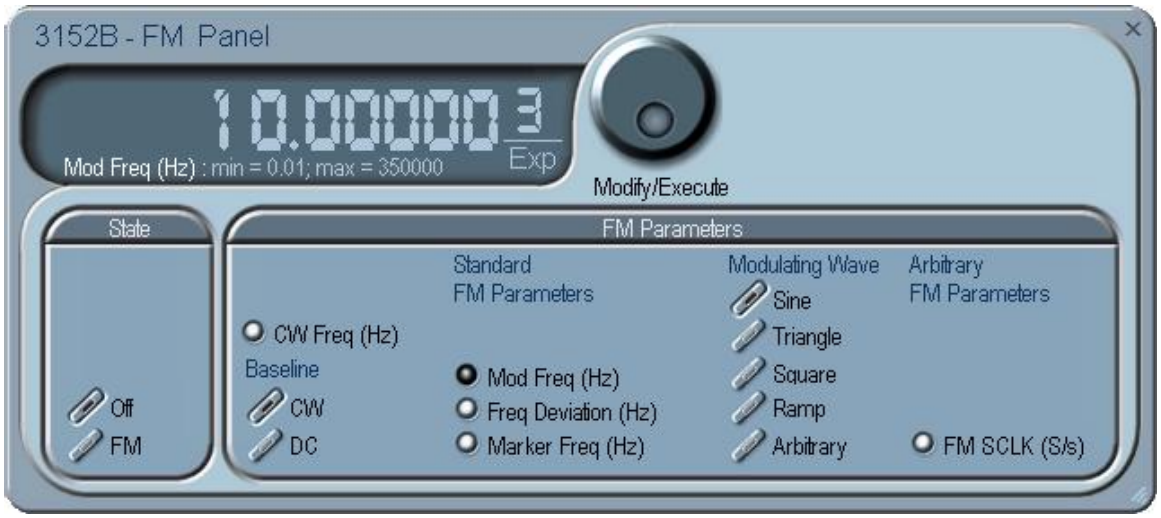


Figure 4-14, FM Panel

Standard FM Parameters - These parameters are active only when one of the built-in waveforms is selected as the modulating signal. These are: Sine, Triangle, Square, or Ramp. The modulation frequency, deviation and marker frequency control the standard FM modulation scheme.

Modulating Wave - Defines the shape of the modulating waveform. There are two basic options: Standard (built-in) waveforms and

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Arbitrary waveforms. If you do not need exotic waveforms, you can use one of the built-in standard wave shapes: Sine, Triangle, Square, or Ramp. These waveforms can be adjusted for their frequency and deviation range. On the other hand, you can select the arbitrary modulating wave option where you can use any shape, although you must load the modulating waveform from an external application, such as the FM composer in ArbConnection. Information on the standard and arbitrary FM functions is given in Chapter 3. Click on the button next to the required modulating waveform shape to select it.

Arbitrary FM Parameters – Allow adjustment of the sample clock of the modulating waveform. These parameters are active only when arbitrary modulating waveform option is selected. The modulating waveform must be downloaded from an external utility such as ArbConnection and the sample clock is programmed from this location.

To access the required parameter, click on the parameter's name and observe that the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, click on the Modify/Execute knob to update the 3152B with the new setting.

AM

The AM panel (Figure 4-15) contains parameters for controlling the amplitude modulation function. To turn the AM function on and off, click on the AM button in the State group. The various groups in the AM panel are described below.

State
The State button turns on and off the AM function.

AM Parameters
This group contains parameters that allow complete control over the AM function. These are:

CW Frequency –The CW Frequency is the frequency of the carrier waveform.

Baseline – The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a DC level, meaning that in between triggers, the output resides on a DC level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

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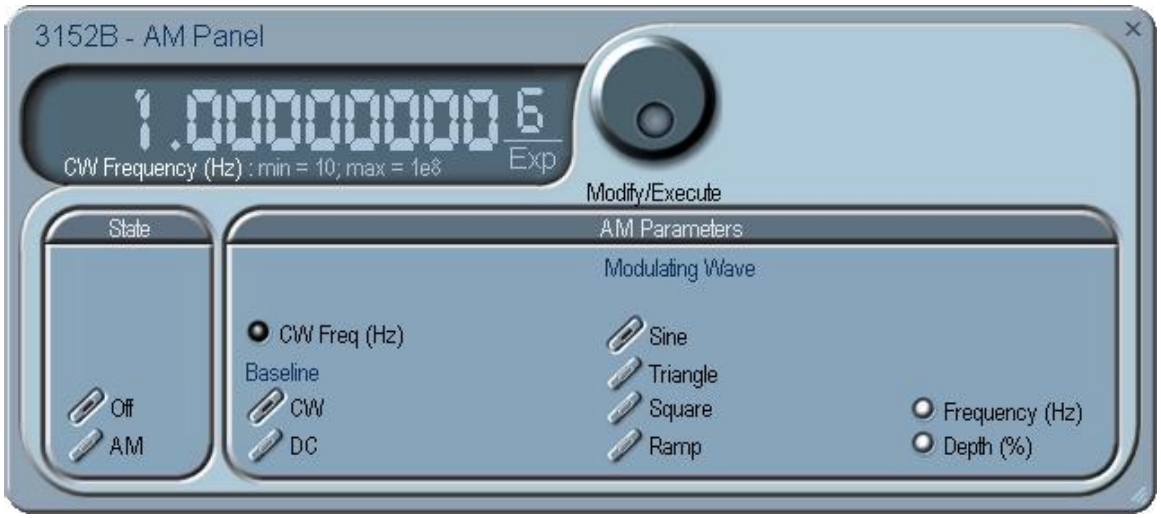


Figure 4-15, AM Panel

Modulating Wave – Defines the shape of the modulating waveform. There are four built-in standard wave shapes: Sine, Triangle, Square, or Ramp. These waveforms can be adjusted for their frequency and deviation range. Click on the button next to the required modulating waveform shape to select it. The modulating waveform can be selected independently for each channel

Freq – Programs the frequency of the modulating waveform. Note that the frequency setting must be smaller than the CW frequency for the AM function to operate correctly. Note that the modulating frequency setting is common to both channels.

Depth – The Depth parameter programs the modulation depth, or index in percent of the un-modulated CW amplitude. The depth is symmetrical about the center of the CW amplitude. Each channel can have a unique setting of the modulation depth.

To access the required parameter, click on the parameter name and observe that the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, click on the Modify/Execute knob to update the 3152B with the new setting.

Sweep

The Sweep Modulation panel (Figure 4-16) contains parameters for controlling the sweep function. To turn the sweep function on and off, click on the Sweep button in the State group. The various groups in the sweep panel are described below.

State
The State button turns on and off the Sweep function.

Sweep Parameters
This group contains parameters that allow complete control over the

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sweep function. These are:

Baseline – The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a DC level, meaning that in between triggers, the output resides on a DC level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output. Note that in sweep modulation, the Start parameter replaces the CW value.

Function – The Function buttons select which of the waveforms will be swept. The sine wave is the default waveform and it is swept using the DDS circuit. The other two waveforms, triangle and square, are computed and the swept coordinates placed in the arbitrary memory. The calculation of the sine and triangle waveforms takes a long time (any time between seconds to minutes, depending on the complexity of the sweep) so should only be used when absolutely necessary in the application.



Figure 4-16, Sweep Modulation Panel

Step
Use these keys to select sweep step from two increment options: linear, or logarithmic.

Direction
Use these keys to program the sweep direction. Up selects a sweep from the Start to Stop sample clock setting and Down selects sweep from the Stop to Start sample clock setting. Refer to Chapter 3 of this manual to learn more about sweep operation.

Parameters
These allow the adjustment of the Sweep Start (CW), Stop and Sweep Time. You can also place a marker at a position

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programmed by the Marker parameter. To access the required parameter, click on the parameter's name and observe that the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓] keys to adjust the readout to the required setting. After you modify the reading, click on the Modify/Execute knob to update the 3152B with the new setting.

FSK/PSK/ASK

The FSK/PSK/ASK panel (Figure 4-17) contains parameters for controlling the shift keying modulation functions. To turn one of the functions on and off, click on the appropriate button in the State group. The various groups in this panel are described below.

State

The State buttons enable or disable the shift keying functions.

General

The General group contains parameters that are common to all of the shift keying functions. These are CW frequency and baseline.

CW Frequency – The CW Frequency is the frequency of the pre-modulation carrier waveform.

Baseline – The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a DC level, meaning that in between triggers, the output resides on a DC level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

FSK

The FSK group contains parameters that control the frequency shift keying function. These parameters are: control data, "0" and "1" frequencies, baud rate, and marker position.

Control Data – The Control Data button in the FSK group provides access to the data string that controls the sequence of base frequency and shifted frequency. It contains the list of "0" and "1" values that the output will repeatedly follow for its frequency shift keying sequence advance as programmed.

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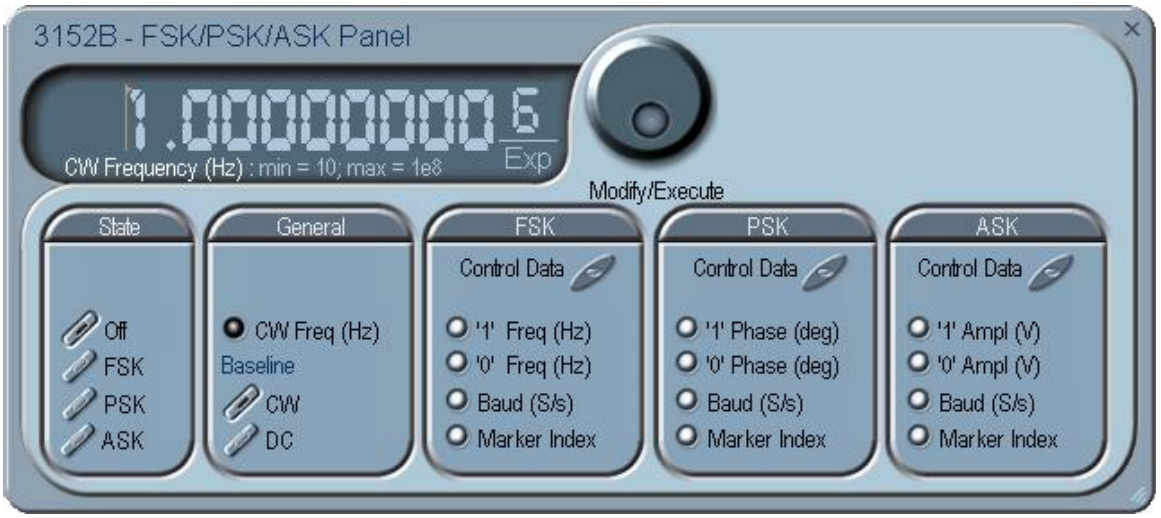


Figure 4-17, FSK/PSK/ASK Modulation Panel

"0/1" Frequency – In FSK, the carrier waveform (CW) has two frequencies: an initial frequency level which is set by the "0" frequency parameter and shifted frequency which is set by the "1" frequency. The control data table has a list of "0" and "1" values that flag when the frequency shifts from base to shifted frequency.

Baud – The baud parameter sets the rate at which the generator steps through the sequence of the FSK Control Data bits.

Marker Index – The marker index programs a step in the control data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the FSK marker output.

PSK

The PSK group contains parameters that control the phase shift keying function. These are: control data, "0" and "1" frequencies, baud rate, and marker position.

Control Data – The Control Data button in the PSK group provides access to the data string that controls the sequence of base phase and shifted phase. It contains the list of "0" and "1" values that the output will repeatedly follow for its phase shift keying sequence advance as programmed.

"0/1" Phase – In PSK, the carrier waveform (CW) has two phase settings: an initial phase which is set by the "0" Phase parameter and shifted phase which is set by the "1" Phase. The control data table has a list of "0" and "1" values that flag when the phase shifts from base to shifted phase.

Baud – The baud parameter sets the rate at which the generator steps through the sequence of the PSK Control Data bits.

Marker Index – The marker index programs a step in the control data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the PSK marker

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output.

To access the required parameter, click on the button below parameters sub-group until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, click on the Modify/Execute knob to update the 3152B with the new reading.

ASK
The ASK group contains parameters that control the amplitude shift keying function. These are: control data, non-modulated and shifted phases, and baud and marker position.

Control Data – The Control Data button in the ASK group provides access to the data string that controls the sequence of base amplitude and shifted amplitude. It contains the list of "0" and "1" values that the output will repeatedly follow for its amplitude shift keying sequence advance as programmed.

"0/1" Amplitude – In ASK, the carrier waveform (CW) has two amplitudes: an initial amplitude level which is set by the "0" Amplitude parameter and shifted amplitude which is set by the "1" Amplitude. The control data table has a list of "0" and "1" values that flag when the amplitude shifts from base to shifted amplitudes.

Baud – The baud parameter sets the rate at which the generator steps through the sequence of the ASK Control Data bits.

Marker Index – The marker setting programs a step (index) in the control data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the ASK marker output.

Ampl/Freq Hop

The Ampl/Freq Hop panel (Figure 4-18), contains parameters for controlling the hop modulation function. To turn one of the functions on and off, click on the appropriate button in the State group. The output has two hop options: Fixed and Variable. In Fixed mode, the output steps through the pre-assigned hop values at a constant rate, as programmed using the dwell time parameter. In Variable mode, the output dwells on each step for a period of time that is programmed in the Dwell Time field in the hop data table that is programmed when using the Variable Hold option.

The various groups in this panel are described below.

State
The State buttons enable or disable the hop functions.

General
The General group contains parameters that are common to all of the hop functions. These are CW frequency and baseline.

CW Frequency – The CW Frequency is the frequency of the pre-

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modulation carrier waveform.

Baseline – The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a DC level, meaning that in between triggers, the output resides on a DC level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

Amplitude Hop

The Amplitude Hop group contains parameters that control the amplitude hop function. These are: hop data, dwell control, dwell time and marker position.

Hop Data – The Hop Data button in the Ampl Hop group provides access to the data string that controls the sequence of amplitude hops. The hop data table contains a list of amplitude levels that the output steps through the amplitude levels of as programmed in the hop data table.

Fixed Hold – The hold parameter determines how long each step of amplitude dwells on this setting before it will step to the next amplitude setting. By selecting Fixed Hold, the hold time remains constant throughout the entire hop table.

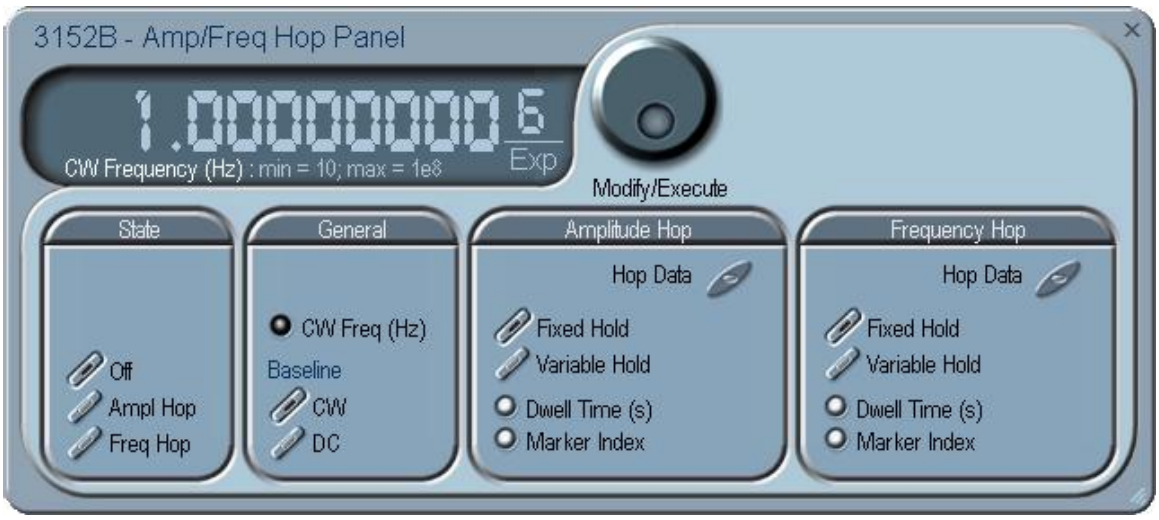


Figure 4-18, Amp/Freq Hop Panel

Variable Hold – The Variable Hold parameter determines how long each step of amplitude dwells before stepping to the next amplitude setting. By selecting Variable Hold, the hold time changes automatically from one step to the next depending on the hold time value that is affixed to the hop step. The values can be programmed in the HOP Data table.

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Dwell Time –The Dwell Time parameter programs the period of time that must elapse before the output amplitude hops to the next amplitude setting. Dwell Time is associated with the Fixed Dwell option only.

Marker Index – The marker index programs a step in the hop data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the hop marker output.

Frequency Hop
The Frequency Hop group contains parameters that control the frequency hop function. These are: hop data, dwell control, dwell time and marker position.

Hop Data – The hop data button in the frequency hop group provides access to the data string that controls the sequence of frequency hops. The hop data table contains a list of frequencies and the output will step from one frequency level to another in the same order as programmed in the hop data table.

To access the required parameter, click on the button below the parameters sub-group until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, click on the Modify/Execute knob to update the 3152B with the new setting.

Auxiliary Panels

The Auxiliary tab (Figure 4-19) provides access to a group of panels that control the auxiliary functions.

There are three panels in this group: Counter/Timer, which provides access to the auxiliary Counter/Timer function; Pulse Generator, which provides access to the digital pulse generator function; and X-Instrument Sync for multi instrument synchronization control.



Figure 4-19, Access to Auxiliary Panels

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Counter/Timer

The Counter/Timer panel (Figure 4-20) contains controls that select the measurement function and adjust the counter/timer parameters for measuring external signals. The counter/timer measures signals that are connected to the TRIG IN input. The various parameters that control the counter/timer features are described below.

State

The State Group has controls to enable or disable the counter. And to reset the counter and arm it for the next measurement cycle. Note that when the counter function is turned on, all other waveform generation features of the 3152B are purged.

Measurement Function

The measurement function group has control to select the measurement function for the counter/timer operation. The 3152B can measure the following function: Frequency, Period, Period Averaged, Pulse Width, and Totalize. The totalize function has two options. If Totalize Infinite function is selected the input will count every legal pulse at the counter input, for an indefinite period of time, and displays the total number of pulses until the counter has been reset. If Totalize Gated function is selected, the input will count every legal pulse at the trigger input for a period of time that is defined with the Gate Time parameter.

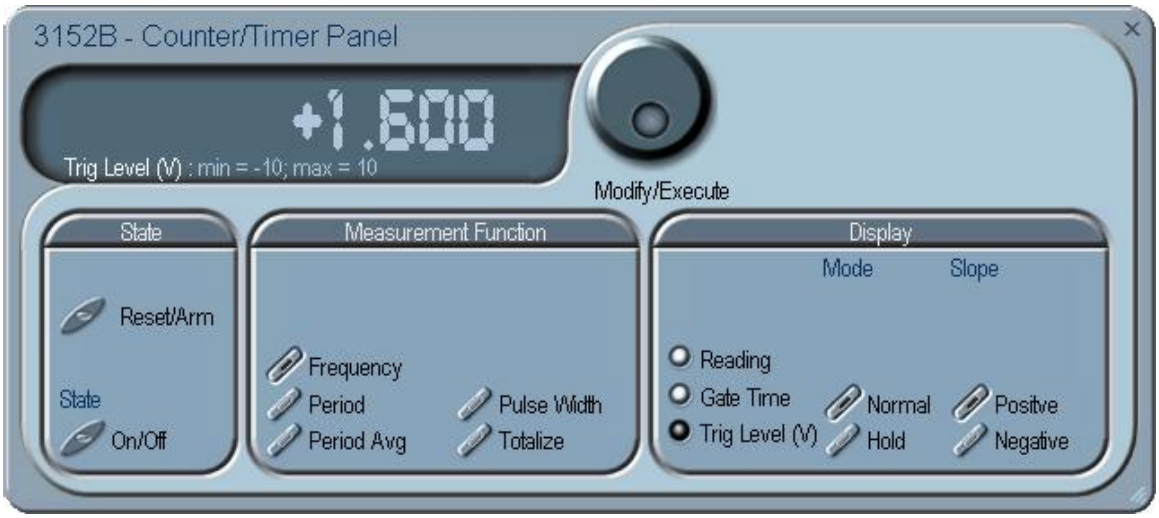


Figure 4-20, Counter/Timer Panel

Display

The Display Group has controls to select the display mode and to select if the display shows measurement or gate time readings.

In normal mode, the counter is armed to receive signal at the trigger input. When signal is sensed, the gate to the counter opens for duration as programmed with the Gate Time parameter, processes the result, displays the reading and continues with the same process as long as the signal is available at the input.

In hold mode, the counter is armed to receive signal at the trigger

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input. When signal is sensed, the gate to the counter opens for duration as programmed with the Gate Time parameter processes the result, displays and holds the reading until the next Reset/Arm command.

To display and modify the gate time parameter, click on the Gate Time LED and modify the gate time per your requirements. Gate time rage is from 100 μs to 1 s. Normal counter/timer readings are displayed when the Reading LED is selected.

Pulse Generator

The Pulse Generator panel (Figure 4-21) contains controls that select the pulse function and adjusts the pulse parameters. The pulses are generated digitally suing the arbitrary waveform memory and digital computation and therefore, there are some limitations to the minimum to maximum range that must be observed. The pulse design limitations are given in Appendix A. The various parameters that control the digital pulse generator features are described below.

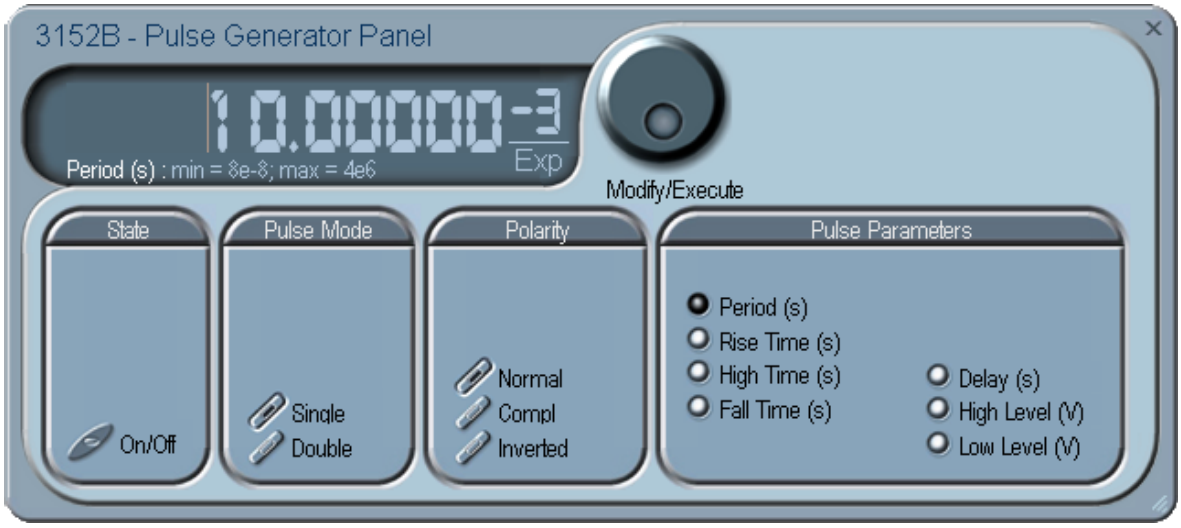


Figure 4-21, Digital Pulse Generator Panel

State

The State Group has a control to enable or disable the pulse generator function. Note that when the pulse generator function is enabled, all other waveform generation features of the 3152B are disabled.

Pulse Mode

The Pulse Mode group has controls to toggle between single and double pulse modes.

Polarity

The Polarity group has controls to select the pulse polarity from one of the Normal, Complemented and Inverted options.

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Pulse Parameters

All parameters that control the pulse timing are available in the Pulse Parameters group. These include: Period, Rise, High and Fall Times, High and Low levels and single or double pulse Delays.

To display and modify parameters, click on the LED next to the required parameter change and modify the time as required. The range of each parameter is specified in Appendix A.

X-Instrument Sync

The X-Instruments Synchronization table provides a fast and easy method of synchronizing modules that reside within a single VXI mainframe. ArbConnection finds 3152Bs which may be synchronized and allows the selection of groups and synchronization paths and allows the setting of phase offsets between modules.

Figure 4-22 shows a list of modules that were detected by ArbConnection and listed in the Instruments Pool. This list can now be manipulated to form one or more groups of synchronized instruments. Use the procedure below to set up groups and to activate the synchronization.

First, notice the variety of instruments that are listed in the Instruments Pool. Actually, they all are the same 3152B units except they are mounted on different platforms for various applications. The 3100-3152B is comprised of a single 3152B and the 3100-3152B-3152B has two 3152B embedded in the same module. The 3152B is the standard, single-slot instrument that has the ability to replace a 3152A module in legacy systems. Information on the various 3152B configurations is given in Chapter 1.

Note

The X-Instruments utility does not allow mixing of registered based instruments, such as the 3100R-3152B with message based instruments, such 3152B and 3100M-3152B. Therefore, if you want to synchronize modules, make sure that they all of the same kind.

Information how to set up synchronization groups along with a description of the various buttons that control the multi-instruments synchronization function is given below.

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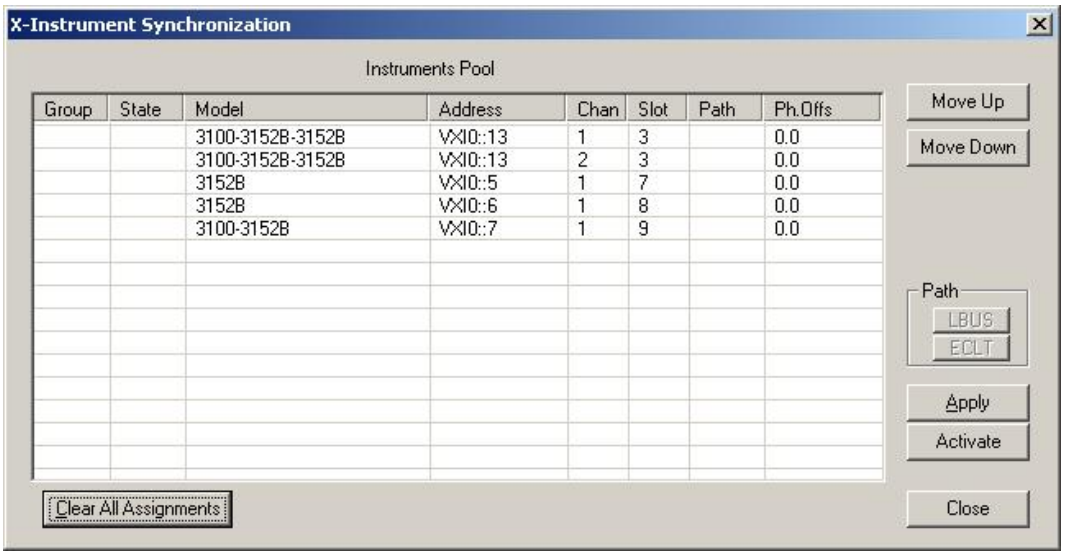


Figure 4-22, X-Instrument Synchronization Pool List

Group – is an edit field which is used for grouping one or more instruments into a set of instruments that share synchronization properties.

State – identifies the master or servant property of an instrument. Note that the first instrument in the group list is always set automatically as the master. If you want it as servant, you can use the Move Up and Move Down buttons to move the module higher or lower in the synchronization hierarchy.

Model – shows all instruments from the 3152B family that ArbConnection detected in the chassis. Leave the group field blank if you do not wish to synchronize a particular module.

Address – shows the logical address associated with the listed module. The address is set using a DIP switch which can be accessed when the module is removed from the chassis.

Chan (Channel) – this field is relevant for the 3100-3152B-3152B model which has two 3152B units installed in a single VXI slot. In this case, each instrument operates as a stand-alone generator but also can be configured as a dual-channel instrument. The example in Figure 4-22 shows this instrument with address 13 installed in slot 3. Channel 1 is always the top instrument and channel 2 is installed below and if selected as a group, by default, channel 1 becomes the master module. There is no way to exchange channel designation but if you move channel 2 up, its state is re-configured to master and channel 1 to servant.

Slot – shows the slot number where ArbConnection found a specific module. The location of the module is extremely important because it defines how it may be synchronized, as explained in the Path description below.

Path – defines the connection between synchronized modules. This field has three options: ADJ, LBUS and ECLT.

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ADJ – defines a connection between two adjacent 3152B modules in a single 3100 carrier. Figure 4-23 shows the model 3100-3152B-3152B in slot 3. After grouping in group 1, the two instruments are automatically assigned the ADJ path. This can not be changed because of the nature of synchronization of two instruments in a single slot. Also note that Channel 1 is now master and channel 2 is the servant.

LBUS – defines a connection between adjacent slots using the VXI backplane local bus lines. In this case, the master is always on the left and the servant units are adjacent to the master on the right side. It is not allowed to break the chain of instruments because local bus lines connect instruments in a daisy-chained link. Note in Figure 4-24 that slots 7, 8 and 9 are daisy-chained through the local bus. The instrument in slot 7 is the master unit and the others are servants.

ECLT – defines a connection between any slot using the VXI backplane ECLTrg lines. In this case, the master can be assigned to any instrument in the chassis regardless if it is on the left, right or mixed with other instruments in the chassis. The example in Figure 4-25 shows how to form two groups in a single chassis where group one synchronizes two channels and group 2 synchronizes three different instruments in a specific master-servant configuration. Note that slot 9 was moved up and assigned master while slots 7 and 8 became servants.

Ph. Offs (Phase Offset) – defines an offset between the master module and its servants. Note that the master instrument can also be set with an offset but then the final offset between modules will be the difference between the offset settings of the salves to the master.

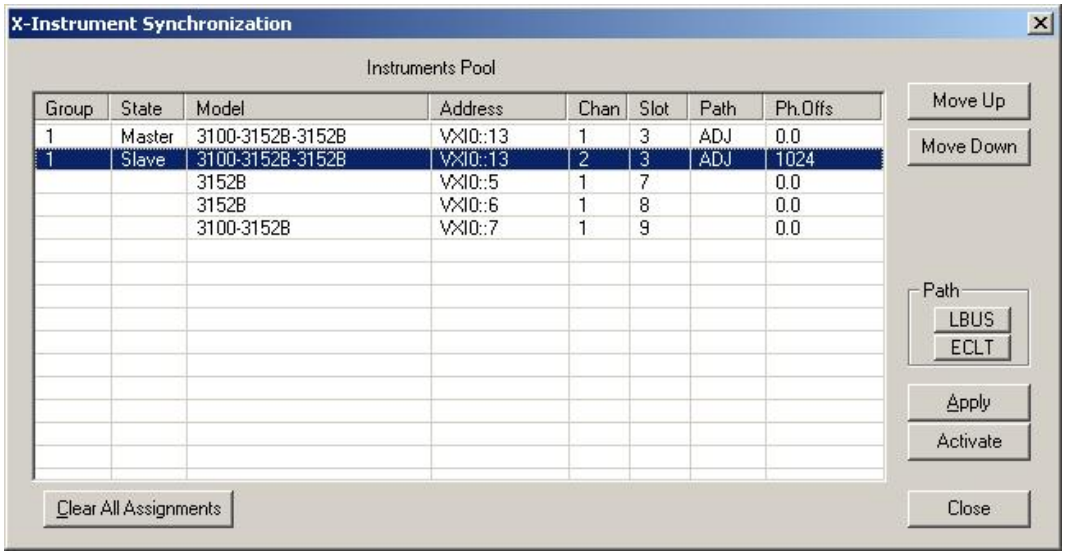


Figure 4-23, Adjacent Synchronization between Two Instruments

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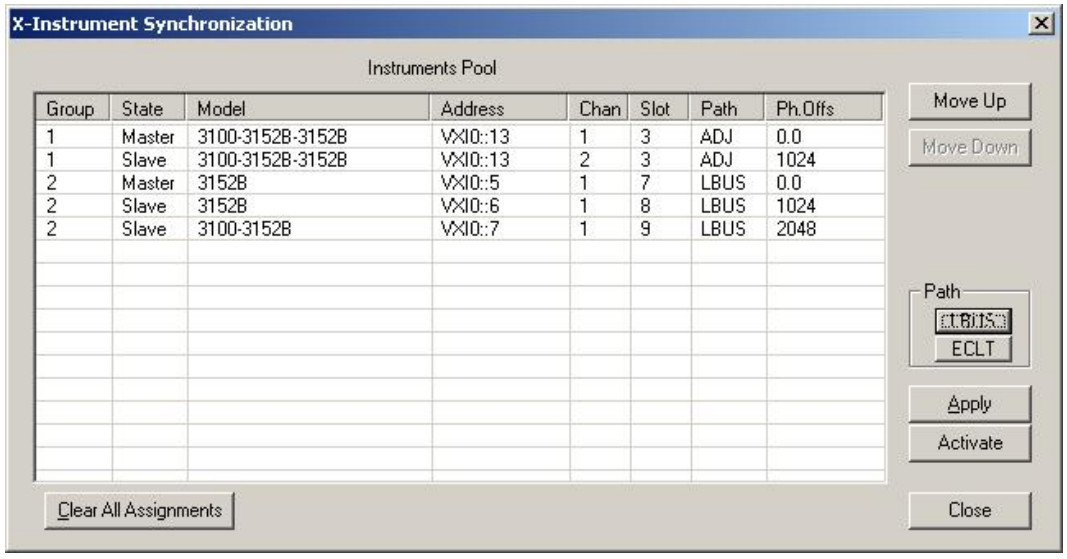


Figure 4-24, LBUS Synchronization Between Adjacent Slots

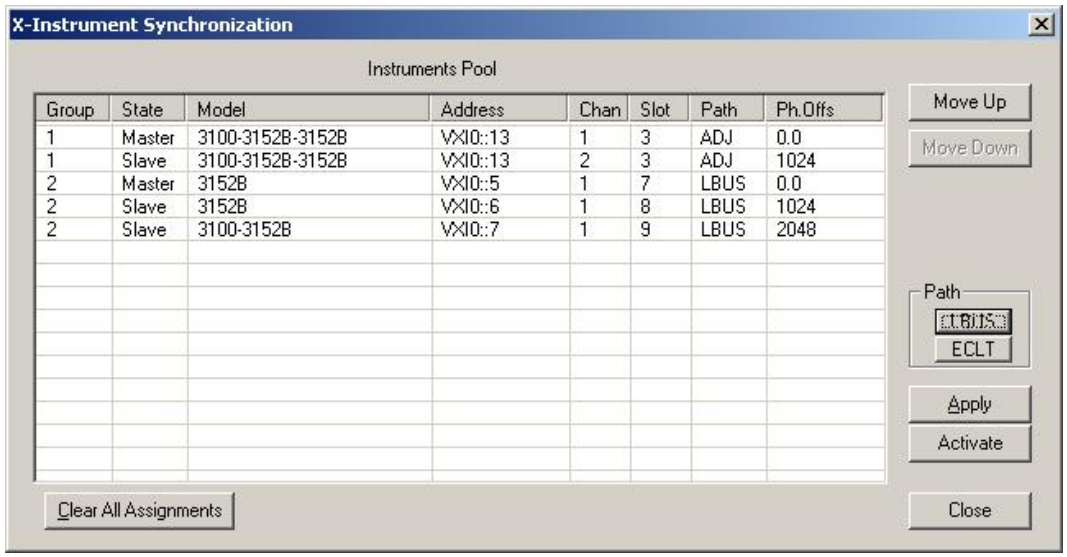


Figure 4-25, ECLT Synchronization Example

So far, the X-Instruments Synchronization fields were discussed and described. The following describes the functions of the buttons.

Clear All Assignments – used to completely reset the table. Note that only editable fields are affected by this action. Once pressed, the table will look as shown in Figure 4-22.

Move Up – used to change the position of a module to place it toward the top of the group and master status. Note that this operation affects the line that is currently highlighted.

Move Down – used to change the position of a module so it is placed below its current position in the group and can be used to

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demote a master to a servant. Note that this operation affects a line that is currently highlighted.

Path (LBUS/ECLT) – is used for selecting the connection path. LBUS specifies a VXI local bus connection and requires that the master is plugged into the leftmost position and all servants are plugged into adjacent slots to the right to the master module. ECLT specifies the VXI backplane ECLTrg line synchronization mode. For this mode, the location of the master and servant units in the chassis is not crucial because the trigger lines run across the backplane through all slots.

Apply – used to prepare the instruments for the synchronization sequence. This button must precede the activation of the synchronization process.

Activate –Once this button is pressed, the instruments will synchronize in the selected groups and the master will control the timing of the servant modules.

Close – terminates the current session but does not change the synchronization status.

The System Panels

The System tab (Figure 4-26) provides access to a group of panels that control some general system parameters and provides access to calibration. There are two panels in this group: General/System, which provides access to some system commands, utilities and filters; and Calibration, which provides access to the remote calibration utility. Note however, that access to the calibration panel is permitted to qualified service personnel and requires a user name and password. Information on how to access the calibration panel is given in Chapter 7.



Figure 4-26, System Panels

General/Filters

The General/Filters panel (Figure 4-27) provides access to some general system common commands, allows read back of

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information stored in the flash and provides a means to add filter(s) in series with the output path. The General/Filters panel and the various parameters that control its functions are described below.

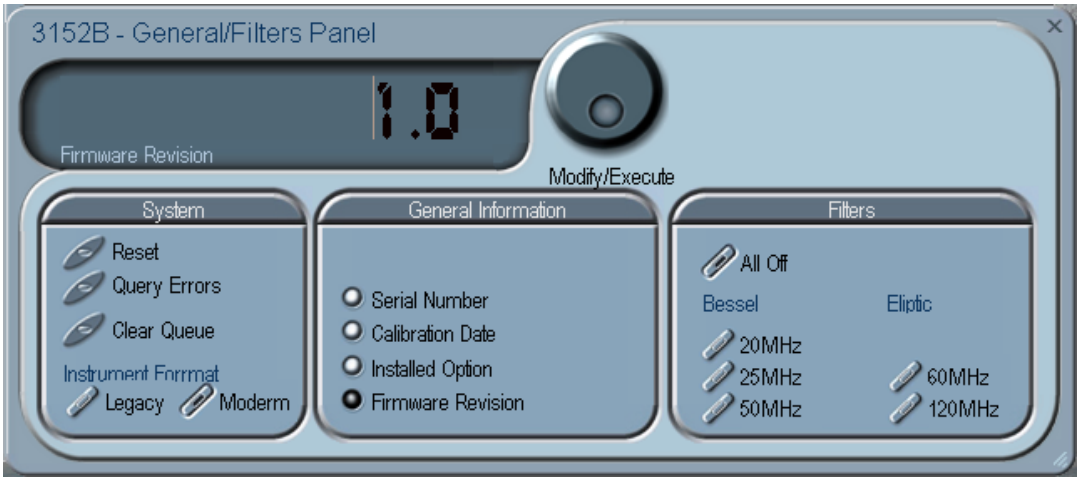


Figure 4-27, General/Filters Panel

System

The System group has three buttons that are normally associated with system control. These are:

Reset – generates a soft reset to the instrument controls and dialog boxes and modifies all parameters to factory default. A list of factory defaults is given in Chapter 5.

Query Error – queries the 3152B for programming errors. This command is normally not necessary because ArbConnection won't generate settings conflicts or syntax erorrs. But, when sending SCPI commands to the instrument using the Command Editor, errors can be generated. An error query allows these errors to be monitored.

Clear Queue – clears the error queue. The error queue can buffer up to 35 errors and then generate a queue overflow message while ignoring new errors. This command clears the error queue and allows fresh errors to be captured.

General Information

This general information group of buttons is used for displaying or monitoring parameters stored in flash memory. These are: Instrument serial number, Last calibration data, 3152B installed options, and the installed firmware revision.

Filters

The Filters group has a set of selectors that select the filter characteristics. Filters can be turned on and off freely as long as you are not generating a standard sine waveform. The following filter options are available:

All Off – no filter is applied to the output path

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20MHz – a Bessel type filter that has a 20 MHz cutoff frequency.
25MHz – a Bessel type filter that has a 25 MHz cutoff frequency.
50MHz – a Bessel type filter that has a 50 MHz cutoff frequency.
60MHz – an Elliptic type filter that has a 60 MHz cutoff frequency.
120MHz – an Elliptic type filter that has a 120 MHz cutoff frequency.

Calibration

The Calibration panel (Figure 4-28) provides access to remote calibration. To access the remote calibration panel, you will need to have a valid User Name and Password. Proper training is required to perform calibration. Information on how to access the calibration panel and how to perform the calibration is provided in Chapter 7. The picture below is just for reference.

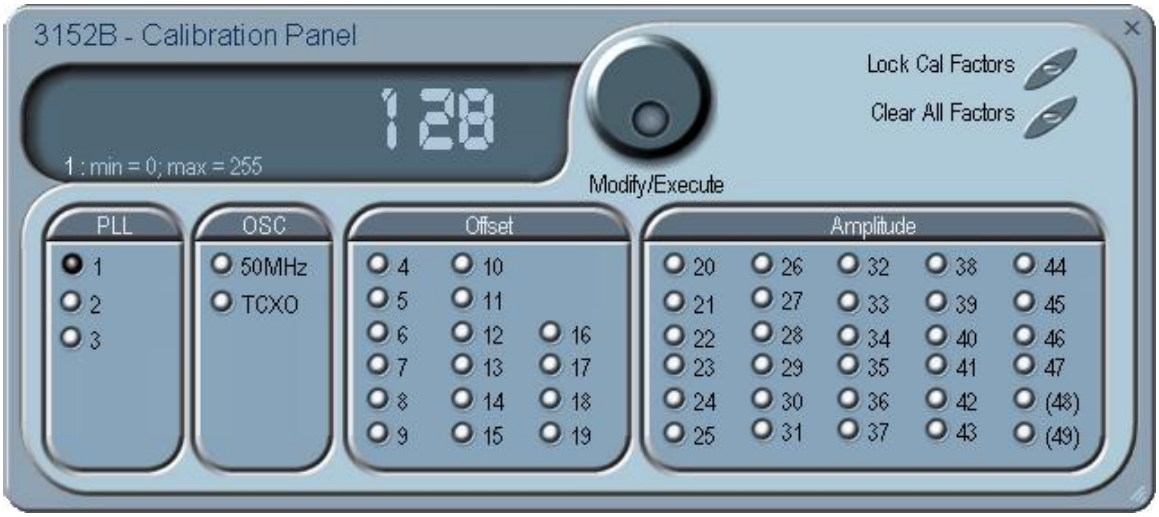


Figure 4-28, Calibration Panel

The Composers Panels

The Composers tab provides access to a group of composers that allow the generation and modification of arbitrary waveforms, pulse shapes, arbitrary frequency modulation, and 3D profiling.

There are four waveform composers built into ArbConnection:

Wave – for generating arbitrary waveforms. Arbitrary waveforms can be generated from standard libraries, from an equation editor, or imported into the composer from external utilities such as MatLAB™. The waveforms can be edited and stored to disk for future use.

Pulse – for generating complex pulse trains. Unlike a standard pulse generator, you can design and edit multiple pulse trains with linear transitions and variable amplitudes.

FM – for generating arbitrary frequency modulation profiles without being limited by the standard sine, triangle and square modulating shapes, and

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3D – for generating chirps and simultaneous variations of amplitude, frequency and phase on each channel, separately.



Figure 4-29, Composers Panel

The Wave Composer

Because the 3152B is an arbitrary waveform generator, it has to be loaded with waveform data before it can start generating waveforms. The waveform generation and editing utility is part of ArbConnection and is called the Wave Composer. This program gives you tools for the definition of arbitrary waveforms. It can also convert waveform data from other products such as oscilloscopes, and use the data directly as waveforms. The program is loaded with many features and options so use the following paragraphs to learn how to create, edit, and download waveforms to the 3152B using the Wave Composer.

To launch the Wave Composer, point and click on the Wave tab in the Composers section of the Panels bar (Figure 4-29).

Figure 4-30 shows the Wave Composer window. The Wave Composer has three main sections: the Menu bar, Toolbar, and Waveform graph. Refer to Figure 4-30 throughout the description of these sections.

The Wave Composer Menu Bar

The Wave Composer menu bar provides access to standard Windows operations such as File, Edit, and View. In addition, there are ArbConnection-specific operations such as Wave and System.

In general, clicking on one of the menus pulls down a list of commands. Clicking on a listed command may then either open a dialog box or generate an immediate action. For example, clicking on File and then Exit will cause the immediate termination of the Wave Composer. On the other hand, clicking on Wave and then on Sine, will open a Sine Wave dialog box that lets you program and edit sine wave parameters. The various commands in the menu bar are listed and described below.

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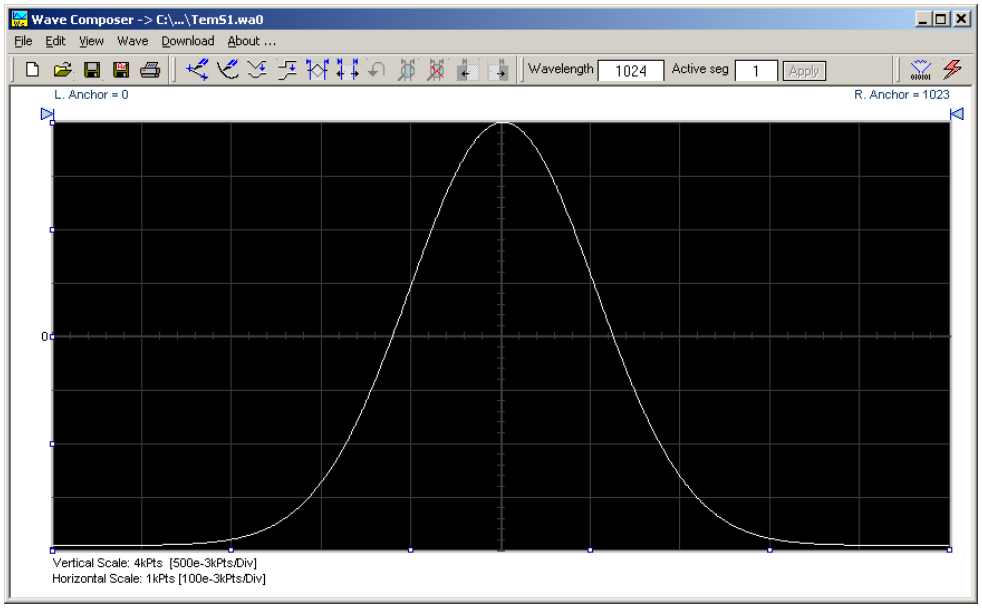


Figure 4-30, Wave Composer Screen

File Menu

The File menu has four selections that control waveform file operations. This menu also can be used to print the active waveform or to exit from Wave Composer. Descriptions of the menu selections from the File pull-down menu are given below.

New Waveform

The New Waveform (Ctrl+N) menu item removes the current waveform from the graph window. Changes made to the waveform graph should be saved before using the New Waveform menu command because this function is destructive to the displayed waveform.

Open Waveform…

The Open Waveform… (Ctrl+O) menu item lets you choose a previously saved waveform file and load it to the waveform graph. This function can also import waveform files of various types to the Wave Composer. The Open Waveform… menu function can import ASCII, *.CSV (comma delimited text), *.PRN (space delimited text), *.0* (LeCroy binary) format, and others. The Open dialog box in Figure 4-31 shows the various file extensions that can be opened into the Wave Composer environment. The file that is opened is automatically converted to the binary *.wav format.

Save Waveform

The Save Waveform (Ctrl+S) menu item lets you store the active waveform as a binary file with a *.wav extension. If this is the first time you save your waveform, the Save Waveform As… command will be invoked automatically, letting you select the name, location, and format for the waveform file.

Save Waveform As…

Use the Save Waveform As… menu item the first time you save your waveform. It will let you select a name, location and format for

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your waveform file.

Print
Lets you print the active waveform graph The standard printer dialog box will appear and will let you setup the printer and print the waveform graph.

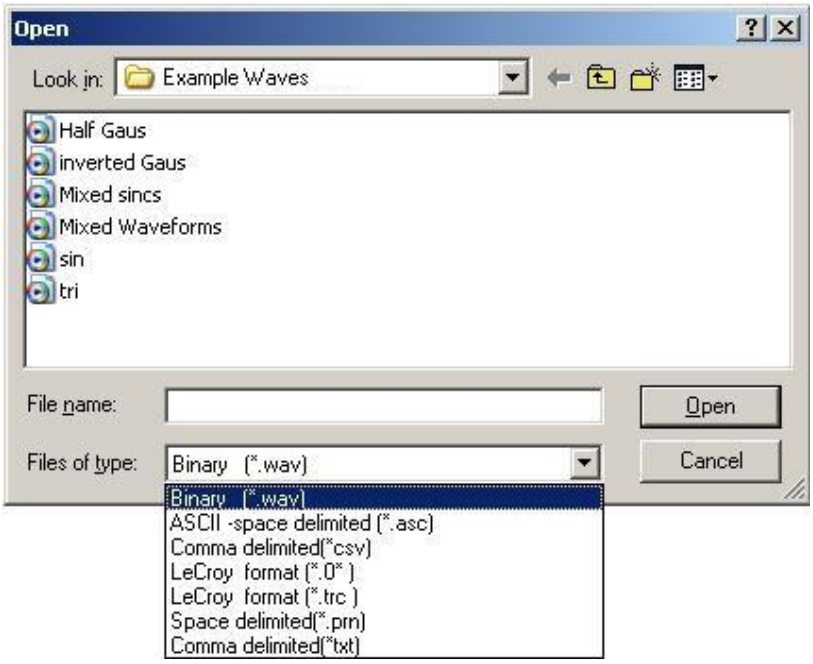


Figure 4-31, Open Waveform Dialog Box

Exit
Ends the current Wave Composer session and takes you back to the Panels screen. If you made changes to your waveform since it was last saved, Wave Composer will prompt you to Save or Abandon these changes.

Edit Menu

The Edit menu is used for manipulating the waveform that is drawn on the graph. The edit operations are explained below.

Autoline
Autoline mode lets you draw one or more connected line segments. To draw a line in Autoline mode, click the left mouse button at the start point. Click again at the next point to complete the line segment, repeating this way until finished creating connected line segments. Click on the right mouse button to terminate Autoline mode.

Sketch
Sketch mode lets you draw freehand segments. To draw in sketch mode, on the waveform graph, drag the cursor using the left mouse button. Release the mouse button when you want to stop. Use the right mouse button to terminate Sketch mode.

Filter

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The Filter operation is calculated using a moving average. This is done by recalculating each point as an average of a number of symmetrical points adjacent to each point. You can filter the entire waveform, or you may chose to filter a segment of the waveform by placing the anchors as boundaries on the left and right of the segment.

Smooth
The Smooth operation lets you smooth out rough transitions in your waveform. This is done mathematically by multiplying the waveform by the nonlinear portion of a cubic curve.

The Smooth operation is done on segments of the waveform graph that are bounded by anchors. Anchor operations are described later in this chapter. Place the anchors to the left and right of the waveform segment to be smoothed and select the Smooth operation. The waveform will change its shape immediately to follow the mathematical pattern of a cubic curve.

Note that small segments with fast transitions, when combined with cubic functions, tend to generate even larger transitions. Therefore, be sure to omit such sections of the waveform when you use the Smooth operation.

Invert
The Invert operation lets you invert the entire waveform or a selected segment of a waveform. The waveform is inverted about the 0-point on the vertical axis.

Trim Left
The trim left command lets you trim waveforms to the left of the anchor point. This command is grayed out if the left anchor was not moved from its original left position. The waveform is trimmed and the point at the left anchor becomes the first point of the waveform.

Trim Right
The trim right command lets you trim waveforms to the right of the anchor point. This command is grayed out if the right anchor was not moved from its original right position. The waveform is trimmed and the point at the right anchor becomes the last point of the waveform.

Unmark
The Unmark operation removes the anchors from the waveform screen and resets anchor positions to point 0 and to the last waveform point.

Undo
The Undo command undoes the last editing operation.

View Commands

The View menu includes operations that let you view various sections of the waveform graph. View operations include: Zoom In, Zoom Out, Hide/Show Toolbars, and Channel selection (for dual channel units only). Descriptions of the view operations are given below.

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Zoom In

The Zoom In operation operates between anchors. Anchors are shown as left pointing and right pointing triangles. The default position of the anchors is the start and the end of the waveform. To move an anchor to a new location, drag the anchor to the left or right as required. If you move the left anchor to the right and the right anchor to the left, the area between the anchors will fill the entire graph when the Zoom In operation is used.

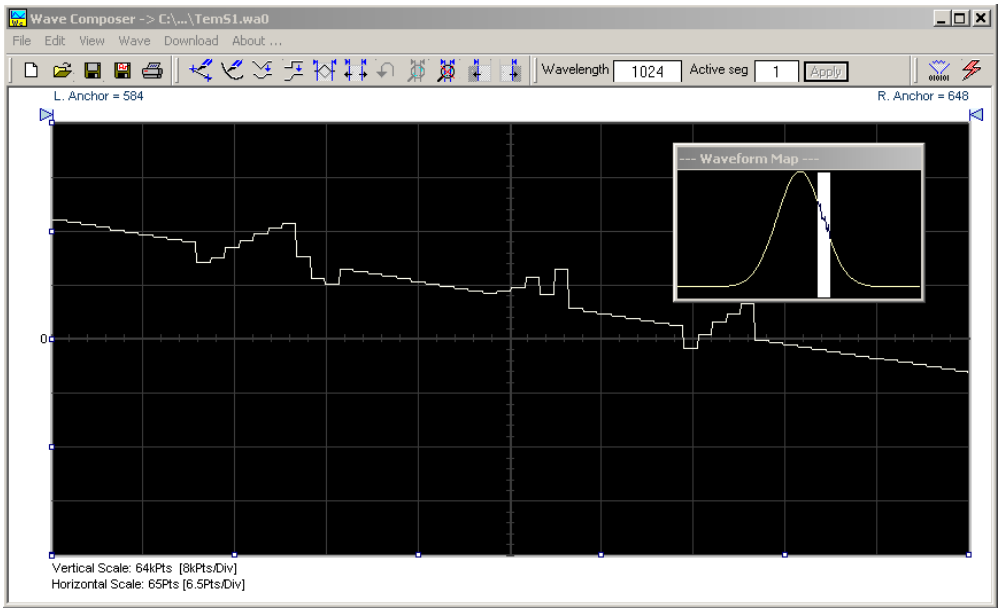


Figure 4-32, Zooming In on Waveform Segments

Looking at the Waveform Map in Figure 4-32, note that the white portion is the zoomed in area. Drag the white area with your cursor to peruse a zoomed in view of any portion of the waveform.

While zoomed in, you can invoke Autoline or Sketch mode.

Zoom Out

The zoom out operation restores the graph to display the complete waveform.

Wave Menu

The Wave menu let you draw standard waveform functions on the graph. The Wave command has a library of 8 standard waveforms: Sine, Triangle, Square, Sinc, Gaussian, Exponent, Pulse, Noise, and DC. It lets you specify a cardiac ECG waveform or a Pulse Width Modulated (PWM) waveform. It also lets you create waveforms using the Equation Editor. Information on how to create waveforms using the Wave menu is given below.

Creating Waveforms From the Built-in Library

You can create any waveform from the built-in library using the Wave menu by clicking on one of the standard wave options to open a dialog box. An example of the Sine waveform dialog box is

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shown in Figure 4-33. This dialog box is similar to the rest of the waveforms, so the other waveform dialog boxes will not be described here.

Creating Sine Waveforms

Use the following procedure to create sine waveforms from the built-in library. Click on Wave, then sine… and the dialog box as shown in Figure 4-33 appears. You can now start programming parameters that are available in this box.

Start Point – Defines the first point where the created wave will start. Note that if you change the start point the left anchor will automatically adjust itself to the selected start point. The example shows start point set at point 0.

End Point – Defines where the created waveform will end. Note that as you change the end point the right anchor will automatically adjust itself to the selected end point. The example shows end point set at point 499.

Cycles – The Cycles parameter defines how many sine cycles will be created within the specified start and end points. The example below shows five sine cycles.

Amplitude – 12-bit resolution waveforms have 4096 levels and 16-bit resolution waveforms have 65,536 levels. The Amplitude parameter defines how many of these steps are used for generating the sine. The example is showing a sine waveform with maximum peak-to-peak amplitude for a 12-bit waveform. Any number range below the maximum and minimum values generates a sine with reduced dynamic range.

Start Phase – The start phase parameter defines the angle at which the sine will start. The example shows start phase of 90°.

Power – The example shows sine cubed. Sine to the power of 1 will generate a perfect sine. Power range is from 1 through 9.

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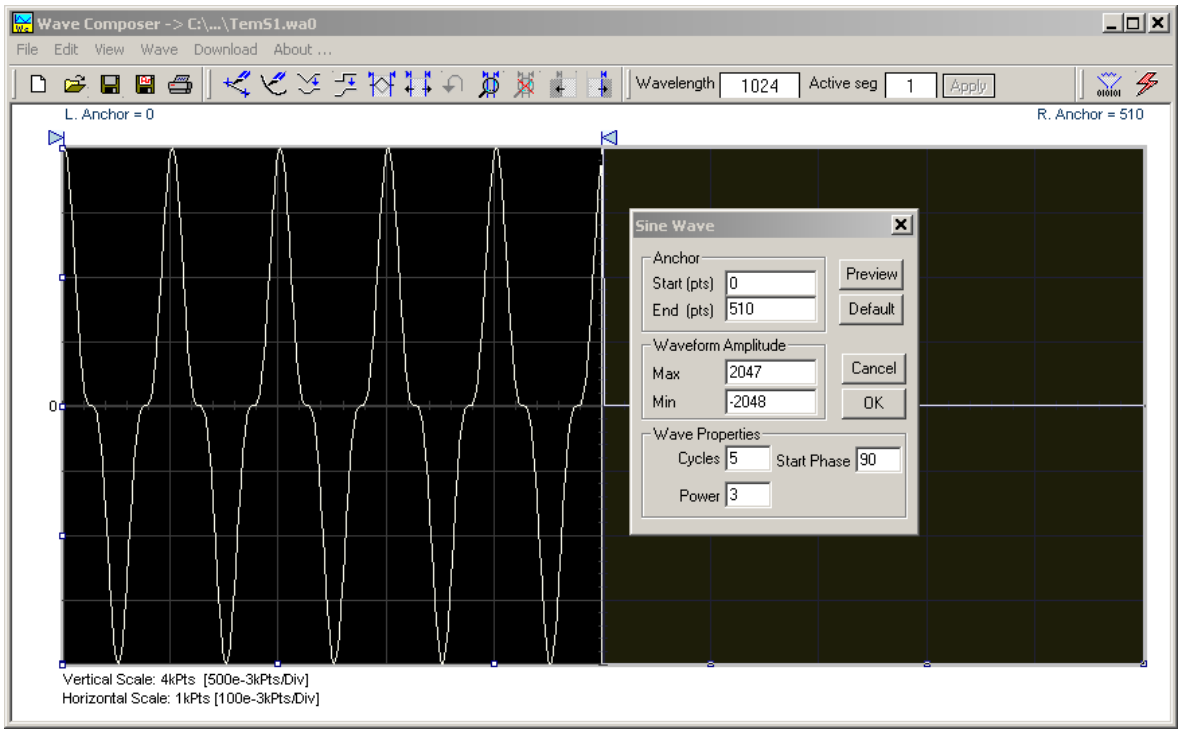


Figure 4-33, Generating Distorted Sine Waves from the Built-in Library

The Toolbar

The toolbar contains icons for editing the waveform screen, icons for saving and loading waveforms, fields for selecting an active channel and for adjusting segment length and more. The Toolbar is shown in Figure 4-34. For the individual icons, refer to the descriptions above of the Wave Composer Menus.



Figure 4-34, Toolbar Icons

The Waveform Screen

Waveforms are created and edited on the waveform screen. Figure 4-35 shows an example of a waveform created using the equation editor and the anchors to limit generation of the waveform to between points 100 and 900. The various elements of the waveform graph are described below.

The waveform graph has two axes – vertical and horizontal. Both axes are divided into points.

The vertical axis represents 12-bits (4k levels) of resolution with 3152B legacy mode selected or 16-bits (64k levels) of vertical resolution when modern mode operation is selected.

The horizontal axis, by default has 1024 points (from point 0 to 1023). This number can be changed using the Wave Length field in the Toolbar. The maximum length depends on the memory installed

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in your instrument. The wave composer will let you define the horizontal axis to a maximum of 1 Meg words with standard 1MB memory and 4 Meg words with the 4MB memory expansion option (where available).

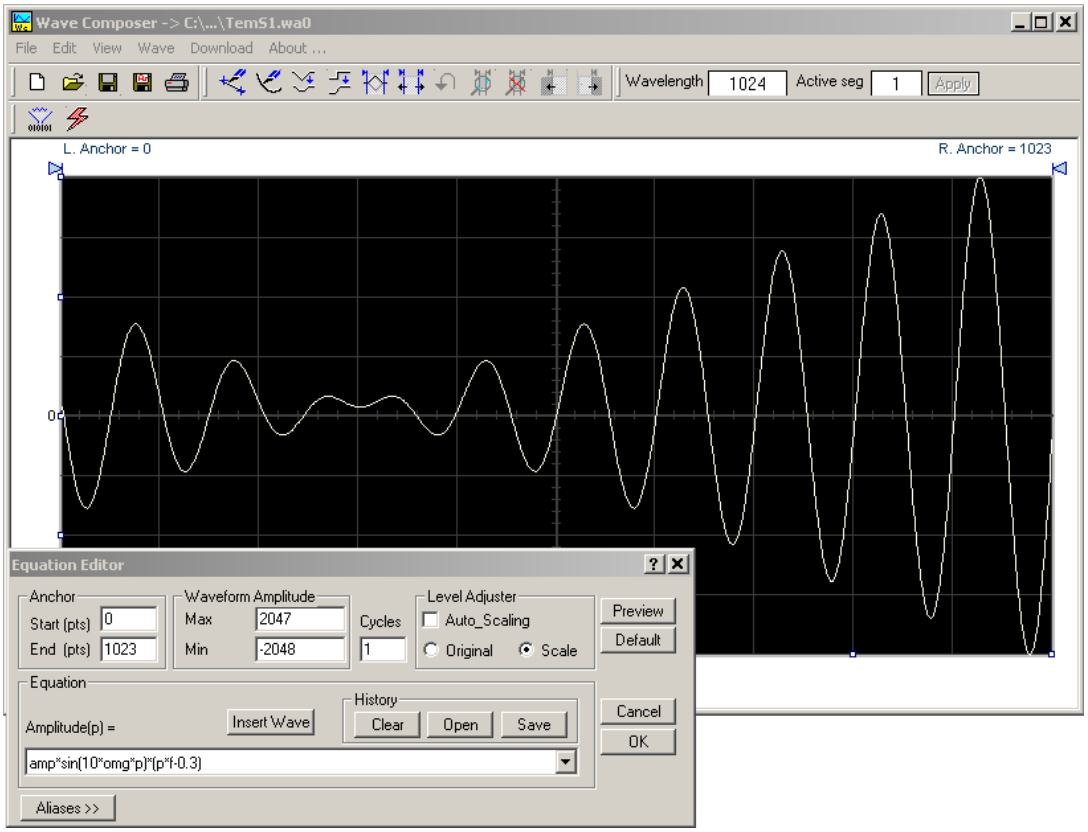


Figure 4-35, Waveform Screen

Notice that on the left top and right top there are two triangles pointing to the center of the screen. These are the anchors. The anchors are used as the start and end pointers for waveform creation. For example, if you want to create a sine waveform between point 100 and point 500, you place the left anchor at point 100 and the right at point 500 and then generate the sine from the built-in library.

There are two ways to control anchor placements.

1) Drag the left anchor triangle to the desired left position. Do the same for the right anchor. Notice that the anchor coordinates appear at the top of the waveform screen and that they change to correspond with your anchor placements.

2) You can also place your anchors in a more precise manner from the waveform library by programming the start and end points for the waveform. An example of anchor placement using the sine dialog box is shown in Figure 4-33.

Finally, when you are done creating and editing your waveform, you can save your work to a directory of your choice. The name of the

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waveform file will be displayed in Wave Composer's title bar, including the path.

Generating Waveforms Using Equation Editor

A more general purpose way to create waveforms using ArbConnection is to use Equation Editor. Equation Editor let you write equations for the desired waveform and lets ArbConnection calculate the values and display them on the graph. Equation Editor detects syntax errors and can auto-scale your waveforms so that no dynamic range is lost.

When you invoke Equation Editor, the dialog box shown in Figure 4-36 appears. The following paragraphs describe how to use the features of Equation Editor..

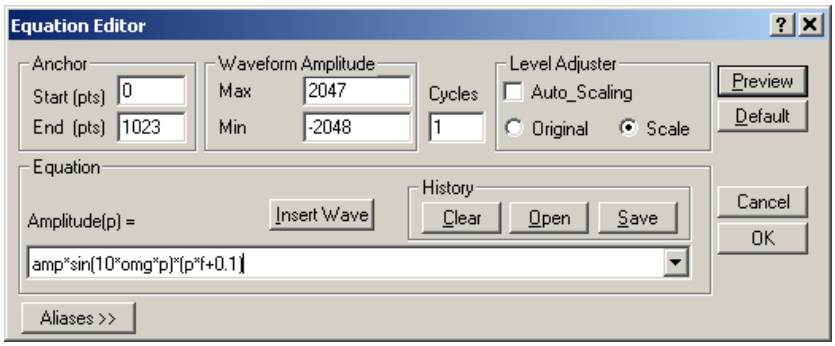


Figure 4-36, Equation Editor Dialog Box

There are four sub-group parameters in the equation editor plus control buttons and the equation field. These parts are described below.

Anchor

The anchors define start and end point at which the equation will be generated. By default the anchors are placed at the start and the end of the horizontal (time) scale however, the equation can be limited to a specific time scale by moving the anchor points from their default locations.

Start – defines the first point where the created wave will start. Note that if you change the start point the left anchor will automatically adjust itself to the selected start point.

End – defines where the created waveform will end. Note that as you change the end point the right anchor will automatically adjust itself to the selected end point.

Waveform Amplitude

The vertical axis of the Wave Composer represents 16-bits of vertical resolution. That means that the equation is computed, resolved and generated with 1/65,536 increments and accuracy. The Waveform Amplitude fields in the Equation Editor are used in two cases: 1) when the "amp" parameter is used in the equation or 2 if the Level Adjuster is set to Auto. Information on these two

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operations is given later.

Max – defines the positive peak of the vertical axis

Min – defines the negative peak of the vertical axis

Cycles

The Cycles parameter defines how many waveform cycles will be created within the specified start and end anchor points.

Level Adjuster

The Level Adjuster is a convenient tool that helps you adjust the amplitude and offset without modifying your equation. The Level Adjuster mode does not interfere with your calculations and displays the waveform as computed from your equation. The only difference is that your final calculations are stretched or shrunk or offset on the vertical scale to fit the new amplitude and offset boundaries.

If you change the Max and Min setting in the Waveform Amplitude fields and press the Adjust key, your waveform will offset immediately without changing the equation. The same way, you can also change amplitude only or both amplitude and offset. If you check the Manual option, you'll have to click on the Adjust button for the Waveform Amplitude parameters to take effect. The Adjust button name will change to Restore and back to Adjust if you click on it again. If you check the Auto option, your waveform will be created automatically with the new Amplitude setting.

Equation

The Equation group has four buttons and the equation field. You will be using the Equation field for writing your equations. Equation syntax and conventions are discussed in the following paragraphs. The *Remove* button clears the equation field so you can start typing a new equation. Click on the *Store* button to store your equation if you intend to use it again. The Browse button provides access to waveform pre-stored files in your computer for combining them in new equations. The *Operands* button expands the bottom of the dialog box to show the operands you can use with your equation.

While you type and store equations, they are collected in a history file and can be used again by expanding the history log from the equation field.

Control Buttons

There are four control buttons at the right corner of the dialog box. Use the *Preview* button to preview an image of your equation, or use the *OK* button to place your waveform on the waveform screen and to leave the dialog box on the screen. The *Default* button restores the parameters in the equation editor to their original factory default values. The *Cancel* button will remove the dialog box from the screen and will discard of any waveforms that you previewed with your Equation Editor.

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Writing Equations

The Equation Editor lets you process mathematical expressions and convert them into waveform coordinates. As you probably already know, waveforms are made of vertical samples. The number of samples on your waveform is determined by the wavelength parameter. For example, if you have 1024 horizontal points, your equation will be computed along 1024 points as a function of the vertical scale. Each vertical sample is computed separately and placed along the horizontal axis. The points are graphically connected to form a uniform and continuous waveform shape however, if you zoom in on a waveform line, you'll see that the points are connected like a staircase. In reality, the 3152B generates its waveforms exactly as shown on the screen but, if the waveform has many horizontal points, the steps get smaller and harder to see without magnification.

Equations are always computed as a function of the vertical (Amplitude) axis therefore the left side of your equation will always look as Amplitude(p) =, where "p" is the equation variables in units of waveform points. You can write equations with up to 256 characters. If the equation is too long to fit in the visible field, parts to the left or right will scroll off the ends.

Equation Conventions

Equations are written in conventional mathematical notation. You may only enter the right part of the equation. The only limitation is that the equation must be of a single variable that is directly related to the current horizontal axis setting. Case is not important and spaces are ignored. Numbers are entered in scientific notation. All calculations are done with double precision. For trigonometric functions, all angles are expressed in radians.

A number of constants are provided: e, which is the base of the natural logarithm; pi, which is the circumference of a unit-diameter circle; per, which equals the programmed horizontal range; f, which equals 1 /per; omg, which equals 2 * pi * f, and numbers in the range of -1E^20 to 1E^20.

There are three classes of precedence: ^ (raise to power) has the highest precedence; * (multiply) and / (divide) come second; + and - have the lowest precedence. Parentheses may be used to change the order of precedence. The following table summarizes the mathematical expressions and their respective abbreviated commands that can be used with Equation Editor.

Equation Editor Operands

^	Raise to the power
*	Multiply
/	Divide
+	Add
-	Subtract
( )	Parentheses
e	Base of natural Logarithm

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pi (π)	Circumference of unit-diameter circle
per	Horizontal wavelength in points
f	I/per
omg (ω)	2*π*f
amp	Amplitude in units of points or Hertz
sin(x)	The sine of x*
cos(x)	The cosine of x*
tan(x)	The tangent of x*
ctn(x)	The cotangent of x*
log(x)	The base IO logarithm of x*
In(x)	The natural (base e) logarithm of x*
abs(x)	The absolute value of x*
-1E^20<>1E^20	Numerals, equation constants

*substitute your mathematical expression for x

After you get familiar with the operands and conventions, you can try a few simple equations and see how they create waveforms.

Typing Equations

Recall that a straight line is defined by Y as a function of X as in the equation Y = mX + b. You can use this to generate a straight line using Equation Editor. Assuming first that p = 0, try this:

Amplitude(p)=1000

Press [Preview] and see what you get. Of course, you get an uninteresting line that runs parallel to the X-axis. Now, lets give the line some angle by typing:

Amplitude(p)=-2*p+2000

Press [Preview] and see that the line slopes down. It may still be not very interesting however, pay close attention to the convention that is used in this equation. You cannot type: Amplitude(p)=-2p+1000, like you would normally do in your notebook; You must use the * (multiply) sign, otherwise you'll get a syntax error. Now we'll try to generate a simple sine waveform. Try this:

Amplitude(p)=sin(10)

Press [Preview] and… sorry, you still get nothing on the screen. The Wave Composer did not make a mistake! The sine of 10 in radians is exactly what it shows. You are unable to see the result because the line on your screen running across the 0 vertical point.



REMEMBER

The equation must be a function of a single variable and that variable must be directly related to the Horizontal axis Scale setting.

Now try this:

Amplitude(p)=sin(omg*p)

Still no good, but now press the [Adjust] button and here is your

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sinewave. So what's wrong? Well, if you'll give it a little amplitude it might help so, do it now exactly as follows:

Amplitude(p)=8000*sin(omg*p)

There you go. You should now see a perfect sine waveform with a period of 1000 points. This is because you have asked the Equation Editor to compute the sine along p points ("p" is the equation variable, remember?). If you want to create 10 sine waveforms, you should multiply p by 10. Try this:

Amplitude(p)=8000*sin(omg*p*10)

Equation Examples

So far, you have learned how to create two simple waveforms: straight lines and trigonometric functions. Let's see if we can combine these waveforms to something more interesting. Take the straight line equation and add it to the sinewave equation:

Amplitude(p)=12000*sin(omg*p*l0)-8*p+4000

Press [Preview]. Your screen should look like Figure 4-37.

Now let's try to modulate two sine waves with different periods and different start phase. Type this:

Amplitude(p)= 12000*sin(omg*p)*cos(omg*p*30)

Press [Preview]. Your screen should look like Figure 4-38.

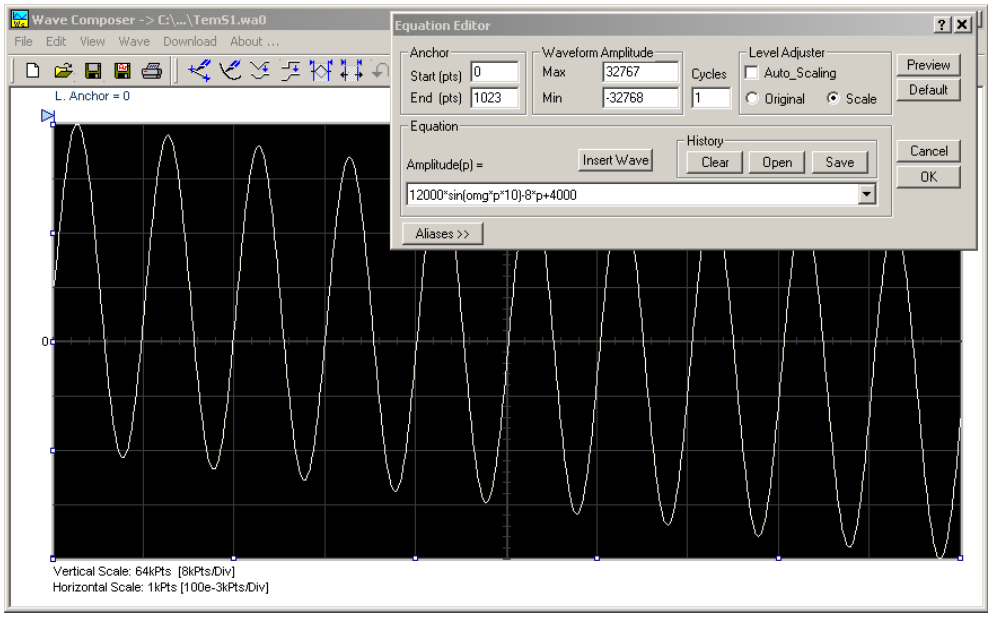


Figure 4-37, Equation Editor Example

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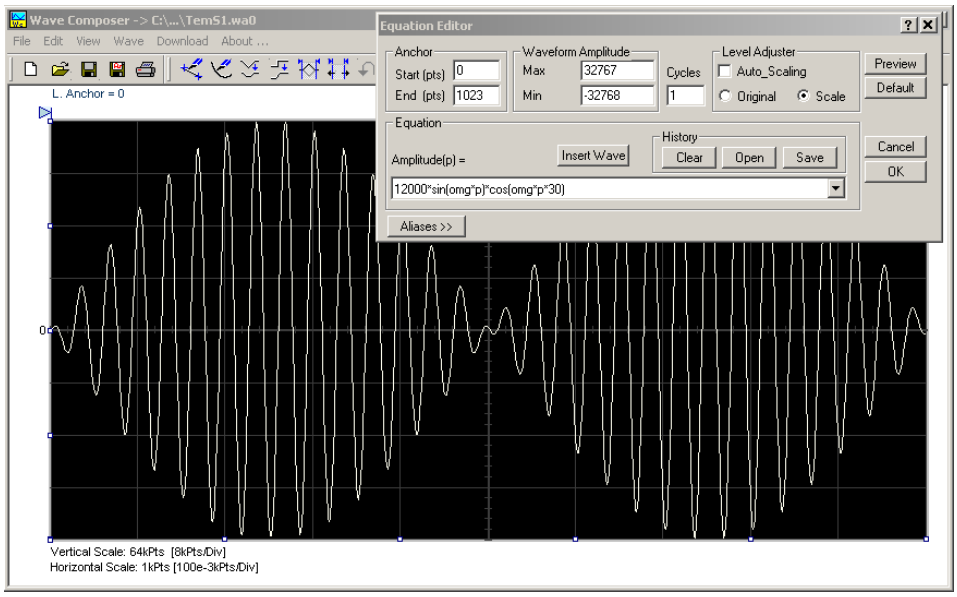


Figure 4-38, Using the Equation Editor to Modulate Sine Waveforms.

In the following example, 20% second harmonic distortion has been added to a standard sinewave. The original waveform had a peak-to-peak value of 24000 points so 19% second harmonic is equivalent to 4500 points. The frequency of the second harmonic is obviously double that of the fundamental, so term +4500*sin(2*omg*p) is added to the original sine wave equation. Use the following equation:

Amplitude(p)=24000*sin(omg*p)+4500*sine(2*omg*p)

Press [Preview]. Your screen should look like Figure 4-39.

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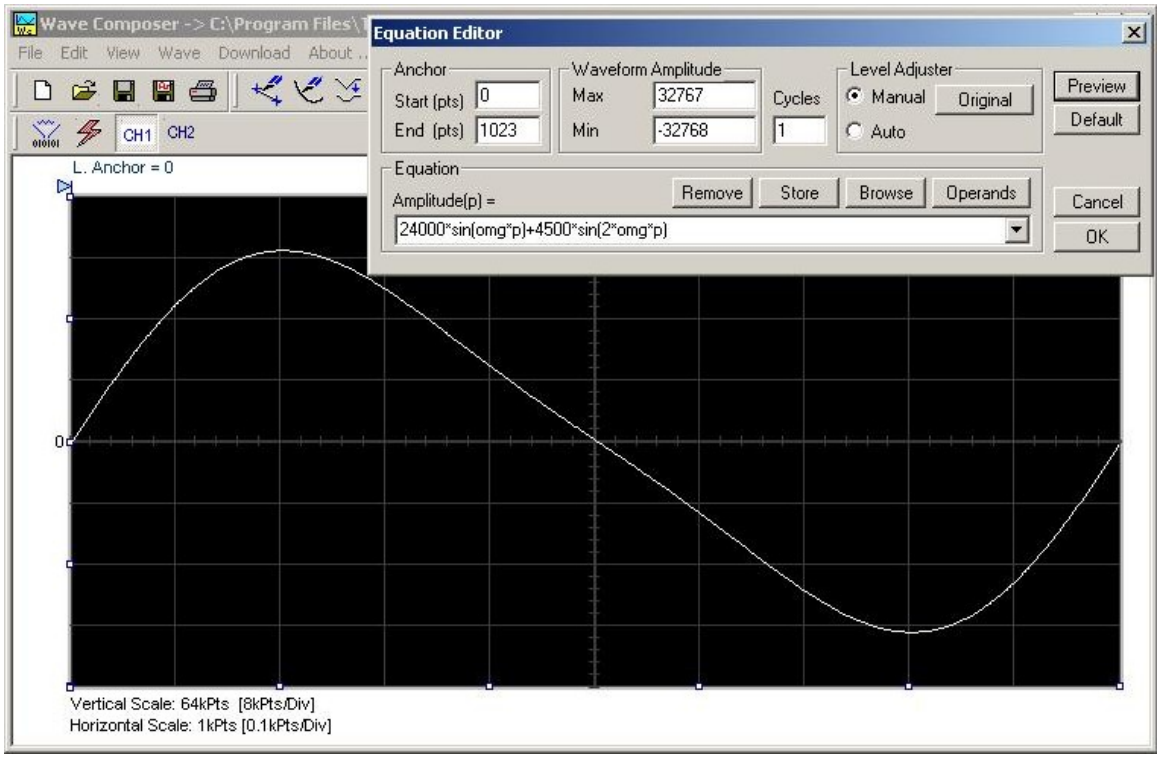


Figure 4-39, Using Equation Editor to Add Second Harmonic Distortion.

In Figure 4-40 we created 10 cycles of sinewave made to decay exponentially. The original expression for a standard sinewave is multiplied by the term e^(p/-250). Increasing the value of the divisor (200 in this case) will slow down the rate of decay.

Use the following equation:

Amplitude(p)=12000*sin(omg*p*10)*e^(p/-250)

Press [Preview] and [Accept] and the waveform graph should look like Figure 4-40.

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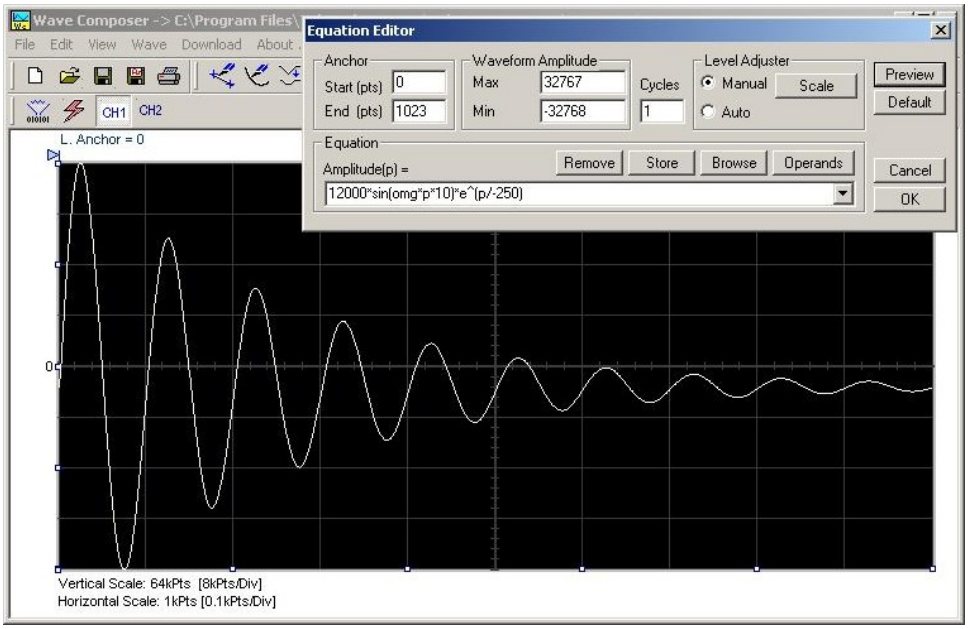


Figure 4-40, Using the Equation Editor to Generate Exponentially Decaying Sinewave

The last example as shown in Figure 4-41 is the most complex to be discussed here. In this example, 100 cycles of a sine wave are amplitude modulated with 10 cycles of sine wave with a modulation depth of 20%. To achieve this, the upper and lower sidebands are defined separately and added to the fundamental or carrier. The upper sideband is produced by the expression 100*cos(110*omg*p) and the lower sideband by the term 100*cos(90*omg*p).

Use the following equation:

Ampl(p)=6000*sin(100*omg*p)+1200*cos(110*omg*p)-1200*cos(90*omg*p)

Press [Preview] and [Accept] and the waveform graph should look like Figure 4-41.

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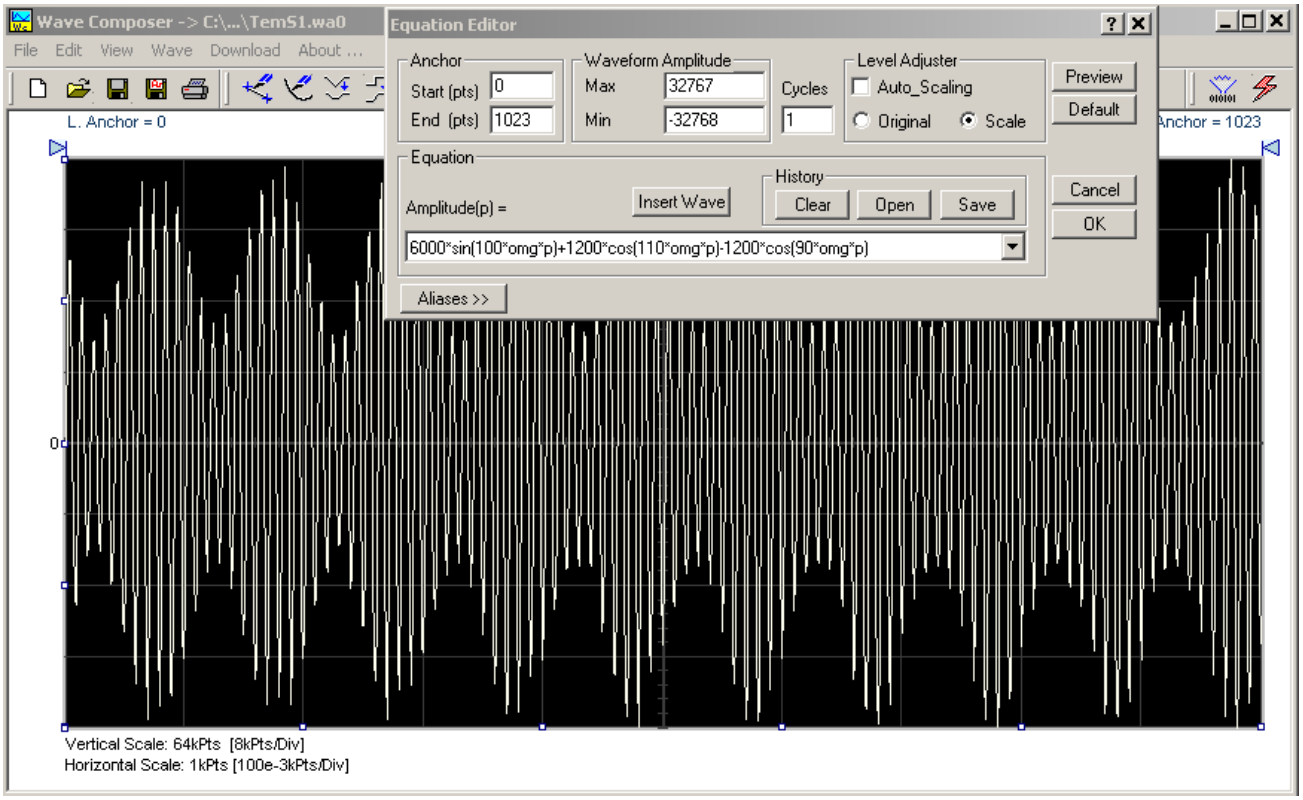


Figure 4-41, Using Equation Editor to Build Amplitude Modulated Signal with Sidebands

Combining Waveforms

The last feature to be described here allows you to combine waveforms which were previously stored in a file. You can write mathematical expressions that contain waveforms, simple operands, and trigonometric functions similar to the example given below. If you want to use stored waveforms in your equations, you must first generate these and store them in files. If you have stored files named Sine.wav and Noise.wav in the Wav12bit folder, you can enter them into your equation as shown.

Amplitude(p)= Sine.wav*sin(omg*p*10)+Noise.wav/1000

The above equation generates an amplitude modulated waveform with added noise. Note: You can also browse for .wav files stored in any folder using the Insert Wave button in the Equation Editor dialog box.

The following steps demonstrate how to create, store and combine waveforms using this example.

Step 1 – Create and store Sine.wav. Invoke the Wave command and generate a sine waveform. Press OK and then select the Save Waveform As… from the File command. Save this file into the default folder using the name Sine.wav in the default folder.

Step 2 – Create and store Noise.wav. From the Wave command select Noise. Click OK and watch your waveform screen draw a

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noise signal. From the File menu select Save Waveform As… and save this waveform into the default folder using the name Noise.wav.

Step 3 – Write and compute the original equation:

Amplitude(p)= Sine.wav*sin(omg*p*5)+Noise.wav/10

Press [Preview] and [Accept] and the waveform graph should look like Figure 4-42.

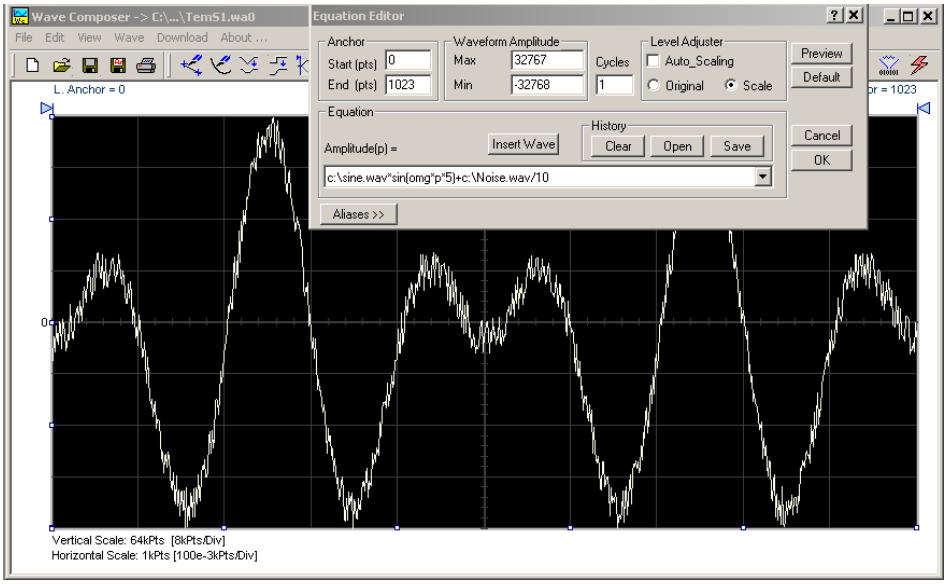


Figure 4-42, Combining Waveforms into Equations

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The Pulse Composer

The Pulse Composer is a tool for creating and editing pulses without the need to think about sample clock, number of points and complex equations. Pulses are created on the screen, simply and efficiently in a special dialog box by typing in the width and level, or by using the "rubber band" method to place straight line segments with the exact amplitude and time duration. The Pulse Composer can also multiply pulse sections to create pulse duplication along lengthy time intervals.

When you finally have your pulse design on the screen the program determines if the pulse design will fit in one memory segment or use multiple segments and employ the sequence generator for repeatable segments. In either case, bear in mind that if you already have some waveforms stored in memory segments, these will be erased to make room for the new pulse design. If you insist on keeping arbitrary waveforms and still download complex pulses, you can check the "Force pulse to one segment" option and the 3152B will do some extra "muscle flexing" to fit the pulse as required.

To launch the Pulse Composer point and click on the Pulse tab in the Panels bar. Figure 4-43 shows an example of the Pulse Composer. The Pulse Composer has three main sections: Commands bar, Toolbar and Waveform screen.

Refer to Figure 4-43 throughout the descriptions to follow.

The Pulse Composer Menu Bar

The Pulse Composer menu bar provides access to standard Windows commands such as File and View. In addition, there are ArbConnection-specific commands such as Edit, Wave and System.

In general, clicking on one of the menus pulls down a list of commands. Clicking on a listed command may then either open a dialog box or generate an immediate action. For example, clicking on File and then Exit will cause the immediate termination of the Pulse Composer. The various commands in the Commands bar are listed and described below.

File Menu

The File menu has 4 menu items that control pulse waveform file operations. This menu also can be used to print the active waveform or to exit from Pulse Composer. Descriptions of the menu selections from the File pull-down menu are given below.

New

The New (Ctrl+N) menu item clears the pulse graph. Changes made to the pulse graph should be saved before using the New function because it is destructive to the displayed pulse.

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Open…

The Open… (Ctrl+O) menu item lets you choose a previously saved pulse file and load it to the Pulse Composer graph. The *.PLS file extension, which is a text format, is supported by this operation.

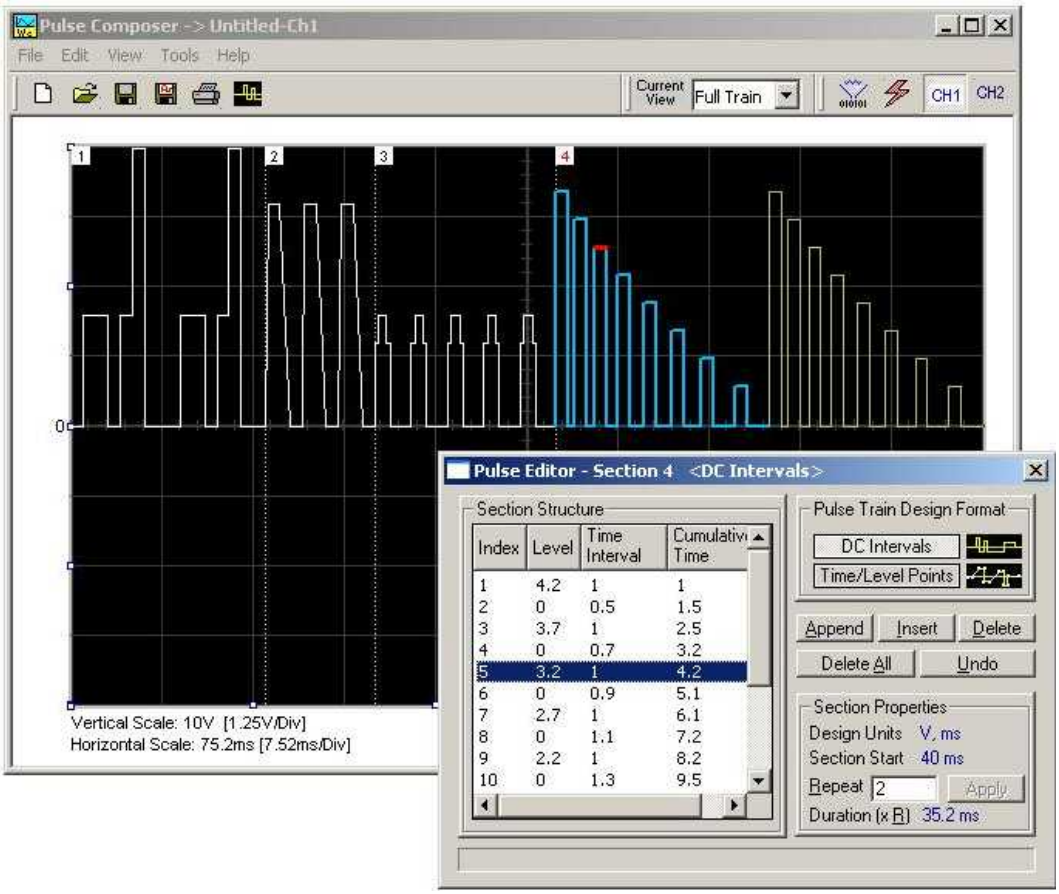


Figure 4-43, Pulse Composer Screen

Save

The Save (Ctrl+S) menu item lets you store your active waveform as a text file with a *.pls or *.wav extension. If this is the first time you save your pulse, the Save As… command will be invoked automatically, letting you select name, path, and format (*.pls or *.wav) for your pulse file.

Save As…

Use the Save As… menu item the first time you save your pulse. It will let you select name, location and format for your pulse file.

Print

With this men u selection you may print the active Pulse Window. The standard printer dialog box will appear and will let you select printer setup or print the waveform page.

Exit

The Exit menu item ends the current Pulse Composer session and

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takes you back to the Panels screen. If you made changes to your pulse since it was last saved, the Pulse Composer will prompt you to Save or Abandon changes these changes.

Edit Menu

The Edit menu isused for adding or removing pulse train sections. Use these commands to Append, Delete, Insert, or Undo last operation. The editing commands are explained in the following paragraphs.

Append Section
The Append Section menu command lets you append a new section at the end of the pulse train. Only one new section can be appended at the end of the train. If an empty section already exists, the append command will give an error. New sections are always appended at the end of the pulse train.

Insert Section
The insert Section menu command lets you insert a new section in between sections that were already designed. Only one new section can be inserted at the middle of the train. If an empty section already exists, the insert command will give an error.

Delete Section
The Delete Section menu command lets you remove sections from the pulse train without affecting the rest of the train. If you use this command from the Edit menu, make sure that the section you want to remove is currently the active section.

Remove all Sections
The Remove all Sections menu command lets you remove the entire pulse design from the pulse screen and start with a fresh page.

Undo
The Undo command reverses the last editing operation. This command is extremely useful in cases where you unintentionally delete a section from the pulse train and want to restore it to the pulse graph.

View Menu

The View menu lets you view various sections of the pulse graph. The View menu include: Pulse Editor, Full Train, Single Sections, and Options. Descriptions of the view menu items are given below.

Pulse Editor
The view Pulse Editor menu item invokes a dialog box as shown in Figure 4-44. In general, the Pulse Editor is used for placing straight line segments on the screen in intervals that define pulse width, rise/fall time, and amplitude. Information how to use the Pulse Editor to create pulse trains is given later in this chapter.

Full Train
The view Full Train menu item shows on the pulse graph all

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sections of the pulse train. Eventually, when all pulse sections have been designed, the entire pulse train as shown when the Full Train option has been selected will be downloaded to the instrument as a single waveform.

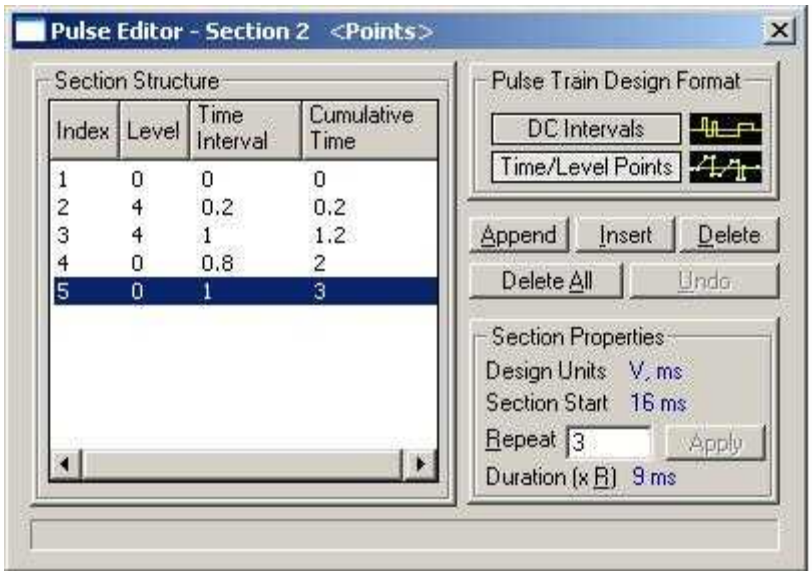


Figure 4-44, Pulse Editor

Single Section

The view Single Section menu item shows on the pulse graph one section at a time. Eventually, when all pulse sections have been designed, the entire pulse train as shown when the Full Train option has been selected will be downloaded to the instrument as a single waveform.

Options

The view options menu item opens the dialog box as shown in Figure 4-45. Use this dialog box to fine-tune the Pulse Composer to the way it should deal with operational modes and the waveform memory. Information on options is given later in this chapter.

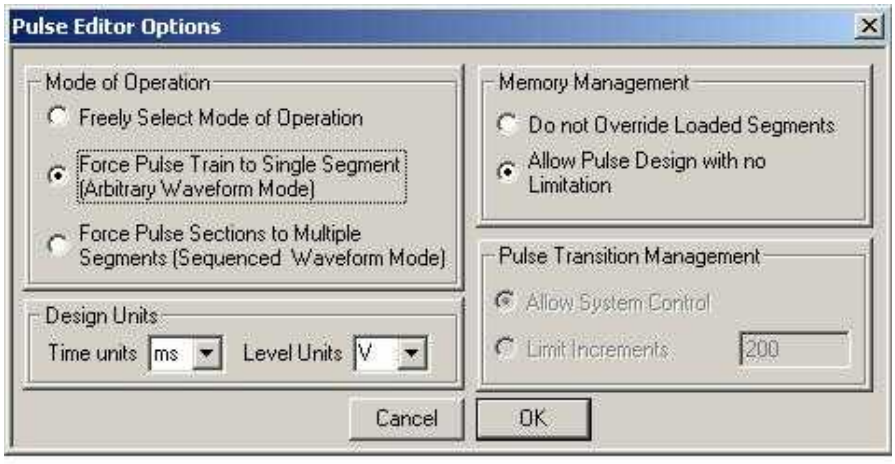


Figure 4-45, Pulse Editor Options

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Tools Menu

The Tools menu lets you download pulse trains. You can also clear the entire pulse waveform memory using the Clear memory command.

Note

The Clear Memory command affects the entire waveform memory of the 3152B. Be careful not to erase memory segments that you need to use and that haven't already been backed up.

The Pulse Composer Toolbar

The Pulse Composer toolbar (Figure 4-46) contains icons for editing the waveform graph, icons for saving and loading waveforms, fields for selecting an active channel, and more. The icons, from left to right, operate the following functions: New waveform, Open an existing waveform file, Save pulse train, Save pulse train As, Print the screen, and open the Pulse Editor dialog box. Other icons select the current view on the screen, clear the memory and download the displayed pulse train to the active channel.



Figure 4-46, Pulse Composer Toolbar

Creating Pulses

As was mentioned above, creating pulses with the Pulse Composer is simple, intuitive, and can save you time when non-trivial pulses are needed. The Pulse Composer takes your design and processes the information, determines the appropriate instrument settings, and converts the pulse into a waveform for download to the instrument.

There are a number of terms that will be used throughout the following description. Make yourself familiar with these terms before attempting to use the Pulse Composer.

Pulse Editor
The Pulse Editor is the prime tool for creating pulses. To invoke the Pulse Editor, point and click on the Pulse Editor icon on the Pulse Composer toolbar. You can also invoke the editor by clicking on the Section Number icon as will be shown later in this description. The Pulse Editor dialog box is shown in Figure 4-44.

Pulse Train
The Pulse Train view exposes the entire pulse design. When downloading the waveform to the instrument, the entire pulse train is downloaded, regardless of the display mode

Pulse Section
A pulse train is constructed of 1 or more sections. If the pulse is simple, it can be created using one section only. For more complex pulse trains, the full train can be divided to smaller sections with

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each section designed separately. Figure 4-47 shows a complex pulse train which was made from five simpler sections and Figure 4-48 shows the design of the fifth section only of the pulse train.

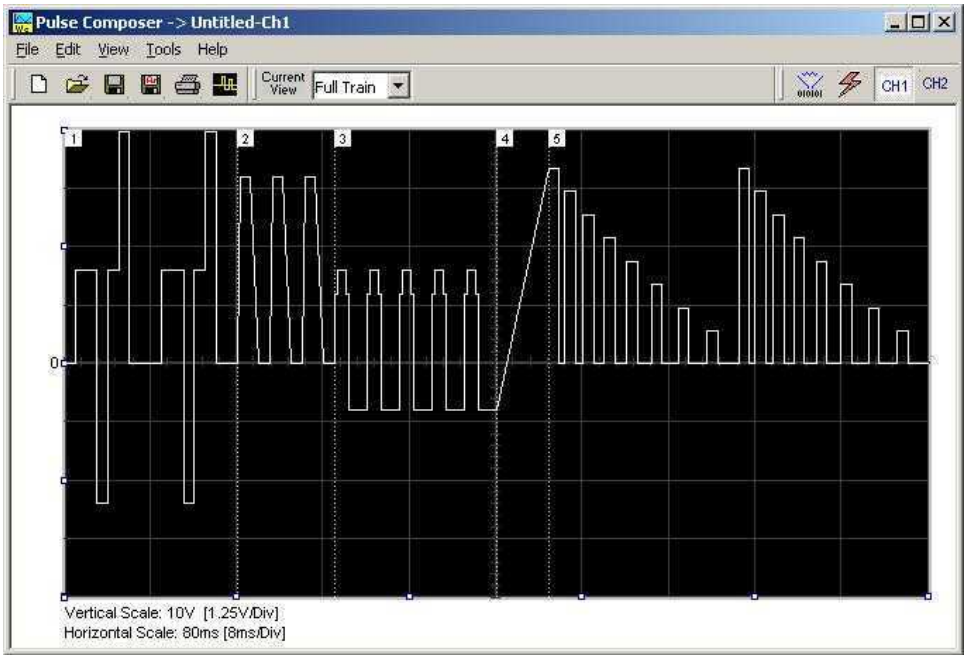


Figure 4-47, Complete Pulse Train Design

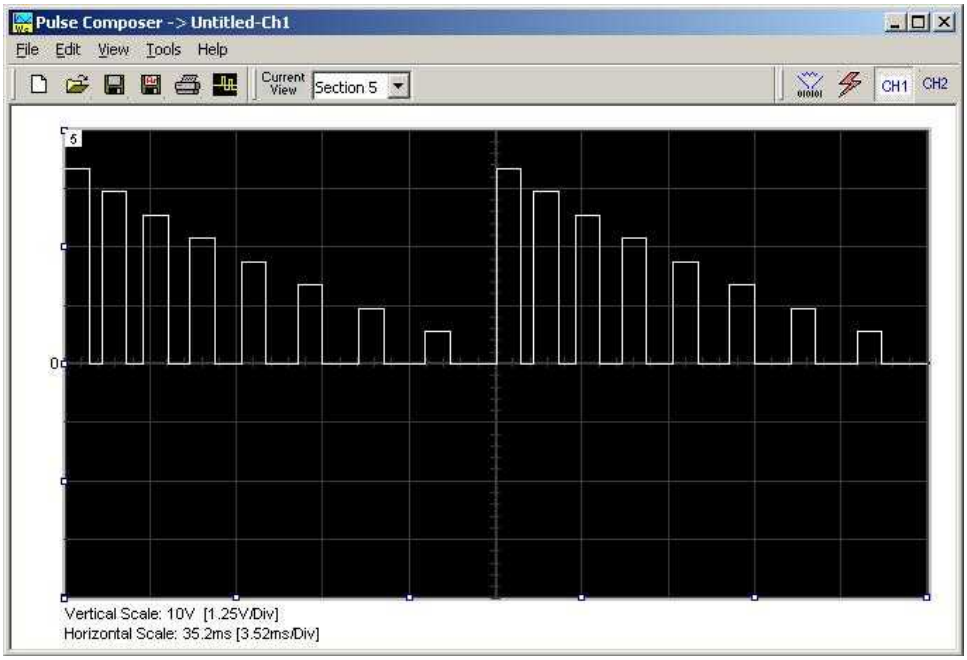


Figure 4-48, Section 5 of the Pulse Train Design

Now that we somewhat understand the Pulse Composer terminology, we can start with an example of how to design a pulse

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train like the one shown in Figure 4-48. If you already have some pulses shown on your Pulse Composer graph, click on New to start with a fresh page. Another initial step is to set the design parameters in the options menu to determine the way that the pulse will be stored in the 3152B waveform memory. Click on View→Options and refer to Figure 4-49 throughout the following description.

Setting the Pulse Editor Options

As shown in Figure 4-49, the Pulse Editor option dialog box is divided into four functional groups: Mode of operation, Design Units, Memory Management, and Pulse Transition Management. These groups are described below.

Mode of Operation

There are three options in the mode of operation group:

Freely Select Mode of Operation - use this mode of operation to let the generator decide for itself how to create pulses in 3152B waveform memory.

Force Pulse Train to Single Segment - recommended if you are using one pulse section only. In this case, the pulse waveform will occupy one segment only and the generator will automatically be set to operate in arbitrary mode.

Force Pulse Sections to Multiple Segments - places each section of the pulse train into a different memory segment and the generator will automatically be set to operate in sequenced mode. Select this option for the example we are going to build later.

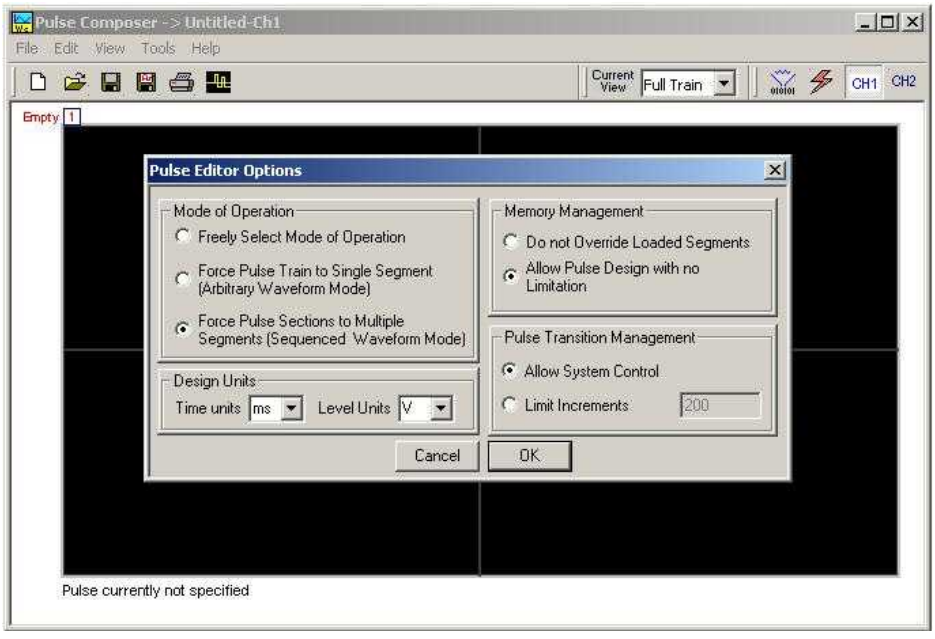


Figure 4-49, Selecting Pulse Editor Options

Design Units

As you design your pulse pattern, it is easiest to design it using the

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same engineering units as are used in your pulse specification.

Time Units - Select between μs, ms and s for the pulse interval

Level Units – Select between mV or V for the amplitude level.

The ms and V units will be used in the example to follow.

Memory management
There are two options in the memory management group.

Do Not Override Loaded Segments - makes sure that Pulse Composer does not overwrite waveforms already stored in memory.

Allow Pulse Design With No Limitations - allows Pulse Composer to overwrite waveforms already stored in memory.

Pulse Transition management
The pulse transition management parameter defines for the program how many waveform points will be used to step from one amplitude level to another amplitude level. The longer the transition time, the more steps the program will need to smooth the transition.

Allow System Control – Lets the 3152B decide how to make the transitions efficient in terms of memory usage and slope smoothness.

Limit Increments – Lets you manually control how many waveform points are used in transitions.

After you complete setting the Pulse Editor options, click on OK.

Using the Pulse Editor

The prime tool for building pulse patterns on the Pulse Composer screen is the Pulse Editor. To invoke the Pulse Editor, click on the Pulse Editor icon on the Pulse Composer toolbar and the editor shown in Figure 4-50 appears. Refer to this figure for the following descriptions.

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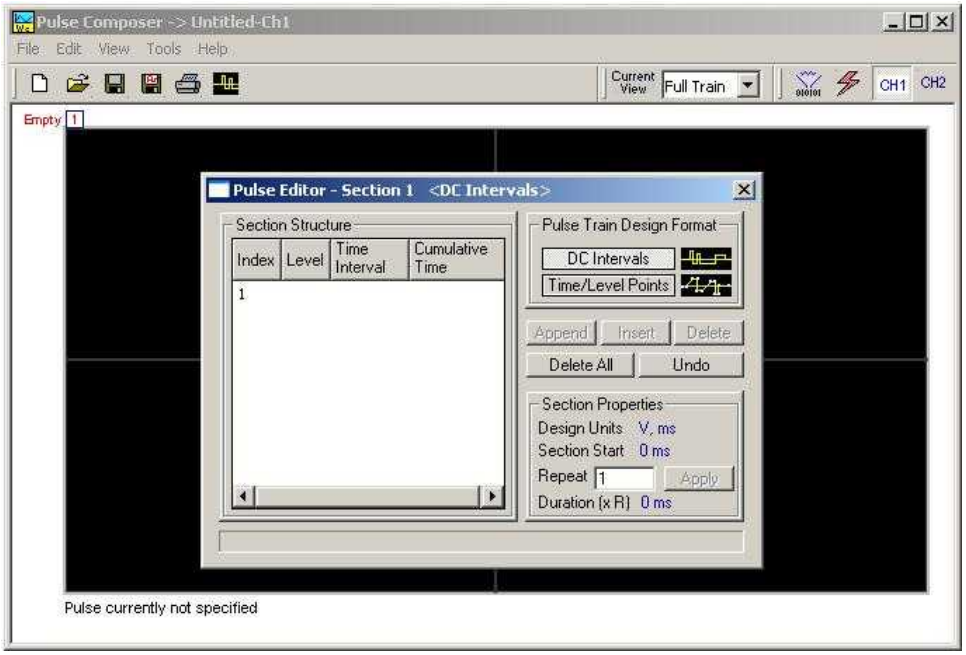


Figure 4-50, Using the Pulse Editor

The Pulse Editor has four groups: Section Structure, Pulse Train Design Format, Section Properties, and control buttons. These groups are described below.

Pulse Train Design Format

There are two methods (or formats) that can be use for designing the pulse shape: DC Intervals and Time/Level Points. The design format is unique for the current section and cannot be switched in the middle of a pulse section design.

DC Intervals – programs pulse duration using DC levels only. Transition times for this format are at the maximum rate that the generator can produce. For example, if you want to draw a simple square waveform that has a 0V to 3.3V amplitude, a 50% duty cycle, and a 1ms period, you enter the following parameters:

Index = 1, Level = 3.3, Time interval = 0.5 (Cumulative Time = 0.5)
Index = 2, Level = 0, Time Interval = 0.5 (Cumulative Time = 1.0)

Note that as you build the segments that the pulse is being drawn on the screen as you type in the parameters. Also note that the Cumulative Time column is updated automatically with the cumulative time lapse from the start of the pulse.

Time/Level Points – programs pulse turning points using level and time markers. This format is a bit more complex to use, however, it allows the design of pulses with linear transition times. For example, if you want to draw a simple square waveform that has a 0V to 3.3V amplitude, a 50% duty cycle, a 1ms period and a 100ns transition time, you enter the following parameters:

Index = 1, Level = 0, Time interval = 0, (Cumulative Time = 0)
Index = 2, Level = 3.3, Time Interval = 0.1, (Cumulative Time = 0.1)
Index = 3, Level = 3.3, Time interval = 0.4, (Cumulative Time = 0.5)

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Index = 4, Level = 0, Time interval = 0.1, (Cumulative Time = 0.6)
Index = 5, Level = 0, Time interval = 0.4, (Cumulative Time = 1.0)

Note that as you build the segments that the pulse is being drawn on the screen as you type in the parameters and the specified point is marked with a red dot. Also note that the Cumulative Time column is updated automatically with the cumulative time lapse from the start of the pulse.

Section Structure

The term Section Structure is used to define the pulse train's common properties. There are four parameters that can be programmed in this group: Index, Level, Time Interval and Cumulative Time.

Index – Is added automatically as you program pulse segments. The index line is highlighted as you point and click on pulse segments on the Pulse Editor screen.

Level – Specifies that peak level of the programmed segment. As you build the pulse, the level window is expended automatically to fit the required amplitude range.

Time Interval – Specifies the time that will lapse for the current index level. You can program the time interval and the cumulative time will be adjusted accordingly.

Cumulative Time – Specifies the time that will lapse from the start of the current pulse section. You can program the cumulative time and the time interval will be adjusted accordingly.

Section Properties

The Section Properties contains a summary of properties that are unique for the current section.

Design Units – Provides information on the units that are used when you draw the pulse segments. These units can be changed in the Pulse Editor options.

Section Start – Provides timing information for the start of the current section. If this is the first pulse section the value will always be 0. Subsequent sections will show the start mark equal to the end mark of the previous section.

Repeat – Allows multiplication of pulse segments without the need to re-design repetitive parts. After you enter a repeat value, press the Apply button to lock in the repeat multiplier.

Duration – Displays the time that will lapse from the start of the pulse section to the end. The duration shows the total time lapse, including the repeated sections.

Control Buttons

The control buttons allow you to append, insert, or delete one or all index lines. The Undo button is useful in cases where an error was made and restoration of the last operation is critical.

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Pulse Example, Section 1

Now that we are familiar with the Pulse Composer and its operation, we are ready to start building the first section of the pulse as shown in Figure 4-51. Point and click on the New icon and open the Pulse Editor. Type in the level and time intervals as shown. Note that the pulse segments are being created on the screen as you type the values.

Tips

1. Use the tab key to navigate Section Structure fields.

2. Use Append to add an index line at the end of the list.

3. Use Insert to add a segment above the selected line.

Before we proceed with the design of the next section, observe some values which are displayed on the Pulse Composer screen. In the lower left corner of the composer, the Vertical Scale is 10 V (1.25 V/Div) and the Horizontal Scale is 14 ms (1.4 ms/Div). These two values are critical for the integrity of the design because they will later be used by the program to set pulse timing. These values can change as you add more sections to the pulse train.

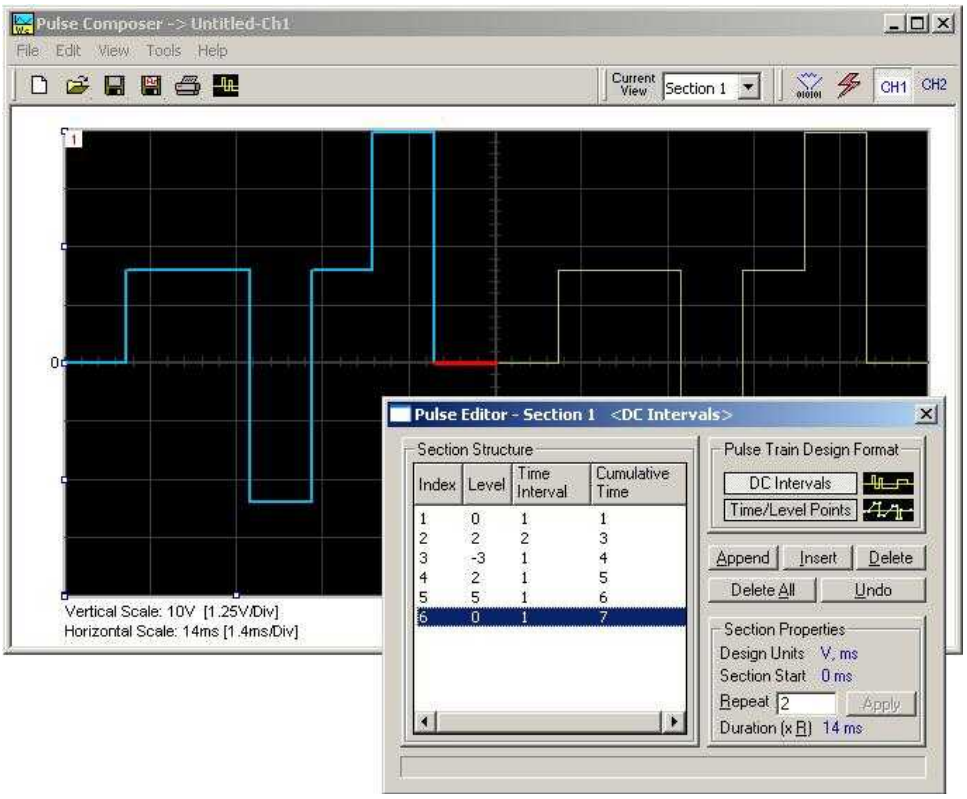


Figure 4-51, Building Section 1 of the Pulse Example

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Pulse Example, Section 2

The first pulse section is complete. We are ready now to start building the second section of the pulse as shown in Figure 4-52. Use the Pulse Composer's Edit menu to select the Append Section operation. A new section number will appear but its fields will be initially empty to the right of the section identifier.

Before you start entering values in this section, note that there are linear transitions required for this section. Therefore, select the Time/Level Points option in the Pulse Train Design Format group. You are now ready to start programming values. If you try to switch design formats after you have already typed in some values, the Pulse Editor will display a warning box alerting you that the design format can only be changed for an empty section. In this case, the only way to recover is to delete all entries and start from an empty index list. Type the section entries as shown in the figure.

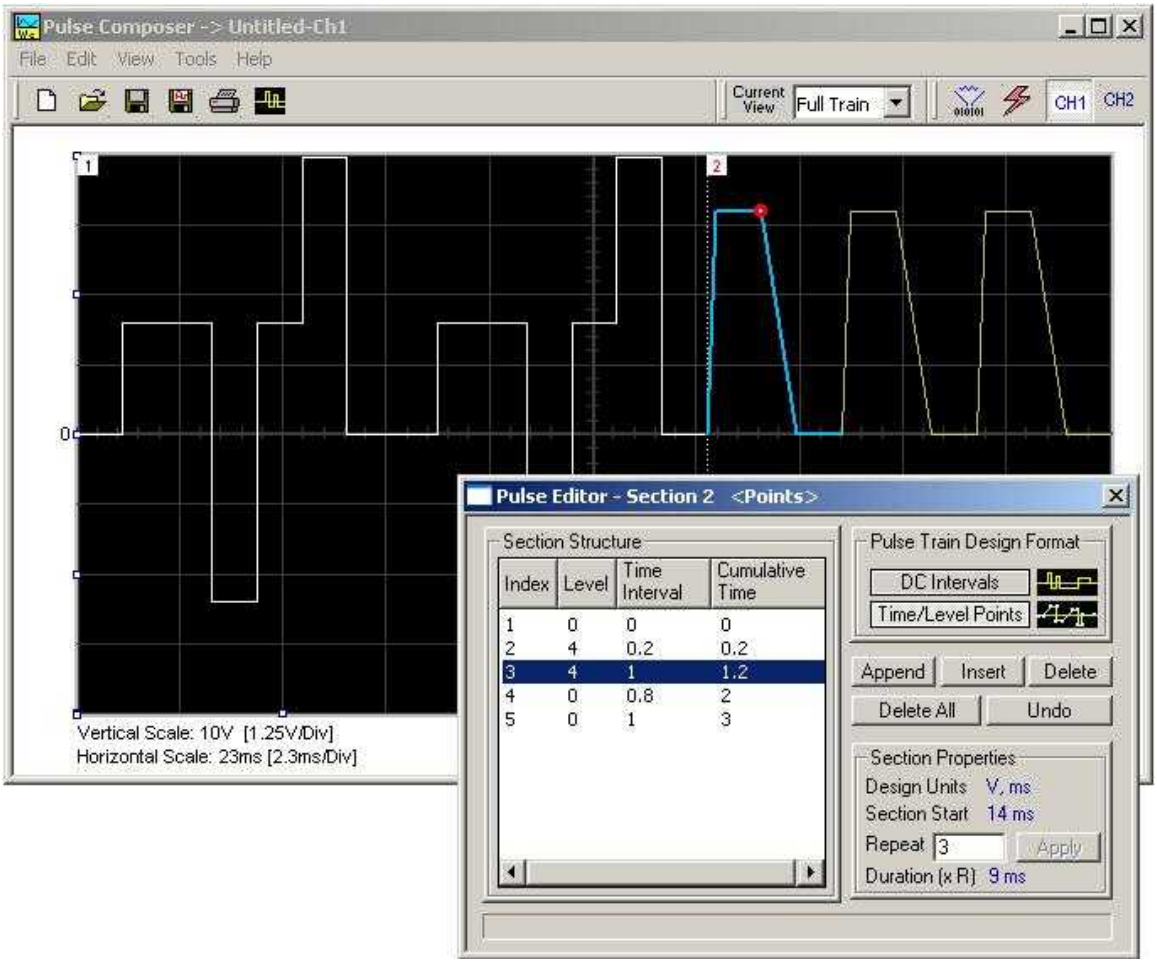


Figure 4-52, Building Section 2 of the Pulse Example

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Pulse Example, Section 3

The second pulse section is now complete. We are ready now to start building the third section of the pulse as shown in Figure 4-53. Use the Edit menu to select the Append Section operation. A new section number will appear but its fields will be initially empty to the right of the section identifier.

Before you start entering values to this section, note that there are fast transitions required for this section. Therefore, select the DC Intervals option in the Pulse Train Design Format. You are now ready to start programming values. If you try to switch design formats after you have already typed in some values, the Pulse Editor will display a warning box alerting you that the design format can only be changed for an empty section. In this case, the only way to recover is to delete all entries and start from an empty index list. Type the section entries as shown in the figure.

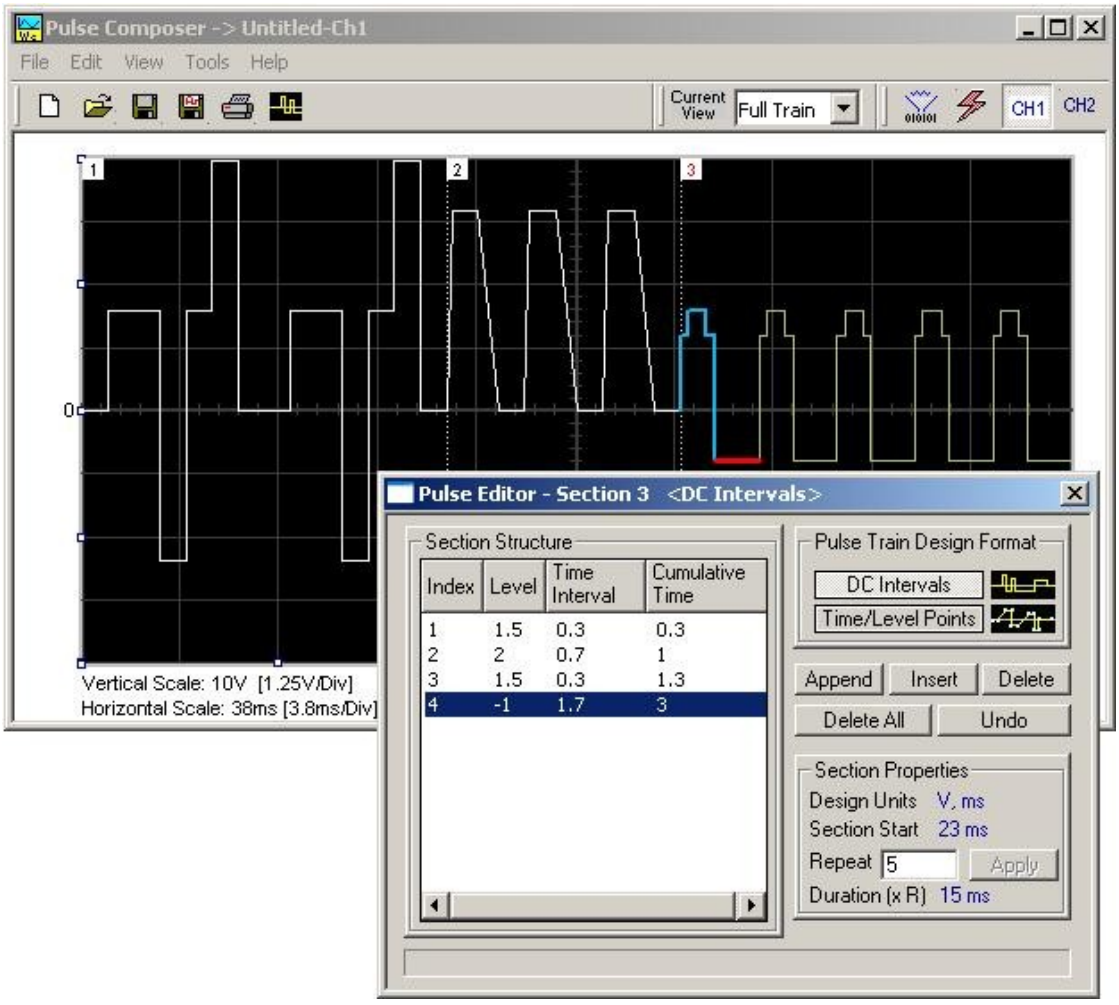


Figure 4-53, Building Section 3 of the Pulse Example

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Pulse Example, Section 4

The third pulse section is now complete. We are ready now to start building the forth section of the pulse as shown in Figure 4-54. Use the Edit menu to select the Append Section operation. A new section number will appear but its fields will be initially empty to the right of the section identifier.

Before you start entering values into this section, note that there is only one linear transition required for this section that will start from the last point of the previous section and will connect to the start point of the next section. Therefore, select the Time/Level Points option in the Pulse Train Design Format. You are now ready to start programming values. Type the section entries as shown in the figure.

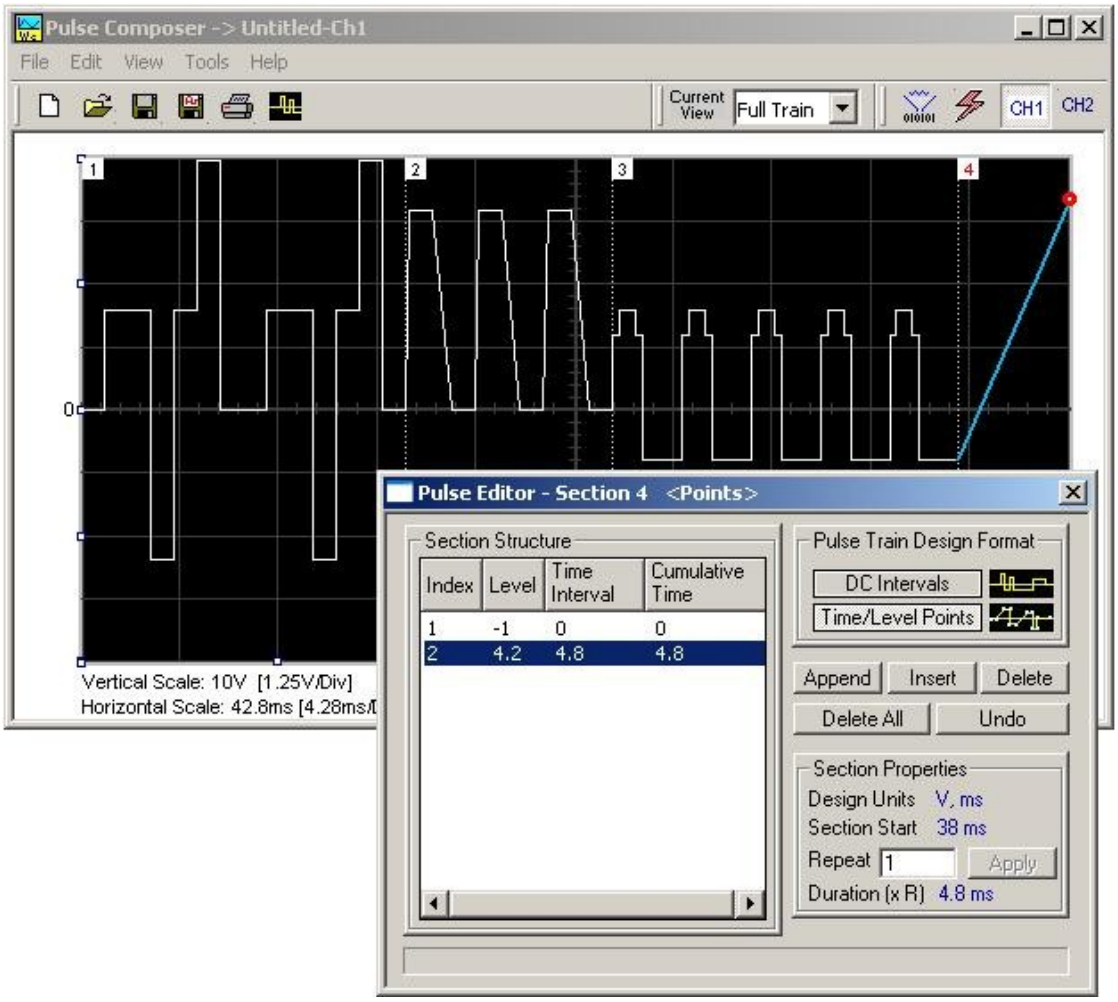


Figure 4-54, Building Section 4 of the Pulse Example

Pulse Example, Section 5

The fourth pulse section is complete so we are now ready to start building the fifth and final section of the pulse as shown in Figure 4-55. Use the Edit menu to select the Append Section operation. A new section number will appear but its fields will be initially empty to

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the right of the section identifier.

Note that there are fast transitions required for this section that will start from the last point of the previous section and will connect to the start point of the next section. Therefore, select the Time/Level Points option in the Pulse Train Design Format. You are now ready to start programming values. Type the section entries as shown in the figure.

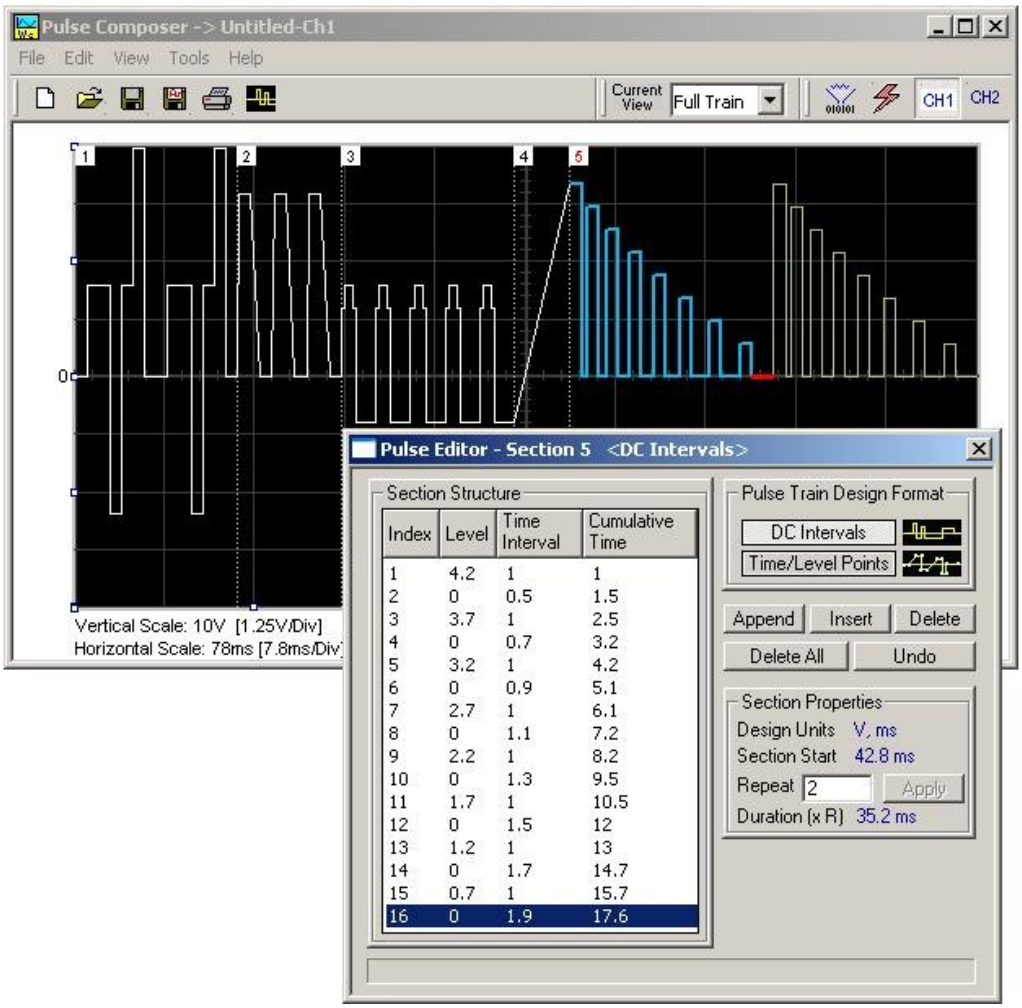


Figure 4-55, Building Section 5 of the Pulse Example

Downloading the Pulse Train

If you followed the above description to build this pulse example, the screen should look as shown in Figure 4-55. The next step is to download what you see on the Pulse Composer graph into the 3152B waveform generator.

One last step before you download the waveform to the instrument is to check the Pulse Train Download Summary which appears after you click on the Download icon on the Pulse Composer toolbar. Refer to Figure 4-56 for the next section on how to interpret the download summary.

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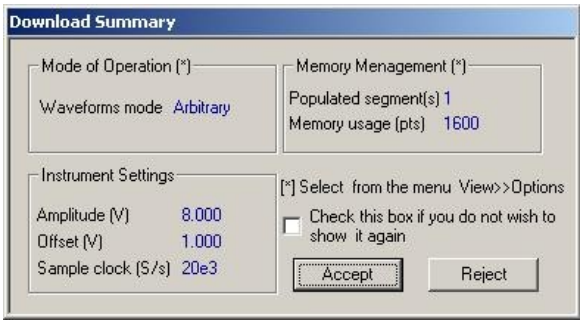


Figure 4-56, Pulse Editor Download Summary

Interpreting the Download Summary

It is important to understand that when you download a pulse waveform from the Pulse Composer, the parameters and mode of operation of the 3152B might be altered. The download summary shows what the new mode of operation will be so that you can reject the new settings if you do not agree to the changes. Once you press the Accept button, the waveform will be downloaded to the generator and the modes and parameters will be updated as shown in the dialog box.

If you are already familiar with the changes and do not wish to see the download summary every time you download a pulse waveform, you can check the box and it will not be shown on future downloads. You can restore this summary by selecting the View>>Download Summary menu item.

Mode of Operation – This describes mode of operation setting to be used after completion of the pulse download. This field could display one of two options: Arbitrary or Sequenced. Pay attention to the note (*) that says “Select from the menu View>>Options” Since, for this example, we checked the Force Pulse Train to Single Segment (see Figure 4-53), so that the generator forces the waveform mode to be Arbitrary and thus only one segment can be loaded with the pulse train.

Memory Management – By selecting the arbitrary mode of operation, the pulse train is forced to a single segment. This summary shows which segment has been populated and how much memory is needed to build the required pulse train.

Instrument Settings – Shows the amplitude, offset, and sample clock settings that will be changed on the generator. The settings in this summary cannot be affected from the Pulse Editor options settings. These are computed and modified automatically for the current pulse train pattern and will change from pattern to pattern.

Accept/Reject – These buttons are the final checks before you download the pulse train to the instrument. If you are unhappy with the instrument setting and want to change some of the options, there is still time click on the Reject button and do more changes. Click on the Accept button to complete the download process.

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The FM Composer

The FM Composer looks and feels almost like the waveform composer except there is a major difference in what it does. If you look at the opening screen as shown in Figure 4-57, you'll see that the vertical axis is marked with frequencies. You'll see later that as you draw waveforms on the FM composer screen, these waveforms represent frequency changes and not amplitude changes as are generated by the waveform composer.

The FM composer is a great tool for controlling frequency agility by generating the agility curve as an arbitrary waveform. For example, if you create a sine waveform, the 3152B will generate frequency-modulated signal that will follow the sine pattern. The resolution and accuracy of the modulated waveform is unsurpassed and can only be duplicated by mathematical simulation. The FM composer is loaded with many features and options so use the following paragraphs to learn how to create and download modulating waveforms to the 3152B using the FM Composer.

Invoke the FM Composer from Panels bar. The Wave Composer has three sections: Commands bar, Toolbar and Waveform screen. Refer to Figure 4-57 throughout the description of these parts.

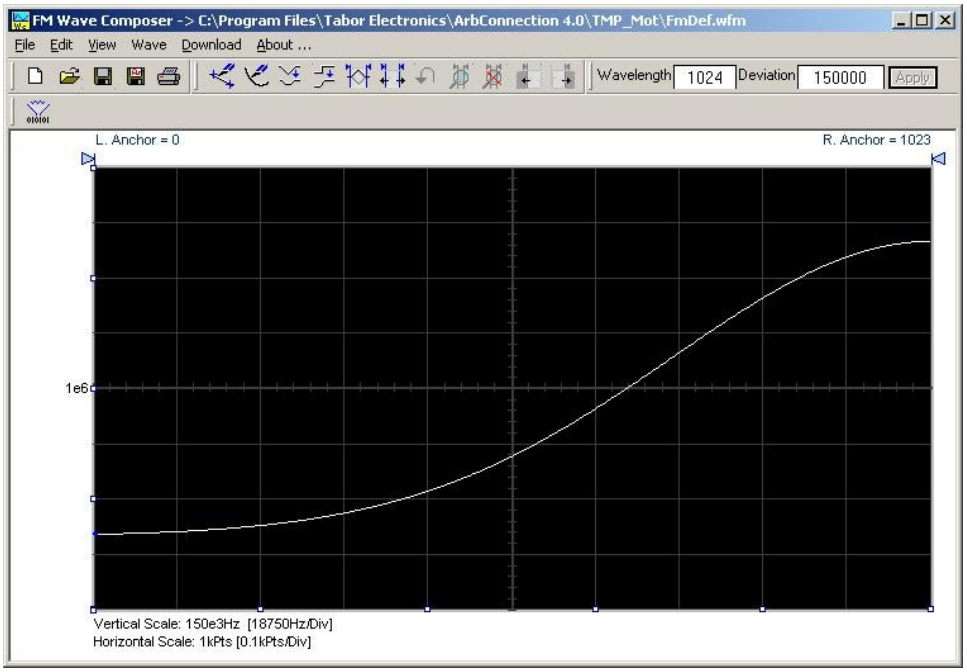


Figure 4-57, FM Composer Opening Screen

The Menu Bar

The FM Composer menu bar is an exact duplication of the menu bar of the Wave composer. It provides access to standard Windows commands such as File and View.

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File Menu

The File menu has 4 menu selections which that control waveform file I/O operations. Also use this menu to print the waveform or to exit the FM Composer program. Description of the various commands under File is given below.

New Waveform
The New Waveform command will remove the waveform from the screen. If you made changes to the waveform area and use this command, you should save your work before clearing the screen. The New Waveform command is destructive to the displayed waveform.

Open Waveform…
The Open Waveform… menu item lets you browse for previously saved waveform files and to load these waveforms to the waveform graph. This command is also very useful for converting waveform files to FM Composer format files (*.wvf).

Save Waveform
The Save Waveform menu item stores your active waveform as a binary file with a *.wvf extension. If this is the first time that you save this FM waveform, the Save Waveform As… command will be invoked automatically, letting you select name, path, and format for the waveform file.

Save Waveform As…
Use the Save Waveform As… menu item the first time you save your waveform. It will let you select name, location and format for your waveform file.

Print
With this command you may print the active Waveform Window. The standard printer dialog box will appear and will let you select printer setup, or print the waveform page.

Exit
The Exit command ends the current FM Composer session and takes you back to the Panels screen. If you made changes to your waveform since it was last saved, make sure to Save your work before you use this command.

Wave Commands

The Wave menu lets you create waveforms on the waveform graph. The Wave menu has a library of 6 waveforms: Sine, Triangle, Square, Exponent, Pulse, and Noise. It also lets you create waveforms using an Equation editor. Information how to create waveforms using the Wave menu is given below.

Creating Waveforms From the Built-in Library
You can create any waveform from the built-in library using the Wave menu. Clicking on one of the Wave options will open a dialog box. An example of the Sine waveform dialog box is shown in Figure 4-58. This dialog box is representative of the rest of the waveforms, so other waveforms will not be described.

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Creating Sine Waveforms

Use the following procedure to create sine waveforms from the built-in library. Click on Wave, then sine… The dialog box shown in Figure 4-58 appears. You can now start programming parameters that are available in this box.

Start Point Anchor – Defines the first point where the created wave starts. Note that if you change the start point the left anchor automatically adjusts itself to the selected start point. The example shows start point set at point 200.

End Point Anchor – Defines where the created waveform will end. Note that as you change the end point the right anchor will automatically adjust itself to the selected end point. The example shows end point set at point 499.

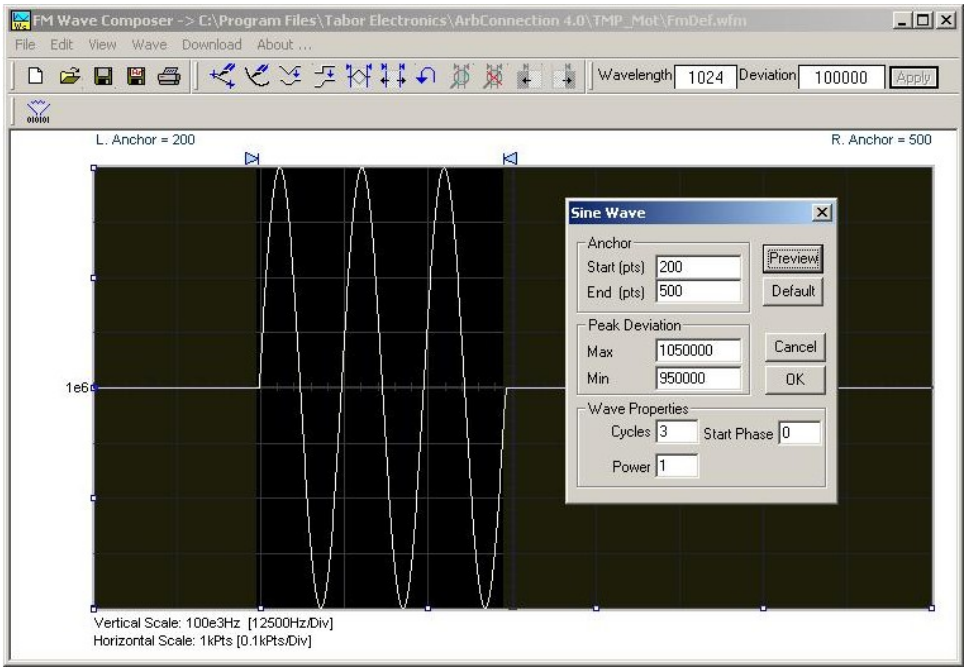


Figure 4-58, Generating Sine Modulation Using the FM Composer

Max. Peak Deviation – This parameter defines the forward peak deviation. Note that the forward peak deviation cannot exceed the pre-defined Deviation parameter as shown on the Toolbar. In case you need to exceed the pre-defined peak value you must quit this box and modify the Deviation parameter to provide sufficient range for the forward peak deviation range.

Min. Peak Deviation – This parameter defines the backwards peak deviation. Note that the backwards peak deviation cannot exceed the pre-defined Deviation parameter as shown on the Toolbar. In case you need to exceed the pre-defined peak value you must quit this box and modify the Deviation parameter to provide sufficient range for the backwards peak deviation range.

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Cycles – The Cycles parameter defines how many sine cycles will be created within the specified start and end anchor points. The example below shows three sine cycles.

Start Phase – The start phase parameter defines the angle at which the sine will start. The example shows 0° start phase.

Power – Sine to the power of 1 will generate a perfect sine. Power range is from 1 through 9.



Tip

The functionality of the FM composer is similar to the Wave composer. If you need more information on the FM Composer functions and Equation Editor, refer to the Wave Composer section in this manual.

The 3D Composer

The 3D Composer was specifically designed for simultaneous profiling of amplitude, frequency and phase. Amplitude profiles can be designed separately for channels 1 and 2, but frequency and phase profiles are shared by both channels. The following paragraphs will describe the various sections of the 3D composer and will guide you through some 3D programming examples.

The opening screen of the 3D composer is shown in Figure 4-59. As you can see it does not at all look like any of the other composers that were described previously discussed however, generating waveforms and programming profiles is very similar to other composer so you will be up and running in no time.

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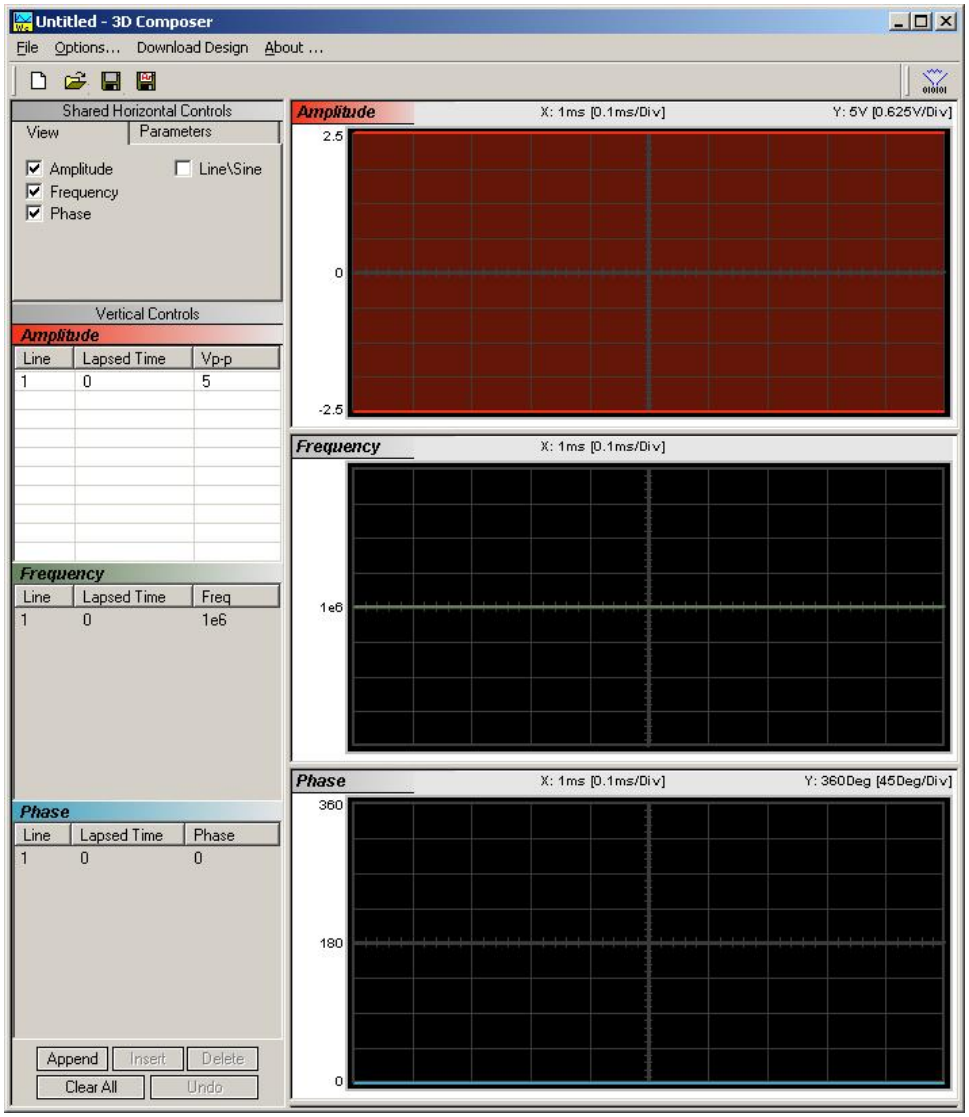


Figure 4-59, 3D Composer Screen

The 3D composer has three main sections: Shared horizontal Controls, Vertical Controls and Graphical Screens. The panels on the left are used for designing the waveform parameters and the screens on the right side depict the shape of the profile. Below find a detailed description of all of these sections. Refer to Figure 4-59 throughout the description.

Shared Horizontal Controls

The *Shared Horizontal Control* has two tabs: *View* and *Parameters*.

View

The *View* tab is useful if you are interested in programming 1 or two profiles only and do not care to see other screens. Check the boxes for the profiles you wish to program only and these will be shown on the screen. For example, if you check the Amplitude and the Frequency options, the Phase screens will not be visible.

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Parameters

The *Parameters* tab, as shown in Figure 4-60, is used for setting up the duration of the signal, the position of the marker (if required) and the amount of memory that is allocated for this purpose. Setting up correctly the parameters in this group is the basic and the most important task before you start designing 3D waveforms. The duration can be set in units of ns, us, ms, and seconds and can be programmed within the range of 800 ns to 30,000 s.

The 3D profiler behaves just like an arbitrary waveform. The shape of the profiler is generated using waveform points and a dedicated 3D sample clock. So, just as the basics for an arbitrary waveform design, the duration is derived from the following relationship:

Duration = SCLK / # of waveform points

where SCLK is the 3D sample clock and the # of waveform points can be programmed from 2 to 30,000.

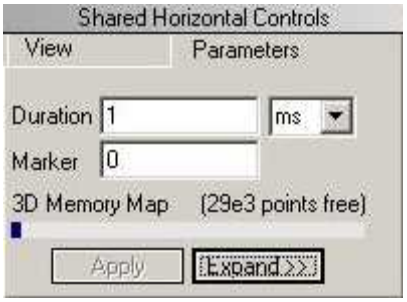


Figure 4-60, Parameters Tab

The recommended method is to let the 3D composer set up the sample clock and the numbers of points automatically for you, however, in some cases you may want to fine tune your requirement by pressing the Expand button. Figure 4-61 shows the Expanded Parameters options dialog box.

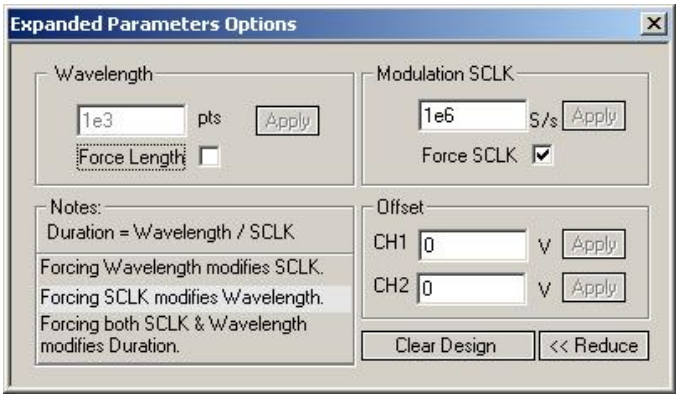


Figure 4-61, Expanded Parameters Options Dialog Box

The Expanded Parameters options dialog box has three sections: Wavelength, Modulation SCLK and Offset. The wavelength and the modulation SCLK control the duration of the entire wave through

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the following relationship:

Duration = Modulation SCLK / Wavelength

Each of the parameters has a finite length and therefore, the duration has maximum and minimum intervals. The modulation SCLK has a range of 1 Hz to 2.5 MHz and the Wavelength is limited from 2 points to 30,000 points. As a result, the duration can be programmed from 800 ns to 30,000 s.

If you do not care to control the wavelength and the SCLK, then you can leave the task for the 3D composer. In that case you must leave the Force Length and Force SCLK check boxes – unmarked. If you check the Force SCLK box, the wavelength will be modified automatically to match the selected duration. If you check the Force Length box, the modulation SCLK will be modified automatically to match the selected duration. Finally, if you check both the Force Length and the Force Modulation SCLK boxes, the duration of the 3D profile will be affected.

To modify wavelength or modulation SCLK, check the appropriate box, modify the value and click on the Apply button to force the selected value. Any successive changes that you make to the edit fields require that you click on the Apply button to accept the new value.

The Offset group controls DC offsets of the modulated waveform. Changing offset does not affect other parameters except the location of the waveform along the vertical axis.

The Clear Design button resets the 3D composer and the Reduce button closes the dialog box.

Vertical Controls

The *Vertical Controls* are used for profiling amplitude, frequency and phase. When you modify the fields in any of the controls, the associated graphical screen are automatically updated with the assigned values and display the profile as designed in the vertical control fields. The Vertical Controls are shown in Figure 4-62. You can start designing profiles only when one of the control fields is active. Control fields become active when you click on a control field.

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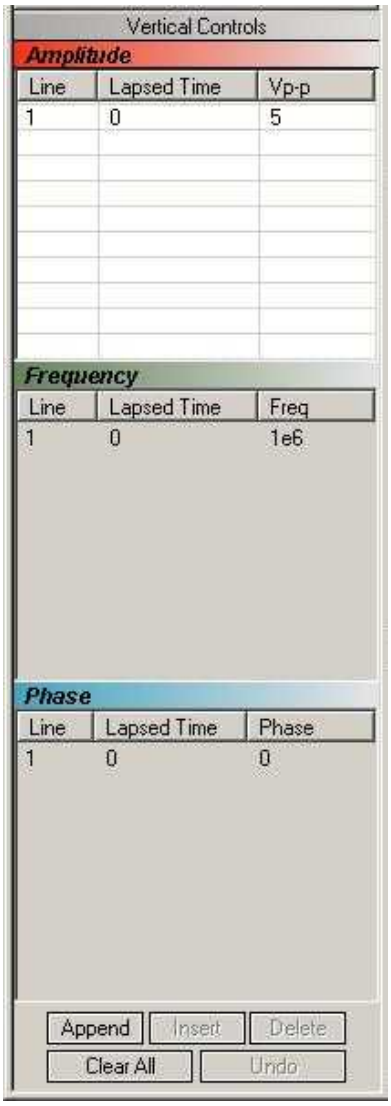


Figure 4-62, 3D Vertical Controls

Graphical Screens

The 3D *Waveform Graphs* are shown in Figure 4-63. You can not change anything on the screens. However, anything that you design in the Vertical Controls fields will automatically be updated and displayed on the graphical screens.

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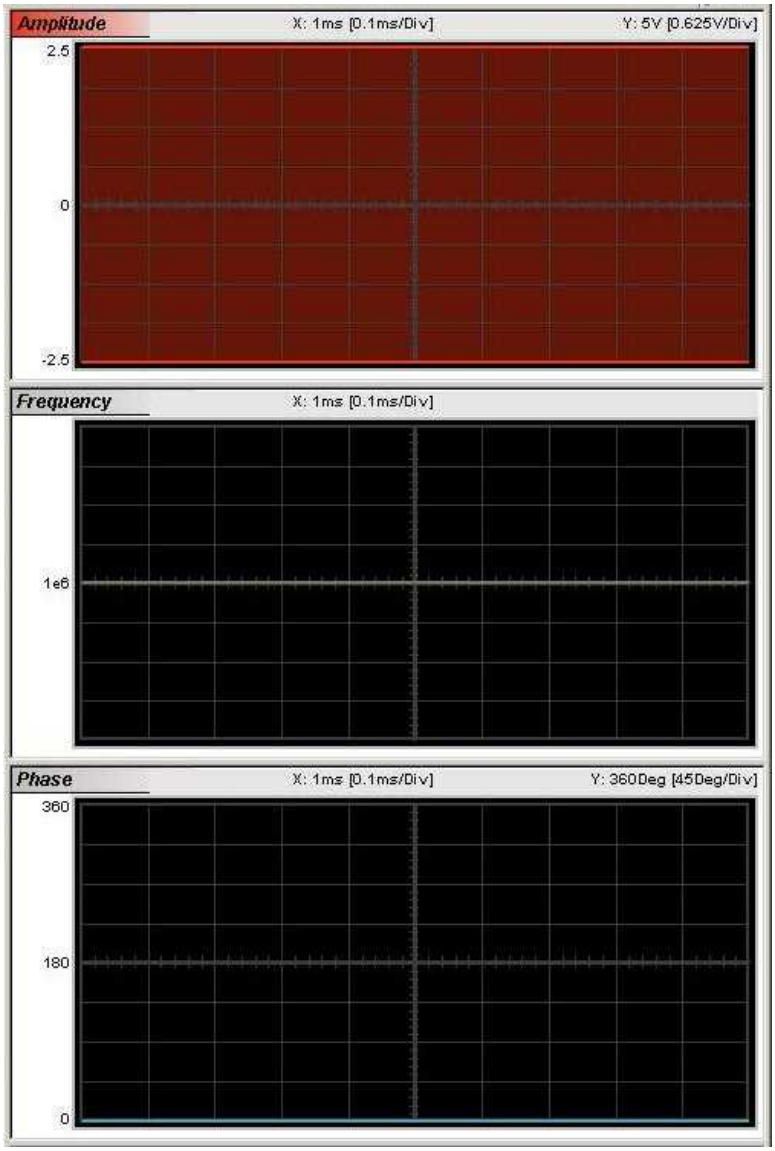


Figure 4-63, 3D Waveform Graphs

Designing 3D profiles

3D profiles are designed in the Vertical Controls fields. Notice that there are three separate control fields: Amplitude, Frequency and Phase.

Always start the design from the Shared Horizontal Controls group. In the View group, remove profiles that you do not care to change. Click on the Parameters tab and set up the duration of the waveform. An example of a 3D profile (chirp, in this example) is shown in Figure 4-64. Profiles were designed for amplitude, frequency and phase. As you can see the duration of the waveform was selected to be 100 ms.

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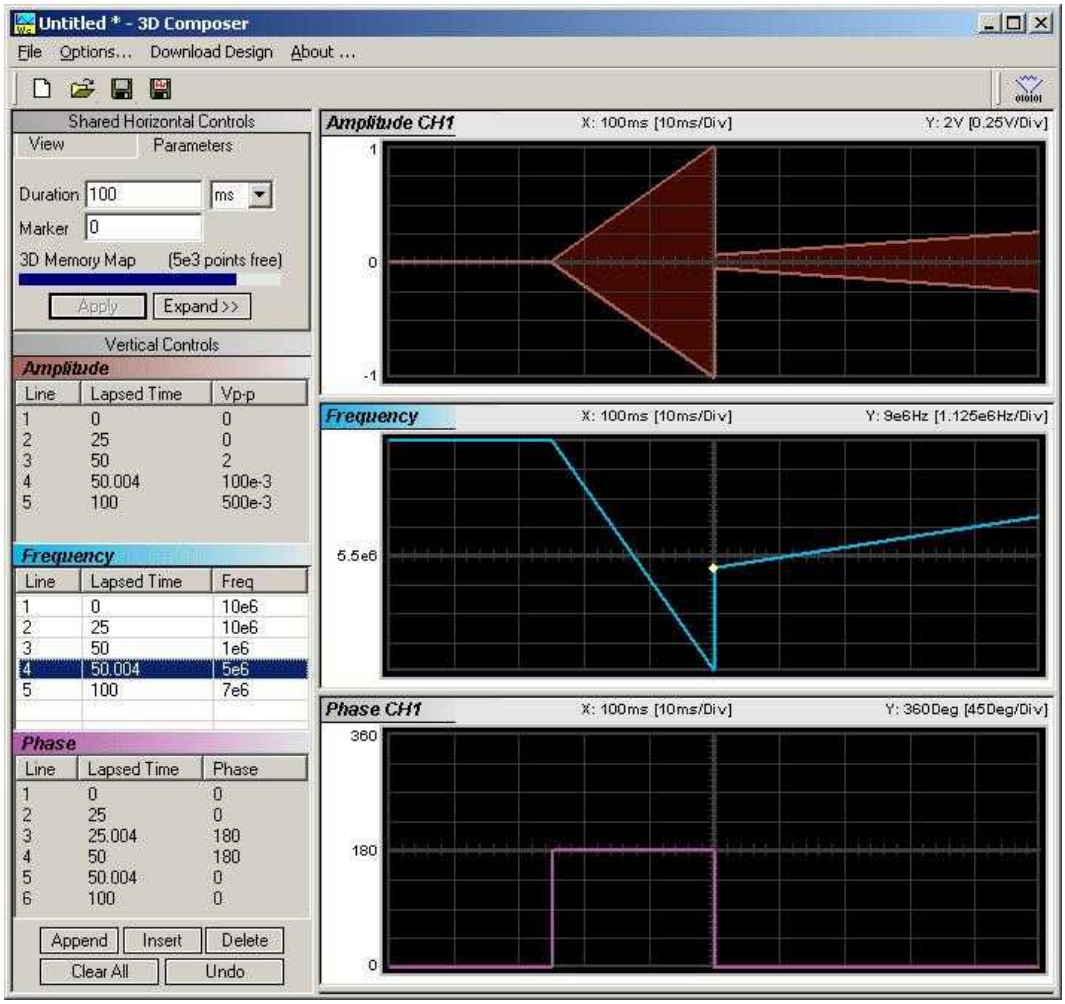


Figure 4-64, 3D Chirp Design Example

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The Command Editor

The Command Editor is a tool for doing low-level programming of the 3152B. Invoke the Command Editor from the System menu at the top of the screen. The Command Editor dialog box, as shown in Figure 4-65, will pop up. If you press the Download button, the function call in the Command field will be sent to the instrument.

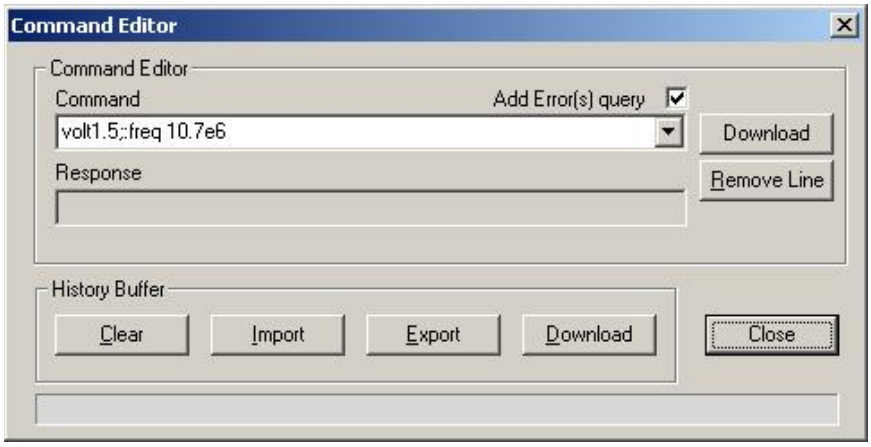


Figure 4-65, Command Editor

Low-level SCPI commands and queries can be sent directly to the 3152B from the **Command** field. Instrument responses to queries automatically appear in the **Response** field. The command editor is a useful troubleshooting tool. This way you can be sure of command syntax and functionality before you use it in your application. The complete list of 3152B SCPI commands is available in Chapter 5.

Logging SCPI Commands

The Log File is very useful for programmers that do not wish to spend a lot of time on manuals. When you use ArbConnection, every time you click on a button or change parameter, the command is logged in the same format as should be used in external applications. Figure 4-66 shows an example of a log file and a set of SCPI commands as resulted from some changes made on ArbConnection panels. You can set up the 3152B from ArbConnection to the desired configuration, log the commands in the log file and then copy and paste to your application without any modifications. Of course, this is true for simple commands that do not involve file download but, on the other hand, this is a great tool to get you started with SCPI programming.

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Figure 4-66, Log File Example

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Chapter 5
Programming Reference

What's in This Chapter

This Chapter lists and describes the set of SCPI-compatible (Standard Commands for Programmable Instruments) remote commands used to operate the 3152B. To provide familiar formatting for users who have previously used the SCPI reference documentation, the command descriptions are dealt with in a similar manner. In particular, each sub-system's documentation starts with a short description, followed by a table showing the complete set of commands in the sub-system; finally the effects of individual keywords and parameters are described. A complete listing of all commands used for programming the 3152B as a legacy replacement is given in Table 5-1. A complete listing of all commands used for programming the 3152B in modern mode or the 3100M models (in default mode) is given in Table 5-2.

In addition, High Speed (HS) commands have been defined corresponding to each of the 3152A SCPI commands. These commands can be used as alternatives to the SCPI command set in cases where raw speed is more important than software readability.

Introduction to SCPI

Commands to program the instrument over the GPIB are defined by the SCPI 1993.0 standard. The SCPI standard defines a common language protocol. It goes one step further than IEEE-STD-488.2 and defines a standard set of commands to control every programmable aspect of the instrument. It also defines the format of command parameters and the format of values returned by the instrument.

SCPI is an ASCII-based instrument command language designed for test and measurement instruments. SCPI commands are based on a hierarchical structure known as a tree system. In this system, associated commands are grouped together under a common node or root, thus forming subsystems.

Part of the OUTPut subsystem is shown below to illustrate the tree system:

```
:OUTPut
  :FILTer
     [:LPASs] {NONE|25M|50M|ALL}
```


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```
[:STATe] OFF | ON
```

OUTPut is the root keyword of the command; FILTer and STATe are second level keywords. LPASs is third level keyword. A colon (:) separates a command keyword from a lower level keyword.

Command Format

The format used to show commands in this manual is shown below:

```
FREQuency {<frequency>|MINimum|MAXimum}
```

The command syntax shows most commands (and some parameters) as a mixture of upper and lowercase letters. The uppercase letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, use the long form.

For example, in the above syntax statement, FREQ and FREQUENCY are both acceptable forms. Use upper or lowercase letters. Therefore, FREQ, FREQUENCY, freq, and Freq are all acceptable. Other forms such as FRE and FREQUEN will generate an error.

The above syntax statement shows the frequency parameter enclosed in triangular brackets. The brackets are not sent with the command string. A value for the frequency parameter (such as "FREQ 50e+6") must be specified.

Some parameters are enclosed in square brackets ([]). The brackets indicate that the parameter is optional and can be omitted. The brackets are not sent with the command string.

Command Separator

A colon (:) is used to separate a command keyword from a lower level keyword as shown below:

```
SOUR:FUNC:SHAP SIN
```

A semicolon (;) is used to separate commands within the same subsystem, and can also minimize typing. For example, sending the following command string:

```
TRIG:SLOP NEG;COUN 10;TIM 5e-3
```

is the same as sending the following three commands:

```
:TRIG:SLOP NEG
:TRIG:COUN 10
:TRIG:TIM 5e-3
```

Use the colon and semicolon to link commands from different subsystems. For example, in the following command string, an error is generated if both the colon and the semicolon are not used.

```
OUTP:STATE ON;:TRIG:BURS ON
```

The MIN and MAX

Substitute MINimum or MAXimum in place of a parameter for some

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Parameters

commands. For example, consider the following command:

```
FREQuency {<frequency>|MINimum|MAXimum}
```

Instead of selecting a specific frequency, substitute MIN to set the frequency to its minimum value or MAX to set the frequency to its maximum value.

Querying Parameter Setting

Query the current value of most parameters by adding a question mark (?) to the command. For example, the following command sets the output function to square:

```
SOUR:FUNC:SHAP SQR
```

Query the output function by executing:

```
SOUR:FUNC:SHAP?
```

Query Response Format

The response to a query depends on the format of the command. In general, a response to a query contains current values or settings of the generator. Commands that set values can be queried for their current value. Commands that set modes of operation can be queried for their current mode. IEEE-STD-488.2 common queries generate responses, which are common to all IEEE-STD-488.2 compatible instruments.

SCPI Command Terminator

A command string sent to the function generator must terminate with a <new line> character (also known as “line feed”, “<LF>”, or ASCII code 10_{10}). A command string may also include a carriage-return character (known as “<CR>” or ASCII code 13_{10}) immediately before the <new line> character. The IEEE-STD-488 EOI message is a <new line> character. Command string termination always resets the current SCPI command path to the root level.

IEEE-STD-488.2 Common Commands

The IEEE-STD-488.2 standard defines a set of common commands that perform functions like reset, trigger and status operations. Common commands begin with an asterisk (*), are four to five characters in length, and may include one or more parameters. The command keyword is separated from the first parameter by a blank space. Use a semicolon (;) to separate multiple commands as shown below:

```
*RST; *STB?; *IDN?
```

SCPI Parameter Type

The SCPI language defines four different data formats to be used in program messages and response messages: numeric, discrete, Boolean, and arbitrary block.

Numeric Parameters

Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs,

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decimal points, and scientific notation. Special values for numeric parameters like MINimum and MAXimum are also accepted.

Engineering unit suffixes with numeric parameters (e.g., MHz or kHz) can also be sent. If only specific numeric values are accepted, the function generator will ignore values, which are not allowed and will generate an error message. The following command is an example of a command that uses a numeric parameter:

```
VOLT:AMPL <amplitude>
```

Discrete Parameters

Discrete parameters are used to program settings that have a limited number of values (i.e., FIXed, USER and SEQuence). They have short and long form command keywords. Upper and lowercase letters can be mixed. Query responses always return the short form in all uppercase letters. The following command uses discrete parameters:

```
SOUR:FUNC:MODE {FIXed | USER | SEQuence}
```

Boolean Parameters

Boolean parameters represent a single binary condition that is either true or false. The generator accepts "OFF" or "0" for a false condition. The generator accepts "ON" or "1" for a true condition. The instrument always returns "0" or "1" when a boolean setting is queried. The following command uses a boolean parameter:

```
OUTP:FILT { OFF | ON }
```

The same command can also be written as follows:

```
OUTP:FILT {0 | 1 }
```

Arbitrary Block Parameters

Arbitrary block parameters are used for loading waveforms into the generator's memory. Depending on which option is installed, the 3152B can accept binary blocks up to 1M bytes. The following command uses an arbitrary block parameter that is loaded as binary data:

```
TRAC:DATA#564000<binary_block>
```

Binary Block Parameters

Binary block parameters are used for loading segment and sequence tables into the generator's memory. Information on the binary block parameters is given later in this manual.

SCPI Syntax and Styles

Where possible the syntax and styles used in this section follow those defined by the SCPI consortium. The commands on the following pages are broken into three columns; the Keyword, the Parameter Form, Default and HS command equivalent.

The Keyword column provides the name of the command. The actual command consists of one or more keywords since SCPI commands are based on a hierarchical structure, also known as the tree system. Square brackets ([ ]) are used to enclose a keyword that is optional when programming the command; that is, the 3152B will process the

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command to have the same effect whether the optional node is omitted by the programmer or not. Letter case in tables is used to differentiate between the accepted short form (upper case) and the long form (upper and lower case).

The Parameter Form column indicates the number and order of parameter in a command and their legal value. Parameter types are distinguished by enclosing the type in angle brackets (< >). If parameter form is enclosed by square brackets ([ ]) these are then optional (care must be taken to ensure that optional parameters are consistent with the intention of the associated keywords). The vertical bar (|) can be read as "or" and is used to separate alternative parameter options.

Alternative Command Set (HS Commands)

In addition to the SCPI command set, there is an alternative command set which increased the throughput of the 3152A by a typical factor of 2 or 3. Actual throughput improvements depend on the test program and the controlling device. Speed increase is obtained by using a system of numerical commands that are decoded by a “jump table” then immediately executed by the code without going through the SCPI parser, thus saving a lot of time.

The HS (High Speed) commands are numeric values that each correspond to a specific SCPI command. A number is substituted for the SCPI command name and a number is substituted for any text type (discrete and Boolean) SCPI parameter(s). Note however that unlike SCPI parsers that are flexible in the way that characters are sent, the HS mode rejects additional spaces and characters and issues error codes. For example, the command to turn off the output of the 3152B is:

OUTP ON

HS command syntax for the same command is:

0200A1

0200A is the HS equivalent to the OUTP command and 1 indicates ON. Special rules for using HS commands are described in the next section. Tables 5-1 and 5-2 provide a complete, cross-referenced listing of all HS commands and their SCPI counterparts.

Invoking HS Command Mode

The first step in the process of using the HS command set is to place the instrument in HS mode. Do this using the following SCPI command:

INSTrument:MODE FAST

To terminate FAST mode to and resume the usage of standard SCPI commands, use the following HS command:

0150A0

Note that 015A0 is the only HS command without a corresponding SCPI command. The implied SCPI command would be INSTrument:MODE NORMal, but this command does not exist

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because it can only have an effect when the instrument is in HS mode. Likewise, there is no HS command that corresponds to the command INSTrument:MODE FAST.

In HS mode, the instrument accepts HS commands only. SCPI commands sent when the 3152A is in HS mode will generate errors. Likewise, in NORMal (SCPI) mode, HS commands will not be accepted.

Rules for Using HS Command Mode

HS commands must be sent to the instrument in accordance with the following usage rules:

1. Unlike SCPI command syntax, a space (or spaces) may not be placed between HS commands and their parameters. For example, the HS command

   0100A1

   is valid. The HS command

   0100A 1

   is incorrect and will generate an error.

2. If more than 1 parameter is associated with a command, use a comma (or commas) to separate parameters. Once again, commas and parameters may not be offset by spaces. For example, the HS command:

   0300C1e6,5,0

   is valid. The HS command:

   0300C 1e6, 5, 0

   is incorrect and will generate an error.

3. As with SCPI, multiple HS commands may be sent together if they are separated a semicolon (or semicolons). Once again:

   0100A1;0200A1

   is valid and

   0100A1; 0200A1

   is incorrect and will generate an error.

4. As with SCPI, “set” type HS commands may be terminated with a question mark (?) instead of parameters to query or “get” a setting from the instrument. For example, you can query the frequency, amplitude and offset settings of the 3152A by sending the query:

   0300C?

5. At the end of an HS command string, terminate the string with the \a character (0xA).

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Legacy vs. Modern Command Set

For users of the 3151B or 3152B models, the instrument defaults to legacy 3152A-compatible mode. The SCPI commands that are shown in Table 5-1 list the legacy 3152A command set and indicate where the 3152B command differs. Notice, however, that the FORM:INST MOD command can be used to enable the additional functionality that was built into the new 3152B. With emulation disabled, note that some of the legacy emulation features will no longer be available until legacy emulation mode (FORM:INST LEG) is restored.

CAUTION

Due to some differences in waveform resolution and size, waveforms can not be shared across the legacy and modern options. Therefore, using the FORM:INST (LEG | MOD) command is not recommended before the consequences to your application are understood

In general the legacy 3152B mode modifies modern 3152B performance in the following major areas:

- Maximum sample clock frequency is reduced to 100 MS/s;
- Waveform interlace is set to 2;
- Minimum waveform length is set to 10; and
- Vertical resolution of arbitrary waveforms is reduced to 12 bits.

If you purchase the 3152B, you most likely want to use 3152A legacy code and, therefore, the instrument defaults to legacy 3152A compatible mode with the above limitations built into the code. The 3100M-3152B and the 3100R-3152B versions default to a different set of values to allow full performance of the generator; The commands needed to use the full performance of the 3152B are summarized in Table 5-2.

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3152B Legacy Commands

The 3152B is a modern and updated version of the Model 3152A employing the latest technology and component improvements.

Although 100% backwards compatibility was the basis for the new 3152B design, some of the 3152A functionality could not be duplicated exactly. Table 5-1 lists all of the 3152B SCPI commands and highlights the areas where it differs from the original 3152A design. Expect that commands that are not compatible with the old 3152A will generate errors when the instrument is in legacy mode.

Table 5-1, 3152B SCPI Command Summary for 3152A Emulation

Keyword	Parameter Form	Default	3152A	HS
Instrument Control Commands				
:INSTrument				
:MODE	NORMal | FAST	NORM	✓	0150A
Run Mode Commands				
:INITiate				
[:IMMediately]			✓	
:CONTinuous	OFF | ON | 0 | 1	1	✓	1110A
:TRIGger				
[:IMMediate]			✓	11000
:BURSt				
[:STATe]	OFF | ON | 0 | 1	0	✓	1120A
:COUNt	1 to 1000000	1	✓	1121A
:DELay	0, 10 to 2e6 (even numbers)	0 (0 = OFF)	✓	1131A
:GATE				
[:STATe]	OFF | ON | 0 | 1	0	✓	1150A
:LEVel	-10 to 10	0	✓	1180A
:SOURce				
[:ADVance]	EXTernal | INTernal | TTLTrg<n> | ECLTrg1	EXT	✓	1140A
:SLOPe	NEGative | POSitive	POS	✓	1160A
:TIMer	1e-6 to 20	15e-6	✓	1170A

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Table 5-1, 3152B SCPI Command Summary for 3152A Emulation (continued)

Keyword	Parameter Form	Default	3152A	HS
Output Control Commands				
:OUTPut				
:SHUNt	OFF | ON | 0 | 1	Error, not supported	✓	0250A
:ECLTrg<n>	<n> = 0 to 1			
[:STATe]	OFF | ON | 0 | 1	0,0	✓	0210B
:FILTer				
[:LPASs]				
:FREQuency	20MHz | 25MHz | 50MHz (20MHz/25MHz = 25M)	20MHz	✓	0201A
[:STATe]	OFF | ON | 0 | 1	0	✓	0202A
:LOAD	50 to 1E6	50		0012A
:CAL	50 | 1M	50		0013A
[:STATe]	OFF | ON | 0 | 1	0	✓	0200A
:SYNC				
[:STATe]	OFF | ON | 0 | 1	0	✓	0240A
:POSition				
[:POINt]	2 to 523288 (even numbers)	2	✓	0242A
:SOURce	BIT | LCOMplete | SSYNc | HCLock | PULSe	BIT	✓	0241A
:WIDTh	2 to 500	2	✓	0243A
:TRIGger				
:SOURce	BIT | LCOMPlete | INTernal | EXTernal	BIT	✓	0220A
:TTLTrg<n>	<n> = 0 to 7			
[:STATe]	OFF | ON | 0 | 1	0,0	✓	0230B
[:SOURce]				
:FREQuency				
:EXTernal?			✓	0420@?
[:CW]	100e-6 to 100e6 | MINimum | MAXimum	1e6	✓	0400A
:RASTer	100e-3 to 250e6 | MINimum | MAXimum	1e6	✓	0410A
:SOURce	INTernal | EXTernal | ECLTrg0	INT	✓	0411A
:VOLTage				
[:LEVel]				
[:AMPLitude]	10e-3 to 16 | MINimum | MAXimum	5	✓	0500A
:OFFSet	-7.992 to 7.992	0	✓	0501A
:FUNCtion				
:MODE	FIXed | USER | SEQuence | SWEep (calculated)	FIX	✓	0610A

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Table 5-1, 3152B SCPI Command Summary for 3152A Emulation (continued)

Keyword	Parameter Form	Default	3152A	HS
Standard Waveform Commands				
[:SOURce]				
:SHAPe	SINusoid | TRIangle | SQUare | PULSe | RAMP | SINC | GAUSsian | EXPonential | NOISe | DC	SIN	✓	0600A
:SINusoid				
:PHASe	0 to 360	0	✓	0700A
:POWer	1 to 9	1	✓	0701A
:TRIangle				
:PHASe	0 to 360	0	✓	0710A
:POWer	1 to 9	1	✓	0711A
:SQUare				
:DCYCle	0 to 99.9	50	✓	0720A
:PULSe				
:DELay	0 to 99.9	10	✓	0730A
:WIDTh	0 to 99.9	10	✓	0731A
:TRANsition				
[:LEADing]	0 to 99.9	10	✓	0732A
:TRAiling	0 to 99.9	10	✓	0733A
:RAMP				
:DELay	0 to 99.9	10	✓	0740A
:TRANsition				
[:LEADing]	0 to 99.9	10	✓	0741A
:TRAiling	0 to 99.9	10	✓	0742A
:SINC				
:NCYCle	4 to 100	10	✓	0790A
:GAUSsian				
:EXPonent	1 to 200	10	✓	0750A
:EXPonential				
:EXPonent	-100 to 100	-10	✓	0760A
:DC				
[:VOLTage]	-100 to 100	100	✓	0770A

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Table 5-1, 3152B SCPI Command Summary for 3152A Emulation (continued)

Keyword	Parameter Form	Default	3152A	HS
Arbitrary Waveform Commands				
:FORMat				
:WAVE	NORMal | USER	Error, not supported	✓	0101A
:RESolution	12BIT | 16BIT	12BIT		
:INSTrument	LEGacy | MODern	LEG		
:BORDer	NORMal | SWAPped	NORM	✓	0100A
:TRACe				
[:DATA]	<data_array>		✓	10001#
:DEFine	<1 to 4096>,<10 to 523288> (<segment_#>,<size>)	1	✓	10102
:DELete				
[:NAME]	1 to 4096		✓	09201
:ALL			✓	10210
:SELect	1 to 4096	1	✓	1030A
:SEGMent				
[:DATA]	<data_array>			10501#
Apply Commands				
[:SOURce]				
:APPLy	FREQ,AMPL,OFFS		✓	0300C
:SINusoid	FREQ,AMPL,OFFS,PHAS,POW		✓	0301E
:TRIangle	FREQ,AMPL,OFFS,PHAS,POW		✓	0302E
:SQUare	SQU,FREQ,AMPL,OFFS,DCY		✓	0303D
:PULSe	FREQ,AMPL,OFFS,DEL,WIDT,LEE,TRE		✓	0304G
:RAMP	FREQ,AMPL,OFFS,DEL,LEE,TRE		✓	0305F
:SINC	FREQ,AMPL,OFFS,CYC		✓	0310D
:GAUssian	FREQ,AMPL,OFFS,EXP		✓	0306D
:EXPonential	FREQ,AMPL,OFFS,EXP		✓	0307D
:DC	DC_AMPL		✓	0308A
:USER	SEG<n>,SCLK,AMPL,OFFS		✓	0309D
Sequence Commands				
[:SOURce]				
:SEQuence				
[:DATA]	<data_array>			13401#
:ADVance	AUTOmatic | STEP | MIXed	AUTO	✓	1300A
:DEFine	<step>,<seg_#>,<repeat>		✓	13103
:DELete				
[:NAME]	1 to 4096		✓	13201
:ALL			✓	13210

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Table 5-1, 3152B SCPI Command Summary for 3152A Emulation (continued)

Keyword	Parameter Form	Default	3152A	HS
Modulated Waveform Commands				
[:SOURce]				
:AM				
:INTernal				
:FREQuency	10e-3 to 1e6	10,000	✓	0781A
:DEPTh	0 to 100	50	✓	0780A
:EXEcute			✓	07820
:SWEep				
:FREQuency				
[:STARt]	10 to 100.0e6	10e3	✓	1610A
:STOP	10 to 100e6	1e6	✓	1611A
:RASTer	10e-6 to 250e6 | MINimum | MAXimum	1e6	✓	1612A
:FUNCtion	SINusoidal | TRIangle* | SQUare*	SIN	✓	1604A
:TIME	1.4e-6 to 40.0	1e-3	✓	1600A
:DIRection	UP | DOWN	UP	✓	1601A
:SPACing	LINear | LOGarithmic	LIN	✓	1602A
:STEP	10 to 2000	20	✓	1603A
:MARKer				
[:FREQuency]	10 to 100e6	505e3	✓	1613A
Synchronization Commands				
[:SOURce]				
:PHASe				
:LOCK				
[:STATe]	OFF | ON | 0 | 1	0	✓	0820A
:ADJust	0 to 360	0	✓	0810A
:NULL		Error, not supported	✓	08500
:SOURce	MASTer | SLAVe	MAST	✓	0800A
[:SOURce]				
:PHASe2		(=PLL)		
:LOCK				
[:STATe]	OFF | ON | 0 | 1	0	✓	0920A
:SOURce	EXTernal | ECLTrg1 | TTLTrg<n>	EXT	✓	0930A
:ADJust	-180 to 180	0	✓	0900A
:FINe	-36 to 36	0	✓	0910A

* Computed and placed into arbitrary waveform memory in segments and re-played as a sequenced waveform.

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Table 5-1, 3152B SCPI Command Summary for 3152A Emulation (continued)

Keyword	Parameter Form	Default	3152A	HS
System Commands				
:RESet			✓	14200
:SYSTem				
:ERRor?			✓	1430@
:VERSion?			✓	1440@
:SMEMory				
:MODe	READ | WRITe	READ	✓	1200A
[:STATe]	OFF | ON | 0 | 1	0	✓	1210A
:TEST				
[:ALL]?			✓	1400@?
Common Commands				
*CLS			✓	15000
*ESE	1 to 255	1	✓	1501A
*OPC			✓	15020
*RST			✓	14200
*SRE	1 to 255	1	✓	1503@?
*TRG			✓	11000
*ESE?			✓	1501@?
*ESR?			✓	1504@?
*IDN?			✓	1506@?
*OPC?			✓	1502@?
*OPT?	(0=64k; 1=256k; 2=512k)		✓	0185@?
*STB?			✓	1508@?
*TST?			✓	1500@?

3100R/M-3152B Commands

As explained in Chapter 1, one or two 3152Bs can be installed in a 3100R or a 3100M carrier. If you purchased this version then you probably did not intend to use the 3152B as a replacement for a 3152A legacy program and hence the commands set is much broader and allows access to the entire functionality of the 3152B.

Table 5-2 lists all of the 3152B SCPI commands and checks the commands which emulate the 3152A design. Expect that commands that are incompatible with the 3152A will generate errors.

SCPI commands that are marked with ✓ emulate the operation of the 3152A. All other commands that are not marked offer additional functionality beyond the original operation of the 3152A.

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Table 5-2, 3152B SCPI Command Summary

Keyword	Parameter Form	Default	3152A	HS
Instrument Control Commands				
:INSTrument				
:MODE	NORMal | FAST	NORM	✓	0150A
[:SELect]	1 | 2	1		0008A
:COUPle				
:MODE	MASTer | SLAVe	MAST		0002A
:DELay	0 to 20	0		0003A
:PATH	ADJacent | ECLT | LBUS	ADJ		0191A
:SLAVe				
:DELete	<LAN_IP_address>			0040
:INSert	<3152B>,<LAN_IP_address>			00051
:STATe	OFF | ON | 0 | 1	0		0006A
Run Mode Commands				
:INITiate			✓	
[:IMMediately]			✓	
:CONTinuous	OFF | ON | 0 | 1	1	✓	1110A
:TRIGger			✓	
[:IMMediate]			✓	11000
:BURSt			✓	
[:STATe]	OFF | ON | 0 | 1	0	✓	1120A
:COUNt	1 to 1000000	1	✓	1121A
:DELay	0, 10 to 2e6 (even numbers)	0 (0 = OFF)	✓	1131A
:STATe	OFF | ON | 0 | 1	0		0188A
:TIMe	100e-9 to 20	100		0156A
:GATE			✓	
:MODe	LEVel | TRANsition	LEV		0157A
[:STATe]	OFF | ON | 0 | 1	0	✓	1150A
:LEVel	-10 to 10	Legacy: 0 V Modern: 1.6 V	✓	1180A
:SOURce			✓	
[:ADVance]	EXTernal | INTernal | TTLTrg<n> | ECLTrg1 | BUS	EXT	✓	1140A
:SLOPe	NEGative | POSitive	POS	✓	1160A
:RETRigger				
[:STATe]	OFF | ON | 0 | 1	0		0187A
:TIMe	100e-9 to 20	100		0161A
:TIMer	1e-6 to 20	15e-6	✓	1170A

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Table 5-2, 3152B SCPI Command Summary (continued)

Keyword	Parameter Form	Default	3152A	HS
Output Control Commands				
:OUTPut			✓	
:SHUNt	OFF | ON | 0 | 1	Error, not supported	✓	0250A
:ECLTrg<n>	<n> = 0 to 1	0		
[:STATe]	OFF | ON | 0 | 1	0,0	✓	0210B
:FILTer			✓	
[:LPASs]			✓	
:FREQuency	20MHz | 25MHz | 50MHz | 60MHz | 120 MHz (20MHz/25MHz = 25M)	20M	✓	0201A
[:STATe]	OFF | ON | 0 | 1	0	✓	0202A
:LOAD	50 to 1e6	50		0012A
:CAL	50 | 1M	50		0013A
[:STATe]	OFF | ON | 0 | 1	0	✓	0200A
:SYNC			✓	
[:STATe]	OFF | ON | 0 | 1	0	✓	0240A
:POSition			✓	
[:POINt]	0 to 1e6-1 (0 to 2/4e6-1 with option 1/2)	0	✓	0242A
:SOURce	BIT | LCOMplete | SSYNc | HCLock | PULSe | ZEROcross	BIT	✓	0241A
:WIDTh	4 to n-8	4	✓	0243A
:TRIGger			✓	
:SOURce	BIT | LCOMPlete | INTernal | EXTernal	BIT	✓	0220A
:TTLTrg<n>	<n> = 0 to 7	0	✓	
[:STATe]	OFF | ON | 0 | 1	0,0	✓	0230B
[:SOURce]				
:ROSCillator				
:SOURce	INTernal | EXTernal | CLK10	Legacy: CLK10 Modern: INT		0028A
:FREQuency			✓	
:EXTernal?			✓	0420@?
[:CW]	10e-3 to 100e6 | MINimum | MAXimum	1e6	✓	0400A
:RASTer	10e-6 to 250e6 | MINimum | MAXimum	1e6	✓	0410A
:SOURce	INTernal | EXTernal | LBUS | ECLTrg0	INT	✓	0411A
:VOLTage			✓	
[:LEVel]			✓	
[:AMPLitude]	10e-3 to 16 | MINimum | MAXimum	5	✓	0500A
:OFFSet	-7.992 to 7.992	0	✓	0501A
:PHASe				
[:OFFSet]	0 to 1e6-1 (0 to 2e6-1 with option 2)	0		0027A
:FUNCtion				
:MODE	FIXed | USER | SEQuence | SWEep (calculated) | MODulation | COUNter | DPULse | HALFcycle	FIX	✓	0610A

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Table 5-2, 3152B SCPI Command Summary (continued)

Keyword	Parameter Form	Default	3152A	HS
Standard Waveform Commands				
[:SOURce]			✓	
:SHAPe	SINusoid | TRIangle | SQUare | PULSe | RAMP | SINC | GAUSsian | EXPonential | NOISe | DC	SIN	✓	0600A
:SINusoid			✓	
:PHASe	0 to 360	0	✓	0700A
:POWer	1 to 9	1	✓	0701A
:TRIangle			✓	
:PHASe	0 to 360	0	✓	0710A
:POWer	1 to 9	1	✓	0711A
:SQUare			✓	
:DCYCle	0 to 99.99	50	✓	0720A
:PULSe			✓	
:DELay	0 to 99.999	10	✓	0730A
:WIDTh	0 to 99.999	10	✓	0731A
:TRANsition			✓	
[:LEADing]	0 to 99.999	10	✓	0732A
:TRAiling	0 to 99.999	10	✓	0733A
:RAMP			✓	
:DELay	0 to 99.99	10	✓	0740A
:TRANsition			✓	
[:LEADing]	0 to 99.99	10	✓	0741A
:TRAiling	0 to 99.99	10	✓	0742A
:SINC			✓	
:NCYCle	4 to 100	10	✓	0790A
:GAUSsian			✓	
:EXPonent	1 to 200	10	✓	0750A
:EXPonential			✓	
:EXPonent	-100 to 100	-10	✓	0760A
:DC			✓	
[:VOLTage]	-100 to 100	100	✓	0770A
:AMPLitude	-8 to 8	5		0046A
Arbitrary Waveform Commands				
:FORMat			✓	
:WAVE	NORMal | USER	Error, not supported	✓	0101A
:RESolution	16BIT | 12BIT	3152B: 12BIT 3100M/R: 16BIT (for backward compatibility)		0102A
:BORDer	NORMal | SWAPped	NORM	✓	0100A
:INSTrument	LEGacy | MODern	3152B: LEG 3100M/R: MOD		0189A
:TRACe			✓	
[:DATA]	<data_array>		✓	10001#
:DEFine	<1 to 10k>,<10 to 1(2/4)e6> (<segment_#>,<size>)	1	✓	10102
:DEFine	<1 to 10k>,<16 to 1(2/4)e6> (<segment_#>,<size>)	1		
:DELete			✓	
[:NAME]	1 to 10k		✓	09201
:ALL			✓	10210
:SELect	1 to 10k	1	✓	1030A
:SEGMent				
[:DATA]	<data_array>			10501#

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Table 5-2, 3152B SCPI Command Summary (continued)

Keyword	Parameter Form	Default	3152A	HS
Apply Commands				
[:SOURce]			✓	
:APPLy	FREQ,AMPL,OFFS		✓	0300C
:SINusoid	FREQ,AMPL,OFFS,PHAS,POW		✓	0301E
:TRIangle	FREQ,AMPL,OFFS,PHAS,POW		✓	0302E
:SQUare	SQU,FREQ,AMPL,OFFS,DCY		✓	0303D
:PULSe	FREQ,AMPL,OFFS,DEL,WIDT,LEE,TRE		✓	0304G
:RAMP	FREQ,AMPL,OFFS,DEL,LEE,TRE		✓	0305F
:SINC	FREQ,AMPL,OFFS,CYC		✓	0310D
:GAUssian	FREQ,AMPL,OFFS,EXP		✓	0306D
:EXPonential	FREQ,AMPL,OFFS,EXP		✓	0307D
:DC	DC_AMPL		✓	0308A
:USER	SEG<n>,SCLK,AMPL,OFFS		✓	0309D
Sequence Commands				
[:SOURce]			✓	
:SEQuence			✓	
[:DATA]	<data_array>			13401#
:ADVance	AUTOmatic | STEP | MIXed	AUTO	✓	1300A
:SELect	1 to 10	1		0107A
:DEFine	<step>,<seg_#>,<repeat>,<adv_mode_x>,<sync_bit_x>	(_x = 3152B only)	✓	13103
:DELete			✓	
[:NAME]	1 to 4096		✓	13201
:ALL			✓	13210
:SYNC				
[:TYPe]	LCOMplete | BIT	LCOM		0108A
Modulated Waveform Commands				
[:SOURce]				
:MODulation				
:TYPE	OFF | AM | FM | SWE | FSK | ASK | PSK | FHOPping | AHOPping | 3D	OFF		0051A
:CARRier				
[:FREQuency]	10 to 100e6	1e6		0049A
:BASeline	CARRier | DC	CARR		0048A

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Table 5-2, 3152B SCPI Command Summary (continued)

Keyword	Parameter Form	Default	3152A	HS
Modulated Waveform Commands (continued)				
[:SOURce]				
:AM			✓	
:FUNCtion				
:SHAPe	SINusoid | TRIangle | SQUare | RAMP	SIN		0057A
:INTernal			✓	
:FREQuency	10e-3 to 1e6	10,000	✓	0781A
:DEPTh	0 to 100	50	✓	0780A
:EXEcute		(= MOD:TYPE AM)	✓	07820
:FM				
:DEViation	10.0e-3 to 100e6	100e3		0075A
:FUNCtion				
:SHAPe	SINusoid | TRIangle | SQUare | RAMP | ARB	SIN		0078A
:FREQuency	10e-3 to 350e3	10e3		0076A
:RASTer	1 to 2.5e6	1e6		0077A
:MARKer				
[:FREQuency]	10e-3 to 100e6	1e6		0079A
:DATA	<data_array>			00741#
:SWEep			✓	
:FREQuency			✓	
[:STARt]	10 to 100.0e6	10e3	✓	1610A
:STOP	10 to 100e6	1e6	✓	1611A
:RASTer	10e-6 to 250e6 | MINimum | MAXimum	1e6	✓	1612A
:FUNCtion	SINusoidal | TRIangle* | SQUare*	SIN	✓	1604A
:TIME	1.4e-6 to 40.0	1e-3	✓	1600A
:DIRection	UP | DOWN	UP	✓	1601A
:SPACing	LINear | LOGarithmic	LIN	✓	1602A
:STEP	10 to 2000	20	✓	1603A
:MARKer			✓	
[:FREQuency]	10 to 100e6	505e3	✓	1613A
:FSK				
:FREQuency				
:SHIFted	10e-3 to 100e6	100e3		0082A
:BAUD	1 to 10e6	10e3		0080A
:MARKer	1 to 4000	1		0083A
:DATA	<data_array>			00811#

* Computed and placed into arbitrary waveform memory in segments and re-played as a sequenced waveform.

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Table 5-2, 3152B SCPI Command Summary (continued)

Keyword	Parameter Form	Default	3152A	HS
Modulated Waveform Commands (continued)				
[:SOURce]				
:ASK				
[:AMPLitude]				
[:STARt]	0 to 16	5		0064A
:SHIFted	0 to 16	1		0065A
:BAUD	1 to 10e6	10e3		0066A
:MARKer	1 to 1000	1		0068A
:DATA	<data_array>			00671#
:PSK				
:PHASe				
[:STARt]	0 to 360	0		0091A
:SHIFted	0 to 360	180		0092A
:RATE	1 to 10e6	10e3		0093A
:DATA	<data_array>			00891#
:MARKer	1 to 4000	1		0090A
:FHOPping				
:DWELl				
:MODe	FIXed | VARiable	FIX		0069A
[:TIMe]	200e-9 to 20	200e-9		0070A
:FIXed				
:DATA	<data_array>			00711#
:VARiable				
:DATA	<data_array>			00731#
:MARKer	1 to 5000	1		0072A
:AHOPping				
:DWELl				
:MODe	FIXed | VARiable	FIX		0061A
[:TIMe]	200e-9 to 20	200e-9		0062A
:FIXed				
:DATA	<data_array>			00591#
:VARiable				
:DATA	<data_array>			00631#
:MARKer	1 to 5000	1		0060A
:3D				
:DATA	<data_array>			00521#
:MARKer	1 to 30000			0053A
:RASTer	1 to 2.5e6	1e6		0054A

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Table 5-2, 3152B SCPI Command Summary (continued)

Keyword	Parameter Form	Default	3152A	HS
Digital Pulse Commands				
:DPULse				
:DELay	0 to 10	0		0143A
:DOUBle				
[:STATe]	OFF | ON | 0 | 1	0		0144A
:DELay	0 to 1e3	1e-3		0145A
:LEVel				
:HIGH	-7.992 to 8	5		0147A
:LOW	-8 to 7.992	0		0148A
:HIGH	0 to 1e3	1e-3		0146A
:POLarity	NORMal | COMPlement | INVerted	NORM		0186A
:PERiod	80e-9 to 1e6 (80e-9 to 2e6 with option 2)	10e-3		0149A
:TRANsition				
[:LEADing]	0 to 1e3	1e-3		0151A
:TRAiling	0 to 1e3	1e-3		0152A
Half Cycle Commands				
:HALFcycle				
:DELay	200e-9 to 20	1e-6		0139A
:DCYCle	0 to 99.99	50		0138A
:FREQuency	10e-3 to 1e6	1e6		0140A
:PHASe	0 to 360	0		0141A
:SHAPe	SINusoid | TRIangle | SQUare	SIN		0142A
Counter Commands				
:COUNter				
:FUNCtion	FREQuency | PERiod | APERiod | PULSe | TOTalize	FREQ		0135A
:DISPlay				
:MODE	NORMal | HOLD	NORM		0133A
:GATE				
:TIME	100e-6 to 1	1		0134A
:RESet				01370
:READ				0136@
Synchronization Commands				
[:SOURce]			✓	
:PHASe			✓	
:LOCK			✓	
[:STATe]	OFF | ON | 0 | 1	0	✓	0820A
:ADJust	0 to 360	0	✓	0810A
:NULL		Error, not supported	✓	08500
:SOURce	MASTer | SLAVe	MAST	✓	0800A

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Table 5-2, 3152B SCPI Command Summary (continued)

Keyword	Parameter Form	Default	3152A	HS
Synchronization Commands (continued)				
[:SOURce]			✓	
:PHASe2		(=PLL)	✓	
:LOCK			✓	
[:STATe]	OFF | ON | 0 | 1	0	✓	0920A
:SOURce	EXTernal | ECLTrg 0| TTLTrg<n>	EXT	✓	0930A
:ADJust	-180 to 180	0	✓	0900A
:FINe	-36 to 36	0	✓	0910A
LXI Configuration Commands				
:SYSTem			✓	
:IP				
[:ADDRess]	<IP_address>			0167A
:MASK	<mask>			0171A
:GATeway	<gate_way>			0169A
:BOOTp	OFF | ON | 0 | 1	0		0168A
HOSTname:	<host_name>			0170A
:KEEPalive				
:STATe	OFF | ON | 0 | 1	1		0173A
:TIMEout	2 to 300	45		0174A
:PROBes	2 to 10	2		0172A
USB Mass Memory Commands				
: :MMEMory				
:CATalog?				
:CDIRectory	<directory_name>			
:DELete?	<file_name>			
:LOAD				
:TRACe?	<label>,<file_name>			
System Commands				
:RESet			✓	14200
:SYSTem			✓	
:ERRor?			✓	1430@
:VERSion?			✓	1440@
:INFOrmation				
:CALibration?				0175A
:MODel?				0176@
:SERial?				0177A
:SMEMory			✓	
:MODe	READ | WRITe	READ	✓	1200A
[:STATe]	OFF | ON | 0 | 1	0	✓	1210A
:TEST			✓	
[:ALL]?			✓	1400@?

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Table 5-2, 3152B SCPI Command Summary (continued)

Keyword	Parameter Form	Default	3152A	HS
System Commands (continued)				
*CLS			✓	15000
*ESE	1 to 255	1	✓	1501A
*OPC			✓	15020
*RST			✓	14200
*SRE	1 to 255	1	✓	1503@?
*TRG			✓	11000
*ESE?			✓	1501@?
*ESR?			✓	1504@?
*IDN?			✓	1506@?
*OPC?			✓	1502@?
*OPT?	3152A, 0=64k; 1=256k; 2=512k			
*OPT?	3152B, 0=1Meg; 1=2Meg; 2=4Meg			
*STB?			✓	1508@?
*TST?			✓	1500@?

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Instrument & Output Control Commands

This group is used to control the output channels and their respective state, amplitude and offset settings, as well as the waveform mode. You can also synchronize multiple instruments and program phase offsets between adjacent channels. The output frequency and the reference source are also selected using commands from this group. Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable. The 3152A column shows where 3152B commands are backward-compatible with the older 3152A design.

Table 5-3, Instrument & Output Control Commands Summary

Keyword	Parameter Form	Default	3152A	HS
:INSTrument				
:MODE	NORMal | FAST	NORM	✓	0150A
[:SELect]	1 | 2	1		0008A
:COUPle				
:MODE	MASTer | SLAVe	MAST		0002A
:DELay	0 to 20	0		0003A
:PATH	ADJacent | ECLT | LBUS	ADJ		0191A
:SLAVe				
:DELete	<LAN_IP_address>			00040
:INSert	<3152B>,<LAN_IP_address>			00051
:STATe	OFF | ON | 0 | 1	0		0006A
:OUTPut				
:ECLTrg<n>	<n> = 0 to 1			
[:STATe]	OFF | ON | 0 | 1	0,0	✓	0210B
:FILTer				
[:LPASs]				
:FREQuency	25M | 50M | 60M | 120M	25M		0201A
[:STATe]	OFF | ON | 0 | 1	0	✓	0202A
:LOAD	50 to 1e6	50		0012A
:CAL	50 | 1M	50		0013A
[:STATe]	OFF | ON | 0 | 1	0	✓	0200A
:SYNC				
[:STATe]	OFF | ON | 0 | 1	0	✓	0240A
:POSition				
[:POINt]	0 to 1e6-1 (0 to 2/4e6-1 with option 1/2)	0	✓	0242A
:SOURce	BIT | LCOMplete | SSYNc | HCLock | PULSe | ZEROcross	BIT		0241A
:WIDTh	4 to n-8	4		0243A
:TRIGger			✓	
:SOURce	BIT | LCOMPlete | SSYnc | HCLock | PULSe | ZEROcross | INTernal | EXTernal	BIT		0220A
:TTLTrg<n>	<n> = 0 to 7			
[:STATe]	OFF | ON | 0 | 1	0,0	✓	0230B

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Table 5-3, Instrument & Output Control Commands Summary (Continued)

Keyword	Parameter Form	Default	3152A	HS
[:SOURce]				
:ROSCillator				
:SOURce	INTernal | EXTernal | CLK10	Legacy: CLK10 Modern: INT		0028A
:FREQuency				
:EXTernal?			✓	0420@?
[:CW]	10e-3 to 100e6 | MINimum | MAXimum	1e6	✓	0400A
:RASTer	10e-6 to 250e6 | MINimum | MAXimum	1e6	✓	0410A
:SOURce	INTernal | EXTernal | LBUS | ECLTrg0	INT		0411A
:VOLTage				
[:LEVel]				
[:AMPLitude]	10e-3 to 16 | MINimum | MAXimum	5	✓	0500A
:OFFSet	-7.992 to 7.992	0	✓	0501A
:PHASe				
[:OFFSet]	0 to 1e6-1 (0 to 2/4e6-1 with option 1/2)	0		0027A
:FUNCtion				
:MODE	FIXed | USER | SEQuence | SWEep (calculated) | MODulation | COUNter | DPULse | HALFcycle	FIX		0610A

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INSTrument:MODE {NORMal|FAST}(?)

HS Syntax: 0150A0(?)

Description

Use this command to modify the 3152B to accept HS commands. Use INST:MODE FAST to program the instrument with HS commands; Use 0150A0 to restore the instrument to accept normal SCPI commands.

Name	Type	Default	Description
NORMal	Discrete	NORM	Normal mode where the 3152B accepts SCPI commands.
FAST	Discrete		Special high speed mode where the instrument accepts codes that bypass the parser and thus improve speed and response of the test program.

Response

This command returns NORM or FAST depending on the speed setting.

INSTrument{1|2}(?)

HS Syntax: 0008A<1|2>(?)

Description

This command sets the active instrument for future programming sequences. Subsequent commands affect the selected instrument only. The 3152B carrier can hold two cards, however, multiple adjacent modules can be slaved to one master and in this case this command prepares slave modules to accept commands.

Parameters

Range	Type	Default	Description
1-2	Discrete	1	Sets the active instrument for programming from remote. Instrument 1 and 2 are associated with one 3152B carrier.

Response

The 3152B returns a 1 or 2 depending on the present active channel setting.

INSTrument:COUPle:MODE {MASTer|SLAVe}(?)

HS Syntax: 0002A<0|1>(?)

Description

This command assigns master or slave properties to the instrument. If the assignment is slave, most of the instrument's operational functions will be controlled from the master instrument. However, waveforms, amplitudes, and offsets can be controlled individually for each slave unit.

Parameters

Name	Type	Default	Description
MASTer	Discrete	MAST	Programs a specific 3152B, in a multi-instrument system, as the master instrument. Note that only one instrument can be designated as master while all other instruments must be programmed as slaves.
SLAVe	Discrete		Programs a 3152B, in a multi-instrument system, as a slave instrument. Note that multiple instruments can be designated as slaves but only one instrument can be

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designated as master.

Response
The 3152B returns MAST or SLAV depending on the current instrument coupling mode assignment.

INSTrument:COUPle:DELay <delay>(?)

HS Syntax: 0003A<float>(?)

Description
Programs the delay time between the master and slave instruments. The waveform start on the slave unit is delayed with respect to the start of the master.

Parameters

Name	Range	Type	Default	Description
<delay>	0 to 20	Numeric	0	Sets the waveform start delay between instruments in units of seconds. Instrument 1 is always the master and reference channel. Instruments 2 to "n" are delayed with respect to instrument 1. Note that this parameter operates in conjunction with continuous run mode and only when multiple instruments are synchronized.

Response
The 3152B returns the current delay value in units of seconds.

INSTrument:COUPle:PATH {ADJacent|ECLT|LBUS}(?)

HS Syntax: 0191A<0|1|2>(?)

Description
This command will select the source path for multi-instrument synchronization.

Parameters

Name	Type	Default	Description
ADJacent	Discrete	ADJ	Selects the adjacent source path. Adjacent path is automatically configured between two instruments in the same carrier in the following configurations only: 3100M-3152B-3152B and 3100R-3152B-3152B.
ECLT	Discrete		Selects the backplane ECLT lines as the synchronization path. In this case, the ECL trigger lines are turned on and connected between slots to provide the synchronization signals. Note that VXI backplane ECL trigger lines are limited to clock frequencies below 66 MHz.
LBUS	Discrete		Selects the backplane LBUS lines as the synchronization path. LBUS lines typically support 3152B operation through its entire frequency range. To use the LBUS, the master and slave instruments must be installed into a contiguous group of VXI chassis slots, with the master on the left. Also, the LBUS jumpers must be installed. For details, refer to the Local Bus Configuration section in Chapter 2.

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Response
The 3152B will return ADJ, ECLT or LBUS depending on the current instrument couple path assignment.

INSTrument:COUPle:SLAVe:DELete <LAN_address>

HS Syntax: 00040<string>(?)

Description
This command will delete a designated slave instrument from a synchronized multi-instrument system list. This command is associated with LAN operation only.

Parameters

Name	Type	Default	Description
<LAN_address>	String		Will remove a designated instrument (specified by IP address) from a synchronized multi-instrument system list. Contact your IT department, if you are not sure how to connect to a LAN address.

INSTrument:COUPle:SLAVe:INSert <3152B>,<LAN_address>

HS Syntax: 00051<3152B,string>(?)

Description
This command will add a designated slave instrument to a synchronized multi-instrument system list. This command is associated with LAN operation only.

Parameters

Name	Type	Default	Description
<3152B>, <LAN_address>	String		Specifying the correct model number is crucial for correct assignment of the instrument designator and for selection of the correct instrument number for the INST:SEL command.

INSTrument:COUPle:STATe {OFF|ON|0|1}(?)

HS Syntax: 0006A<0|1>(?)

Description
This command will turn the 3152B coupled state on and off.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Turns coupled mode on and off. Note that this command must be applied to the master instrument only, otherwise, slave instruments will not couple. To select the master instrument use the INST:SEL 1 command.

Response
The 3152B returns 1 if the coupled state is on or 0 if the couple state is off.

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OUTPut:SHUNt {OFF|ON|0|1}(?)

Response

This 3152A legacy command is not supported by the 3152B. The 3152B returns an error.

OUTPut:ECLTrg<n> {OFF|ON|0|1}(?)

HS Syntax: 0210A<0|1>(?)

Description

This command converts ECLTRG lines to outputs and places signals on these lines to be used by other instruments in the chassis as synchronization signals. Although the original purpose of these lines was to be used as ECL triggers to other instruments, the 3152B uses these lines to synchronize clocks and start signals with other instruments in the chassis. The ECLTRG lines run in parallel from slot to slot so it is not important where the receiving module is placed inside the chassis, as long as the receiving instrument assigns the same lines as inputs. Only two of these trigger lines are used: ECLTRG0 and ECLTRG1.

Parameters

Name/Range	Type	Default	Description
<n>	Numeric (integer only)	0	Specifies the ECL trigger line that will be affected by this command. Only two lines are available in this case, 0 and 1.
0-1	Discrete	0	Specifies the state of the designated ECL trigger line either on or off.

Response

For ECLTRG0, the 3152B returns 0,1 if the output is on, or 0,0 if the output is off.
For ECLTRG1, the 3152B returns 1,1 if the output is on, or 1,0 if the output is off.

OUTPut:FILTer {25M|50M|60M|120M}(?)

HS Syntax: 0201A<1|2|3|4>(?)

Description

This command selects which filter is connected in series with the 3152B output signal. Observe the following restrictions when using this command:

1) Filter selection is not available when the instrument is set to output the standard sine waveform
2) The 3152A originally had three filters: 20MHz, 25MHz, and 50MHz. The 3152B has four filters: 25MHz, 50MHz, 60MHz, and 120MHz. In legacy mode, when you select a 3152A filter, the corresponding 3152B filter is automatically selected. For example, for the 3152A command OUTP:FILT 20M translates to OUTP:FILT 25M because this is the closest cutoff frequency available. In any case, 3152A filter commands are accepted and filters are applied without issuing errors although the selected filter will have a slightly different cutoff frequency than the legacy model had.

Parameters

Name	Type	Default	Description
25M	Discrete		Connects a 25MHz, Bessel filter into the output path
50M	Discrete		Connects a 50MHz, Bessel filter into the output path
65M	Discrete		Connects a 25MHz, Elliptic filter into the output path
120M	Discrete		Connects a 120MHz, Elliptic filter into the output path

Response

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The 3152B returns NONE, 25M, 50M, 60M, or 120M depending on the filter currently connected in series with the output signal.

OUTPut:FILTer {OFF|ON|0|1}(?)

HS Syntax: 0202A<0|1>(?)

Description

This command toggles selection of the filter selected by the OUTP:FILT command. Note that the filters are not accessible during standard sine waveform output. In order to control filters, change the output waveform function to another waveform type to allow this command to execute.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Toggles selection of the selected output filter

Response

The 3152B returns 1 if a filter is enabled or 0 if a filter is disabled

OUTPut:LOAD <load>?

HS Syntax: 0012A<integer>(?)

Description

This command specifies the load impedance to be applied to the 3152B main output.

Parameters

Name	Type	Default	Description
<load>	Numeric (integer only)	50	Specifies the load impedance that will be applied to the 3152B outputs in units of Ω. The default setting is 50 Ω. The range of load impedance is 50 Ω to 1 MΩ. Accurate specification of the load impedance is required to automatically apply the programmed amplitude level at the load.

OUTPut:LOAD:CAL {50|1M}(?)

HS Syntax: 0013A<0|1>(?)

Description

This command specifies the table of calibration constants to activate. This provides maximum accuracy for either 50 Ω or high-impedance (≥1 MΩ) loads.

Parameters

Name	Type	Default	Description
50	Discrete	50	Specifies that the 50 Ω calibration table will be applied to output offset and amplitude settings.
1M	Discrete		Specifies that the 1 MΩ calibration table will be applied to output offset and amplitude settings.

Response

The 3152B returns 50 for 50 Ω or 1M for 1 MΩ.

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OUTPut {OFF|ON|0|1}(?)

HS Syntax: 0200A<0|1>(?)

Description

This command toggles the 3152B output relay. Note that for safety, the outputs always defaults to off, even if the last instrument setting before power down was on.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Toggles the output relay between on and off

Response

The 3152B returns 1 if the output is on or 0 if the output is off.

OUTPut:SYNC {OFF|ON|0|1}(?)

HS Syntax: 0240A<0|1>(?)

Description

This command toggles the 3152B SYNC output. Note that for safety, the SYNC output always defaults to off, even if the last instrument setting before power down was on.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Toggles the SYNC output between on and off.

Response

The 3152B returns 1 if the SYNC output is on or 0 if the SYNC output is off.

OUTPut:SYNC:POSition<position>(?)

HS Syntax: 0242A<long>(?)

Description

Programs the 3152B SYNC position.

Parameters

Name	Range	Type	Default	Description
<position>	0 to 1e6-1	Integer	0	Sets the SYNC position, expressed in waveform points. The sync position can be programmed in increments of 4 points (2 points in legacy mode). The range is extended to 4e6-1 when the 4M memory option is installed.

Response

The 3152B returns the current SYNC position value.

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OUTPut:SYNC:SOURce {BIT|LCOMplete|SSYNc|HCLock|PULSe|ZEROcross}(?)

HS Syntax: 0241A<1|2|3|4|5>(?)

Description

Selects the source characteristic of the 3152B SYNC output.

Parameters

Name	Type	Default	Description
BIT	Discrete	BIT	Outputs a narrow sync pulse at a selected position along a standard or arbitrary waveform. For modulated modes, the sync output is automatically used as a marker. The fixed width of the sync pulse in this mode is 4 points in modern mode and 2 points in legacy mode. Use PULSe mode instead of BIT if the width of the pulse needs to be changed.
LCOMplete	Discrete		The LCOM sync pulse starts at the beginning of the selected segment of a sequence and ends at the end of the sequence. You may change the start position within the segment by using the outp:sync:pos command. You may change the segment using the trace:sel command. In either case the LCOM pulse will start at the specified position but will always end at the end of the sequence.
SSYNc	Discrete		Similar to the bit option except that for triggered or gated modes it eliminates the ±1 clock jitter between the trigger and the output signal by using a special circuit that synchronizes the sync output to the triggered signal.
HCLock	Discrete		Generates a sync signal that has a 50% duty cycle and the same period as the output.
PULSe	Discrete		Similar to the bit option except that the sync pulse width and position are adjustable. The position of the sync pulse is programmed using the outp:sync:pos command, and the width is programmed using the outp:sync:widt command.
ZEROcross	Discrete		Zero crossing is a special mode where the sync signal remains low as long as the output waveform level is negative (below 0 V) and changes to high when the output level becomes positive (above 0 V).

Response

The 3152B returns BIT, LCOM, SSYN, HCL, PULS, or ZERO depending on the selected SYNC source.

OUTPut:SYNC:WIDTh <width>(?)

HS Syntax: 0243A<integer>(?)

Description

Sets the SYNC width. This command is active for arbitrary (USER) and standard waveform (FIX) modes only.

Parameters

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Name	Range	Type	Default	Description
<width>	4 to 500 (2 to 500 in legacy mode)	Integer	4 (2 in legacy mode)	For standard waveform: Sets the SYNC duty cycle. The percentage duty cycle is <width>/20. For example, if <width> = 500, then the duty cycle is 500/20, or 25%. The <width> values are in increments of 4 (2 in legacy mode). For arbitrary (user) waveform: Sets the SYNC pulse width. The <width> value specifies the time expressed in waveform points, in increments of 4 (2 in legacy mode).

Response

The 3152B returns the current SYNC width value.

OUTPut:TRIGger:SOURce {BIT|LCOM|SSYN|HCL|PULS|ZERO|INTernal|EXTernal}(?)

Description

The TTLTRG signals, when enabled and placed on the backplane, can be asserted with signals coming from a number of sources. Use this command to assign the source for the active TTLTRG line.

HS Syntax: 0220A<1|2|3|4>(?)

Parameters

Name	Type	Default	Description
BIT	Discrete	BIT	Generates a trigger signal at a designated point on the waveform. The trigger position is programmed using the outp:sync:pos command. The same command sets the position of the trigger output and the position of the SYNC output.
LCOMplete	Discrete		Generates a single trigger signal in sequenced mode synchronous with the active segment in the sequence.
SSYNc	Discrete		Similar to the bit option except that it in triggered or gated modes it eliminates the ±1 clock jitter between the trigger and the output signal.
HCLock	Discrete		Generates a sync output pulse that has a 50% duty cycle and the same period as the output waveform.
PULSe	Discrete		Similar to the bit option except that the width of the sync pulse in 4 point increments from 4 to n-8 points (2 point increments from 2 to n-4 in legacy mode). The position of the pulse is programmed using the outp:sync:pos command and the width is programmed using the outp:sync:wid command.
ZEROcross	Discrete		Zero crossing is a special mode where the sync signal remains low as long as the output waveform level is negative (below 0 V) and changes to high when the output level becomes positive (above 0 V).
INTernal	Discrete		This type selects the internal generator as the source.

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EXTernal	Discrete	This type selects the external trigger input as the trigger source. An external signal must be connected to the TRIG IN connector for this mode to operate correctly.

Response
The 3152B returns BIT, LCOM, SSYN, HCL, PULS, ZERO, INT, or EXT depending on the current 3152B trigger source setting.

OUTPut:TTLTrg <n,OFF|ON|0|1>(?)

HS Syntax: 0230B<0|1|2|3|4|5|6|7,0|1>(?)

Description
The TTLTRG lines can be used to transmit and receive trigger signals between the 3152B and other VXIbus modules. Use this command to transmit signals on the backplane trigger lines.

Parameters

Name	Range	Type	Default	Description
<n>	0-7,0-1	Integer	1	Designates a specific backplane trigger line as an output and enables or disables it. Trigger line used is specified using the outp:trig:sour command.

Response
The 3152B returns n,0 when a specific backplane trigger line is off or n,1 when a specific backplane trigger line is enabled. The trigger line <n> can range from 0 to 7.

ROSCillator:SOURce {INTernal|EXTernal|CLK10}(?)

Description
This command selects the reference source for the sample clock generator.

HS Syntax:0028A <0|1>(?)

Parameters

Name	Type	Default	Description
INTernal	Discrete	Modern: INT	Selects the internal source, a 1ppm TCXO
EXTernal	Discrete		Enables the external reference input (available on 3151B and 3100 models only). An external reference must be connected to REF IN for normal operation.
CLK10	Discrete	Legacy: CLK10	Selects the VXI CLK10 reference. The CLK10 is routed in parallel to all backplane connectors allowing all of the modules installed in the VXI mainframe to use the same clock source which can be useful for synchronization purposes.

Response
The 3152B returns INT, EXT, or CLK10 depending on the current 3152B reference clock source setting.

FREQuency:EXTernal?

HS Syntax: 0420@?

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Description
This command queries the frequency at the trigger input. The same trigger is also used for phase locking to an external signal. This command returns the frequency value of the external signal only when the instrument is in PLL mode and locked.

Response
The 3152B measures and returns the current frequency applied to the trig/pll input. If no signal is applied to the trigger input, the response will be 0. The returned value will be in scientific notation(for example: 100mHz would be returned as 100e-3.

FREQuency {<freq>|MINimum|MAXimum}(?)

HS Syntax: 0400A<float>(?)

Description
Modifies the frequency of the standard waveform and is specified in units of Hertz (Hz). It has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<freq>	100e-6 to 100e6	Numeric	1e6	Sets the frequency of the standard waveform in units of Hz. The frequency command can be used with resolutions up to 14 digits.
<MINimum>		Discrete		Sets the frequency of the standard waveform at the lowest possible frequency (100e-6).
<MAXimum>		Discrete		Sets the frequency of the standard waveform to the highest possible frequency (100e6).

Response
The 3152B returns the current frequency value. The returned value will be in scientific notation(for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FREQuency:RASTer {<sclk>|MINimum|MAXimum}(?)

HS Syntax: 0410A<float>(?)

Description
Modifies the sample clock frequency of the arbitrary waveform in units of samples per second. It has no affect on standard waveforms.

Parameters

Name	Range	Type	Default	Description
<sclk>	100e-3 to 250e6	Numeric	1e6	Sets the sample clock frequency of the arbitrary and sequenced waveform in units of samples per second. The sample clock can be programmed with a resolution of up to 14 digits.
<MINimum>		Discrete		Sets the sample clock frequency to the lowest possible frequency (100e-3).

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<MAXimum>	Discrete	Sets the frequency of the standard waveform to the highest possible frequency (250e6).

Response
The 3152B returns the current sample clock frequency in scientific notation, e.g., 100MHz would be 100e6.

FREQuency:RASTer:SOURce {INTernal|EXTernal|LBUS<n>|ECLTrg0}(?)

HS Syntax: 0411A<3|4|5|16>(?)

Description
Selects the source for the sample clock. This command affects standard, arbitrary, and sequenced waveforms. The ECLTrg0 and the LBUS<n> sources are useful for applications requiring synchronization between adjacent modules.

Parameters

Name	Type	Default	Description
INTernal	Discrete	INT	Selects an internal source.
EXTernal	Discrete		Activates the external sample clock reference input. An external reference must be connected to the 3152B, in the range of the internal source, for it to continue normal operation. Observe the input level and limitations before connecting an external signal.
LBUS<0-7>	Discrete		Activates a selection from LBUS0 to LBUS7 as the source for the sample clock input. The signal must be generated from another module in the chassis, acting as the master. Also, the master and slave modules must be configured for LBUS operation. For details, refer to the Local Bus Configuration section in Chapter 2.
ECLTrg0	Discrete		Activates the backplane ECLTrg0 as the source for the sample clock input. Signal must be generated from another module in the chassis on this line, otherwise, the 3152B will not operate correctly. Observe the input level limitations before connecting an external signal to this line.

Response
The 3152B returns INT, EXT, ECLT0, or LBUS<n> depending on the current sample clock source setting.

VOLTage {<ampl>|MINimum|MAXimum}(?)

HS Syntax: 0500A<float>(?)

Description
Programs the peak to peak amplitude of the output waveform. The amplitude is calibrated when the source impedance is 50Ω.

Parameters

Name	Range	Type	Default	Description
<ampl>	10e-3 to 16e0	Numeric	5	Sets the amplitude of the output waveform in units of Volts. Amplitude setting is always peak to peak. Offset and amplitude settings are independent providing that

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		the offset + amplitude does not exceed 16.
<MINimum>	Discrete	Sets the amplitude to the lowest possible level (10mV).
MAXimum>	Discrete	Sets the amplitude to the highest possible level (16V).

Response
The 3152B returns the current amplitude value. The returned value will be in scientific notation, e.g., 100 mV would be 100e-3.

VOLTage:OFFSet <offs>(?)

HS Syntax: 0501A<float>(?)

Description
Programs the amplitude offset of the output waveform. The offset is calibrated when the source impedance is 50Ω.

Parameters

Name	Range	Type	Default	Description
<offs>	-7.992 to 7.992	Numeric	0	Sets the offset of the output waveform in units of Volts. Offset and amplitude settings are independent providing that the offset + amplitude do not exceed the specified window.

Response
The 3152B returns the current offset value. The returned value will be in scientific notation, e.g., 100 mV would be 100e-3.

PHASe:OFFSet <phase_offs>(?)

HS Syntax: 0027A<float>(?)

Description
This command will affect a slave instrument only when it is synchronized to another module in the chassis. It programs the start phase offset with respect to an adjacent master module. Phase offset resolution when using this command is 1 point.

Parameters

Name	Range	Type	Default	Description
<phase_offs>	0 to 1e6-1	Numeric (Integer only)	0	Sets the phase offset in reference to a master instrument. Slave instruments trail the master instrument edge. The range is extended 4 Meg-1 when the 4 Meg memory option is installed. 1 Meg is standard.

Response
The 3152B returns the current phase offset value.

FUNCtion:MODE {FIXed|USER|SEQuence|SWEep|MODulation|COUNter|DPULse|HALFcycle}(?)

HS Syntax: 0610A<0|1|2|3|4|5|6|7>(?)

Description
This command selects the operating mode of the 3152B.

Parameters

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Name	Type	Default	Description
FIXed	Discrete	FIX	Selects standard waveform mode. There is an assortment of standard waveforms that may be selected. You can find these waveform shapes in the standard waveforms section.
USER	Discrete		Selects arbitrary waveform mode. Arbitrary waveforms must be loaded into 3152B memory before they can be re-played.
SEQuenced	Discrete		Selects sequenced waveform output. To generate a sequence, first download waveforms to different memory segments and then build a sequence table to generate a complex waveform using these segments.
SWEep	Discrete		Selects the sweep generator function. Sweep generator functions and parameters are programmable.
MODulated	Discrete		Selects the modulated waveforms. There is an array of built-in modulation schemes. However, you can also build custom modulation schemes using the arbitrary function.
COUNter	Discrete		Selects the counter/timer auxiliary function. Note that when you select this function, all waveform generation of the 3152B are purged and the 3152B is transformed to behave as if it was a stand-alone counter/timer.
DPULse	Discrete		Selects the digital pulse function.
HALFcycle	Discrete		Selects the half-cycle function.

Response

The 3152B returns FIX, USER, SEQ, SWE, MOD, COUN, DPUL, or HALF depending on the current 3152B operating mode.

Run Mode Commands

The Run Mode Commands group is used to synchronize device actions with external events. These commands control the trigger modes of the waveform generator. The instrument can be placed in Triggered, Gated or Burst mode. Trigger source is selectable from external, a backplane trigger line, an internal trigger generator that has asynchronous, free-running programmable intervals, and a software command. The 3152B also has a built-in internal re-trigger generator that provides accurate and self-repeating control from waveform end to waveform start.

Run Mode command settings affect all waveform shapes equally except when using the modulated waveforms. In the case of modulated waveforms, the output idles on either the carrier waveform or on a DC level until stimulated to output a modulation cycle or a burst of cycles. Additional information on the run mode options and how the generator behaves in the various run mode options is given in Chapter 3. Factory defaults after *RST are shown in the default column. Parameter low and high limits are given where applicable.

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Table 5-4, Run Mode Commands

Keyword	Parameter Form	Default	3152A	HS
:INITiate				
[:IMMediately]				
:CONTinuous	OFF | ON | 0 | 1	1	✓	1110A
:TRIGger				
[:IMMediate]			✓	11000
:BURSt				
[:STATe]	OFF | ON | 0 | 1	0	✓	1120A
:COUNt	1 to 1000000	1	✓	1121A
:DELay	0, 10 to 2e6 (points, even numbers)	0 (0 = OFF)	✓	1131A
[:STATe]	OFF | ON | 0 | 1	0		0188A
:TIMe	100e-9 to 20	100		0156A
:GATE				
:MODe	LEVel | TRANsition	LEV		0157A
[:STATe]	OFF | ON | 0 | 1	0	✓	1150A
:LEVel	-10 to 10	1.6	✓	1180A
:SOURce				
[:ADVance]	EXTernal | INTernal | TTLTrg<n> | BUS	EXT		1140A
:SLOPe	NEGative | POSitive	POS	✓	1160A
:RETRigger				
[:STATe]	OFF | ON | 0 | 1	0		0187A
:TIMe	100e-9 to 20	100		0161A
:TIMer	1e-6 to 20	15e-6	✓	1170A

INITiate:CONTinuous {1|0|ON|OFF}(?)

HS Syntax: 1110A<1|0>(?)

Description

Toggles the 3152B to operate in either continuous mode (INIT:CONT ON | 1) or in interrupted run mode (INIT:CONT OFF | 0). Trigger subsystem commands affect the 3152B only after it is set for interrupted run mode.

Parameters

Range	Type	Default	Description
1-0	Discrete	1	"1" selects continuous run mode. "0" selects interrupted run mode. In INIT:CONT 0 mode, you can program the 3152B to operate in triggered, gated, or counted burst run modes.

Response

The 3152B returns 1 or 0 depending on the selected option.

TRIGger

HS Syntax: 11000

Description

Use this command to send a software trigger to the 3152B. The *trg command has the same effect. This command will affect the 3152B while it is running in interrupted run mode (INIT:CONT 0) and only when the selected trigger source is BUS.

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Response
The 3152B will respond to a remote trig command if INIT:CONT 0 and TRIG:SOUR BUS are both true.

TRIGger:BURSt {OFF|ON|0|1}(?)

HS Syntax: 1120A<0|1>(?)

Description
This command toggles counted burst run mode on and off. This command affects the 3152B when it is in INIT:CONT 0 mode.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	"1" enables counted burst run mode. "0" turns burst run mode off. Burst count is programmable using the TRIG:BURS:COUN command.

Response
The 3152B returns 0 or 1 depending on the selected option.

TRIGger:BURSt:COUNt <burst>(?)

HS Syntax: 1121A<long>(?)

Description

This function sets the number of burst cycles to be output when Burst Mode is enabled. Use the INIT:CONT OFF;:TRIG:BURS ON commands to select Burst Mode.

Parameters

Name	Range	Type	Default	Description
<burst>	1 to 1M	Numeric (integer only)	1	Programs the burst count.

Response
The 3152B returns the current burst count value.

TRIGger:DELay <sample clock cycles>(?)

HS Syntax: 1131A<long>(?)

Description

The trigger delay time parameter defines the time that elapses between the receipt of a valid trigger signal until the initiation of the first output waveform. Trigger delay is turned off using the TRIG:DEL 0 command. The trigger delay time command will affect the generator only after it has been programmed to operate in interrupted run mode. Set the 3152B into interrupted run mode using the INIT:CONT OFF command. Note that this command is left in the commands list for compatibility with the model 3152A. The delay time is programmed in sample clock increments. For new applications the TRIG:DEL:TIME command is recommended because it allows you to program delays in time units instead of in sample clock periods.

Parameters

Name	Range	Type	Default	Description

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<time>	0, 10 to 2e6	Numeric (integer only)	0	"0" turns off the delayed trigger function. Delay is programmed in sample clock increments, so expect the delay time to change if you modify your sample clock setting.

Response
The 3152B returns the current trigger delay time value in sample clock cycles.

TRIGger:DELay {OFF|ON|0|1}(?)

HS Syntax: 0188A<0|1>(?)

Description

Use this command to toggle the delayed trigger feature. The trigger delay command affects the generator only after it has been programmed to operate in interrupted run mode. Set the 3152B to interrupted run mode using the INIT:CONT OFF command.

Range	Type	Default	Description
0-1	Discrete	0	Toggles delayed trigger mode.

Response
The 3152B returns 0 or 1 depending on the selected option.

TRIGger:DELay:Time <time>(?)

HS Syntax: 0156A<float>(?)

Description

The trigger delay time parameter defines the time that elapses between the receipt of a valid trigger signal until the initiation of the first output waveform. Trigger delay can be turned off and on using the TRIG:DEL <0|1> command. The trigger delay time command affects the generator only after it has been programmed to operate in interrupted run mode. Modify the 3152B to interrupted run mode using the INIT:CONT OFF command.

Parameters

Name	Range	Type	Default	Description
<time>	100e-9 to 20	Numeric	100e-9	Programs the trigger delay time. Programming resolution is 20 ns across the range.

Response
The 3152B returns the current trigger delay time value.

TRIGger:GATE:MODE {LEVel|TRANsition}(?)

HS Syntax: 0157A<0|1>(?)

Description
Sets the 3152B gate mode to TRANsition (start and stop pulses) or LEVel (open gate on high or low level). The trig:slop command defines the polarity of both modes. Select the source as either the front panel TRIG IN connector or one of the backplane trigger lines. Note that you can control the trigger level threshold, but only if you can only do it if you are using the front panel input. This command affects the 3152B only after it is set to non-continuous mode (INIT:CONT OFF).

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Parameters

Name	Type	Default	Description
LEVel	Discrete	LEV	Selects level-controlled gating with a programmable threshold and slope at the external trigger input as the gating source.
TRANsition	Discrete		Selects a transition pulse with a programmable threshold and slope to first turn the gate on and then to turn it off.

Response
The 3152B returns LEV or TRAN depending on the selected option.

TRIGger:GATE {OFF|ON|0|1}(?)

HS Syntax: 1150A<0|1>(?)

Description
Toggle gated run mode on or off. Affect the 3152B only after it is set to INIT:CONT OFF mode.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Turns gate run mode off or on.

Response
The 3152B returns 0 or 1 depending on the selected option.

TRIGger:LEVel<level>(?)

HS Syntax: 1180A<float>(?)

Description

The trigger level command sets the threshold level at the trigger input connector. The trigger level command affects the generator when it is an in interrupted run mode which can be selected using the INIT:CONT OFF command.

Parameters

Name	Range	Type	Default	Description
<level>	-10 to 10	Numeric	0	Programs the trigger threshold. The value affects the front panel input only.

Response
The 3152B returns the current trigger threshold value.

TRIGger:SOURce:ADVance {EXTernal|INTernal|TTLTrg<n>|ECLT1|BUS}(?)

HS Syntax: 1140A<4|3|8|9|10|11|12|13|14|15|16|17>(?)

Description
This selects the trigger source forthe 3152B. The source advance command affects the generator only after it has been programmed to operate in an interrupted run mode which can be selected using the INIT:CONT OFF command.

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Parameters

Name	Type	Default	Description
EXTernal	Discrete	EXT	Selects the front panel TRIG IN input as the trigger source.
INTernal	Discrete		Activates the built-in internal trigger generator. BUS and external triggers are ignored. The period of the internal trigger is programmable and can be used to replace an external trigger source.
TTLTrg<0 to 7>	Discrete		Selects a backplane trigger line as the source for the trigger input. To avoid hardware conflicts, make sure that no more than one instrument is programmed to output trigger signals on any specific TTLT line.
ECLTrg1	Discrete		Selects the backplane ECL trigger line number 1 as the source for the trigger input.
BUS	Discrete		Selects the remote controller as the trigger source. Only software commands are accepted; backplane and front panel signals are ignored.

Response

The 3152B returns EXT, INT, TTLT<n>, or BUS depending on the selected trigger advance source setting.

TRIGger:SLOPe {NEGative|POSitive}(?)

HS Syntax: 1160A<0|1>(?)

Description

The trigger slope command selects the polarity of the trigger signal as the trigger source. This affects both Transition (edge) mode and Level mode.

Transition mode: If the POS option is selected, then positive-going transitions toggle the gate open or closed. If the NEG option is selected, then negative-going transitions toggle the gate open or closed. Two transitions in the same direction are required to gate the output on and then off. The trigger slope command affects the generator when in an interrupted run mode, which can be selected using the INIT:CONT OFF command.

Level mode: If the POS option is selected, then a trigger signal above the threshold opens the gate, and a trigger signal below the threshold closes the gate. If the NEG option has been selected, then a trigger signal below the threshold opens the gate, and a trigger signal above the threshold closes the gate.

Parameters

Name	Type	Default	Description
NEGative	Discrete		Transition (edge) mode: Selects the negative going edge as the trigger source. Level mode: A negative level (below the trigger level setting) opens the gate.
POSitive	Discrete	POS	Transition (edge) mode: Selects the positive going edge as the trigger source. Level mode: A positive level (above the trigger level setting) opens the gate.

Response

The 3152B returns POS or NEG depending on the selected trigger slope setting.

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RETRigger {OFF|ON|0|1}(?)

HS Syntax: 0187A<0|1>(?)

Description

Toggles the state of the re-trigger function. The re-trigger feature causes the 3152B to self-trigger at the end of a triggered signal cycle. This differs from internally triggered mode in that the internal trigger timer starts the waveform at a periodic interval and the re-trigger feature re-triggers the waveform after a delay which begins at the end of the waveform cycle. The re-trigger command affects the generator only when it is programmed to operate in an interrupted run mode which can be selected using the INIT:CONT OFF command.

Parameters

Name	Type	Default	Description
0-1	Discrete	0	Toggles re-trigger mode.

Response

The 3152B returns 0 or 1 depending on the selected option.

RETRigger:TIMe <time>(?)

HS Syntax: 0161A<float>(?)

Description

Specifies the amount of time between the end of a waveform cycle and the beginning of the next waveform cycle. The re-trigger interval is measured from waveform end to the triggering of a new waveform cycle to start. The re-trigger command affects the generator when it is in an interrupted run mode which can be selected using the INIT:CONT OFF command.

Parameters

Name	Range	Type	Default	Description
<time>	100e-9 to 20	Numeric	100e-9	Programs the re-trigger period. Programming resolution is 20 ns across the range.

Response

The 3152B returns the current re-trigger period value.

TRIGger:TIMer <timer>(?)

HS Syntax: 1170A<float>(?)

Description

Specifies the period of the internal trigger generator. TRIG:TIM is used with the internally triggered run mode only and has no affect on other trigger modes. The internal trigger generator is a free-running oscillator which is asynchronous to the frequency of the output waveform. The timer intervals are measured from waveform start to waveform start. Note that this differs from the re-triggered mode where there the delay time setting is measured from waveform cycle end to the triggering of a new waveform cycle.

Parameters

Name	Range	Type	Default	Description
<time>	1e-6 to 20	Numeric	15e-6	Programs the internal trigger generator period.

Response

The 3152B returns the current internal trigger period value.

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Standard Waveform Control Commands

This group is used to control the standard waveforms and their respective parameters. There is an array of standard waveforms that could be used without the need to download waveform values to the instrument. You can also modify the parameters for each waveform to a shape suitable to your application.

Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Table 5-5, Standard Waveform Control Commands Summary

Keyword	Parameter Form	Default	3152A	HS
[:SOURce]				
:SHAPe	SINusoid | TRIangle | SQUare | PULSe | RAMP | SINC | GAUSsian | EXPonential | NOISe | DC	SIN	✓	0600A
:SINusoid				
:PHASe	0 to 360	0	✓	0700A
:POWer	1 to 9	1	✓	0701A
:TRIangle				
:PHASe	0 to 360	0	✓	0710A
:POWer	1 to 9	1	✓	0711A
:SQUare			✓	
:DCYCle	0 to 99.99	50	✓	0720A
:PULSe				
:DELay	0 to 99.999	10	✓	0730A
:WIDTh	0 to 99.999	10	✓	0731A
:TRANsition				
[:LEADing]	0 to 99.999	10	✓	0732A
:TRAiling	0 to 99.999	10	✓	0733A
:RAMP			✓	
:DELay	0 to 99.99	10	✓	0740A
:TRANsition				
[:LEADing]	0 to 99.99	10	✓	0741A
:TRAiling	0 to 99.99	10	✓	0742A
:SINC				
:NCYCle	4 to 100	10	✓	0790A
:GAUSsian			✓	
:EXPonent	1 to 200	10	✓	0750A
:EXPonential				
:EXPonent	-100 to 100	-10	✓	0760A
:DC				
[:VOLTage]	-100 to 100	100	✓	0770A
:AMPLitude	-8 to 8	5		0046A

FUNCtion:SHAPe {SINusoid|TRIangle|SQUare|PULSe|RAMP|SINC|GAUSsian|EXPonential|DC|NOISe}(?)

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HS Syntax: 0600A<0|1|2|3|4|5|6|7|8|9>(?)

Description

Defines the standard waveform shape to be output by the 3152B.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects the built-in sine waveform.
TRIangle	Discrete		Selects the built-in triangular waveform.
SQUare	Discrete		Selects the built-in square waveform.
SPULse	Discrete		Selects the built-in pulse waveform.
RAMP	Discrete		Selects the built-in ramp waveform.
SINC	Discrete		Selects the built-in sinc waveform.
EXPonential	Discrete		Selects the built-in exponential waveform.
GAUSsian	Discrete		Selects the built-in gaussian waveform.
DC	Discrete		Selects the built-in DC waveform.
NOISe	Discrete		Selects the built-in noise waveform.

Response

The 3152B returns SIN, TRI, SQU, SPUL, RAMP, SINC, GAUS, EXP, DC, or NOIS depending on the current 3152B setting.

SINusoid:PHASe <phase>(?)

HS Syntax: 0700A<float>(?)

Description

Programs the start phase for the standard sine waveform. This command has no affect on modulated waveforms.

Parameters

Name	Range	Type	Default	Description
<phase>	0 to 360	Numeric	0	Programs the start phase parameter in units of degrees.

Response

The 3152B returns the current start phase value.

SINusoid:POWer <power>(?)

HS Syntax: 0701A<integer>(?)

Description

Programs power for the $\sin^x$ waveform. This command has no affect on modulated waveforms.

Parameters

Name	Range	Type	Default	Description
<power>	1 to 9	Numeric	1	Programs the power that the sine function will be raised to. Note that even powers will provide waveforms that are positive (all points >= 0) whereas odd powers will provide functions that are positive or negative 50% of

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the time.

Response
The 3152B returns the current power value for the sine^x function.

TRIangle:PHASe <phase>(?)

HS Syntax: 0710A<float>(?)

Description
Programs the start phase for the standard triangular waveform. This command has no affect on modulated waveforms.

Parameters

Name	Range	Type	Default	Description
<phase>	0 to 360	Numeric	0	Programs the start phase parameter in units of degrees.

Response
The 3152B returns the current start phase value for the triangle function.

TRIangle:POWer <power>(?)

HS Syntax: 0711A<integer>(?)

Description
Programs power for the triangle^x waveform. This command has no affect on modulated waveforms.

Parameters

Name	Range	Type	Default	Description
<power>	1 to 9	Numeric	1	Programs the power that the triangle function will be raised to. Note that even powers will provide waveforms that are positive (all points >= 0) whereas odd powers will provide functions that are positive or negative 50% of the time.

Response
The 3152B returns the current power value for the triangle^x function.

SQUare:DCYCle <duty_cycle>(?)

HS Syntax: 0720A<float>(?)

Description
Programs duty cycle of the standard square waveform.

Parameters

Name	Range	Type	Default	Description
<duty_cycle>	0 to 99.99	Numeric	50	Programs the square wave duty cycle parameter in units of percent (ratio of on-time to off-time).

Response
The 3152B returns the current duty cycle value for the square wave function.

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PULSe:DELay <delay>(?)

HS Syntax: 0730A<float>(?)

Description
Programs delay of the standard pulse waveform.

Parameters

Name	Range	Type	Default	Description
<delay>	0 to 99.999	Numeric	10	Programs the pulse delay parameter in units of percent.

Response
The 3152B returns the current pulse delay value.

PULSe:WIDTh <pulse_width>(?)

HS Syntax: 0731A<float>(?)

Description
Programs pulse high portion of the standard pulse waveform.

Parameters

Name	Range	Type	Default	Description
<pulse_width>	0 to 99.999	Numeric	10	Programs the pulse width parameter in units of percent.

Response
The 3152B returns the current width value.

PULSe:TRANsition <rise>(?)

HS Syntax: 0732A<float>(?)

Description
Programs pulse transition from low to high of the standard pulse waveform.

Parameters

Name	Range	Type	Default	Description
<rise>	0 to 99.999	Numeric	10	Programs the pulse rise time parameter in units of percent.

Response
The 3152B returns the current rise time value.

PULSe:TRANsition:TRAiling <fall>(?)

HS Syntax: 0733A<float>(?)

Description
Programs the pulse transition time from high to low for the standard pulse waveform.

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Parameters

Name	Range	Type	Default	Description
<fall>	0 to 99.999	Numeric	10	Programs the pulse fall time parameter in units of percent.

Response
The 3152B returns the current fall time value for the pulse function.

RAMP:DELay <delay>(?)

HS Syntax: 0740A<float>(?)

Description
Programs ramp start delay for the standard ramp waveform.

Parameters

Name	Range	Type	Default	Description
<delay>	0 to 99.99	Numeric	10	Programs the ramp delay parameter in units of percent.

Response
The 3152B returns the current ramp delay value for the ramp function.

Ramp:TRANsition <rise>(?)

HS Syntax: 0741A<float>(?)

Description
Programs the ramp transition from low to high for the standard ramp waveform.

Parameters

Name	Range	Type	Default	Description
<rise>	0 to 99.99	Numeric	60	Programs the ramp rise time parameter in units of percent.

Response
The 3152B returns the current rise time value for the ramp function.

RAMP:TRANsition:TRAiling <fall>(?)

HS Syntax: 0742A<float>(?)

Description
Programs the ramp transition from high to low for the standard ramp waveform.

Parameters

Name	Range	Type	Default	Description
<fall>	0 to 99.99	Numeric	30	Programs the ramp fall time parameter in units of percent

Response

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The 3152B returns the current fall time value.

SINC:NCYCle <N_cycles>(?)

HS Syntax: 0790A<integer>(?)

Description

Programs the number of “0-crossings” of the standard SINC pulse waveform.

Parameters

Name	Range	Type	Default	Description
<N_cycle>	4 to 100	Numeric (Integer only)	10	Programs the number of zero-crossings parameter.

Response

The 3152B returns the current number of zero-crossings value.

GAUSsian:EXPonent <exp>(?)

HS Syntax: 0750A<integer>(?)

Description

Programs the exponent for the standard gaussian pulse waveform.

Parameters

Name	Range	Type	Default	Description
<exp>	1 to 200	Numeric	10	Programs the exponent parameter for the Gaussian function.

Response

The 3152B returns the current exponent value for the Gaussian function.

EXPonential:EXPonent <exp>(?)

HS Syntax: 0760A<integer>(?)

Description

Programs the exponent for the standard exponential waveform.

Parameters

Name	Range	Type	Default	Description
<exp>	-100 to 100	Numeric	-10	Programs the exponent parameter.

Response

The 3152B returns the current exponent value for the exponential function.

DC <voltage>(?)

HS Syntax: 0770A<float>(?)

Description

Programs the voltage level for the DC function. The peak to peak amplitude value is programmed in units of percent relative to the programmed peak to peak amplitude level.

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Parameters

Name	Range	Type	Default	Description
<voltage>	-100 to 100	Numeric	100	Programs level of the DC function in units of percent.

Response
The 3152B returns the current DC voltage value.

DC:AMPLitude <amplitude>(?)

HS Syntax: 0046A<float>(?)

Description
Programs the amplitude of the DC function in units of Volts. Unlike the previous command, you do not have to compute percent value to determine the actual output.

Parameters

Name	Range	Type	Default	Description
<amplitude>	-8 to 8	Numeric	5	Programs the DC amplitude parameter.

Response
The 3152B returns the current DC amplitude value in units of Volts.

Arbitrary Waveform Control Commands

This group is used to control the arbitrary waveforms and their respective parameters. This will allow you to create segments and download waveforms. Using these commands you can also define segment size and delete some or all unwanted waveforms from your memory. Use the commands in this group to turn the digital output on and off and to download data to the digital pattern buffer.

Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Generating Arbitrary Waveforms
Arbitrary waveforms are generated from digital data points, which are stored in a dedicated waveform memory. Each data point has a vertical resolution of 16 bits (65536 points), i.e., each sample is placed on the vertical axis with a precision of 1/65536. The 3152B has the following waveform memory capacity:

1M – standard memory configuration
4M – optional memory expansion

Each horizontal point has a unique address - the first being 00000 and the last depends on the memory option. In cases where smaller waveform lengths are required, the waveform memory can be divided into smaller segments.

When the instrument is programmed to output arbitrary waveforms, the clock samples the data points (one at a time) from address 0 to the last address. The rate at which each sample is replayed is defined by the sample clock rate parameter.

Unlike the built-in standard waveforms, arbitrary waveforms must first

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be loaded into the instrument's memory. Correct memory management is required for best utilization of the arbitrary memory. An explanation of how to manage the arbitrary waveform memory is given in the following paragraphs.

Arbitrary memory Management

The arbitrary memory in comprised of a finite length of words. The maximum size arbitrary waveform that can be loaded into memory depends on the option that is installed in your instrument. The various options are listed in Chapter 1 of this manual. If you purchased the 3152B with in its basic configuration then you have 1 Meg words for the loading of arbitrary waveforms.

Waveforms are created using small sections of arbitrary memory. The memory can be partitioned into smaller segments (up to 16k) and different waveforms can be loaded into each segment, each having a unique length. Minimum segment size is 16 points. Information on how to partition the memory, define segment length, and download waveform data to the 3152B is given in the following paragraphs.

Table 5-6, Arbitrary Waveform Command Summary

Keyword	Parameter Form	Default	3152A	HS
:FORMat				
:WAVE	NORMal | USER	Error, not supported	✓	0101A
:RESolution	16BIT | 12BIT	16BIT		0102A
:INSTrument	LEGacy | MODern	MOD		0189A
:BORDer	NORMal | SWAPped	NORM	✓	0100A
:TRACe				
[:DATA]	<data_array>		✓	10001#
:DEFine	<1 to 10k>,<16 to 1(2/4)e6> (<segment_#>,<size>)			10102
:DELete				
[:NAME]	1 to 10k		✓	09201
:ALL			✓	10210
:SELect	1 to 10k	1	✓	1030A
:SEGMent				
[:DATA]	<data_array>			10501#

FORMat:WAVE {NORMal|USER}(?)

HS Syntax: 0101A<0|1>?

Response

This 3152A command is not supported by the 3152B. The 3152B returns an error.

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FORMat:WAVE:RESolution {16BIT|12BIT}(?)

HS Syntax: 0102A<0|1>?

Description

This selects between 12-bit or 16-bit waveform formats. 16-bits is the default resolution for the 3100M and 12-bits is the default resolution for the 3151B and 3152B for compatibility with legacy models.

Parameters

Name	Type	Default	Description
16BIT	Discrete	16BIT (3100 models)	Arbitrary waveforms are downloaded as 16-bit (0xFFFF) binary block. Data is sent in byte-high byte-low order.
12BIT	Discrete	12BIT (3151B and 3152B)	Arbitrary waveforms are downloaded as 16-bit (0xFFFF) binary block. Data is sent in byte-high byte-low order however, the four least significant digits are ignored and therefore, data is shifted to the left. For compatibility issues with the 3152A, the default setting for this model is 12BIT.

Response

The 3152B returns 16BIT or 12BIT depending on the current format setting.

FORMat:INSTrument {LEGacy|MODern}(?)

HS Syntax: 0189A<0|1>?

Description

Toggles between legacy and modern operation of the 3152B. Legacy implies that the 3152B behaves exactly like the 3152A for backward compatibility. This automatically modifies certain parameters to duplicate the 3152A limits. For example: maximum sample clock frequency is limited to 100 MS/s; waveform interlace is changed to 2, and; waveform vertical resolution is changed to 12 bits. The Modern option removes all limitations and full performance is available. Note: In FORM:INST LEG mode, if the external sample clock is used, the resultant frequency will be 50% of what would be expected using a legacy 3152A. To eliminate this problem, switch to FORM:INST MOD mode.

Parameters

Name	Type	Default	Description
LEGacy	Discrete	3152B: LEG	This is the default setting if you ordered the 3152B. You may still modify the format to modern to restore full performance.
MODern	Discrete	3100-M/R: MOD	This is the default position if you ordered the 3100M/R-3152B. 3152A legacy compatibility is available by switching to FORM:INST LEG.

Response

The 3152B returns LEG or MOD depending on the current compatibility mode setting.

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FORMat:BORDer {NORMal|SWAPped}(?)

HS Syntax: 0100A<0|1>?

Description

Binary data is sent to the instrument in byte-high, byte-low order. For convenience, programmers can write their code in reverse order but have to let the instrument know that the data is reversed. In case the code stores the data in byte-low, byte-high order, use the FORM:BORD SWAP command to reverse the byte order.

Name	Type	Default	Description
NORMal	Discrete	NORM	Binary data is sent in byte-high, byte-low order
SWAPped	Discrete		Binary data is sent in byte-low, byte-high order

Response

The 3152B returns NORM or SWAP depending on the current binary data format setting.

TRACe#<header><binary_block>

HS Syntax: 10001#<string>

Description

Downloads waveform data to 3152B waveform memory. Waveform data is loaded into the 3152B using a binary transfer. A special command is defined by IEEE-STD-488.2 for this purpose. Binary transfer allows any 8-bit bytes (including extended ASCII codes) to be transmitted in a message. As an example, the next command will download an arbitrary block of data of 1024 points:

```
TRACe#42048<binary_block>
```

This command causes the transfer of 2048 bytes of data (1024 waveform points) into the active memory segment. The <header> is interpreted this way:

- The ASCII "#" ($23) designates the start of the binary data block.
- "4" designates the number of digits that follow.
- "2048" is the even number of bytes to follow.

The generator accepts binary data as 16-bit integers, which are sent in two-byte words. Therefore, the total number of bytes is always twice the number of data points in the waveform. For example, 20000 bytes are required to download a waveform with 10000 points. The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data format is demonstrated in Figure 5-1.

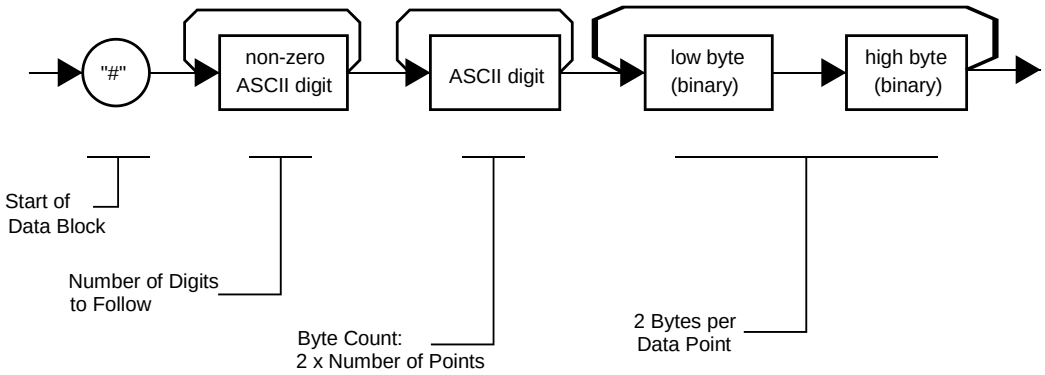


Figure 5-1, Definite Length Arbitrary Block Data Format

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Transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0DH) and line feed (LF – 0AH) characters can be used as waveform data points and will not cause unexpected termination of the arbitrary block data.

- <binary_block> Waveform data

The waveform data is made of 16-bit words, however, programmers may choose to prepare the data in two bytes and arrange to download these two bytes in a sequence. Figure 5-2 shows a waveform word that is acceptable for the 3152B. There are a number of points you should be aware of before you start preparing the data:

1. Waveform data points have 16-bit values - 0x0000 to 0xFFFF
2. Data point range is 0 to 65,535 decimal for the 3152B and 0 to 4095 decimal for 3152A emulation. 0x0000 correspond to -8 V and 0xFFFF corresponds to +8V (0xFFF corresponds to +8 V for 3152A emulation).
3. 3152B data point data point 65,535 corresponds to full-scale amplitude setting. Point 32768 (point 2048 for the legacy 3152A) corresponds to the 0 V amplitude setting.

Figure 5-2 shows how to initially prepare the 16-bit word for a waveform data point. Figure 5-3 shows how legacy 3152A waveform data point was represented.

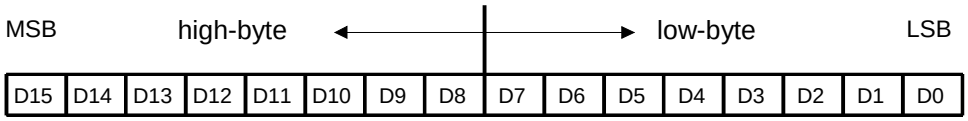


Figure 5-2, 3152B 16-bit Waveform Data Point Representation

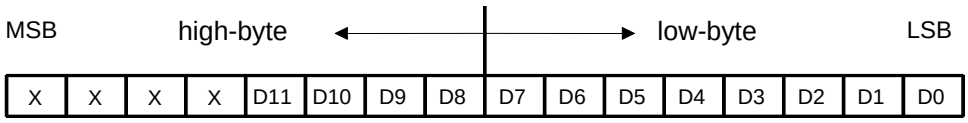


Figure 5-3, 3152A 12-bit Waveform Data Point Representation

Parameters

Name	Type	Description
<header>	Discrete	Contains information on the size of the binary block that contains waveform data.
<binary_block>	Binary	Block of binary data that contains waveform data points as explained above.

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TRACe:DEFine <segment_# >,<length>

HS Syntax: 10102<integer,long>

Description

Use this command to define the size of a specific memory segment. The final size of the arbitrary memory is 1 Meg points (4 Meg optional). The memory can be partitioned to smaller segments, up to 16k segments. This function allows the definition of segment size. Total length of memory segments cannot exceed the size of the waveform memory.



NOTE

The 3152B operates in interlaced mode where four memory cells generate one byte of data. Therefore, segment size can be programmed in numbers evenly divisible by four only. For example, 2096 bytes is an acceptable length for a binary block. 2002 is not a multiple of 4, therefore the generator will generate an error message if this segment length is used. If you use 3152A emulation mode (FORM:INST LEG), use the command FORM:WAVE:RES 12BIT to allow the 3152B to mimic the by 2 interlace of the 3152A.

Parameters

Name	Range	Type	Default	Description
<segment_#>	1 to 16k	Numeric (integer only)		Selects the segment number to be defined.
<length>	16 (10 for FORM: INST LEG) to max size of memory	Numeric (integer only)		Programs the size of the selected segment. Minimum segment length is 16 points (10 points minimum for FORM:INST LEG in 12-bit format), the maximum is limited by the total amount of installed memory.

TRACe:DELete<segment_number>

HS Syntax: 09201<integer>

Description

This command deletes a waveform memory segment. The memory space that is being freed will be available for new waveforms as long as the new waveform is equal to or smaller than the size to the deleted segment. If the deleted segment is the last segment, then the size of another waveform written to the same segment is not limited. For example, consider two segments, the first with1000-points and the second with 100 points. If you delete segment 1, you can load another waveform into segment 1 with 1000 points. If you load segment 1 with 1004 points, the instrument will generate an error and will not accept this waveform. On the other hand, if you delete segment 2, then you can re-load this segment with a waveform having length limited only by the size of the entire memory space.

Parameters

Name	Range	Type	Default	Description

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number>	1 to 10k	Numeric (integer only)	1	Selects the segment number of which will be deleted.

TRACe:DELete:ALL

HS Syntax: **10210**

Description

This command deletes all waveform memory segments and clears the entire waveform memory. This command is useful for the memory management of arbitrary waveforms.



TIP

The TRAC:DEL:ALL command does not re-write the memory so, whatever waveforms were downloaded to the memory are still there for recovery. The TRAC:DEL:ALL command removes all stop bits and clears the segment table. You can recover memory segments using the TRAC:DEF command. You can also use this technique to re-size or to combine waveform segments.

TRACe:SELect <segment_number>

HS Syntax: **1030A<integer>**

Description

This command selects the active waveform segment to be output. By selecting the active segment you are performing two function:

1. The TRACe:DEF command applies to the selected segment
2. The SYNC output is assigned to the selected segment. This is critical when using sequenced mode, where multiple segments form a large sequence. TRACE:SEL allows you to synchronize external devices to the segment of interest.

Parameters

Name	Range	Type	Default	Description
<segment_ number>	1 to 16k	Numeric (integer only)	1	Selects the active segment number.

Response

The 3152B returns the active segment number.

SEGment# <header><binary_block>

HS Syntax: **10501#<string>**

Description

This command partitions the waveform memory into smaller segments. The principle is the same as when using the TRACE:DEF command, but this is a more efficient implementation for when a large number of segments need to be defined. The idea is that waveform segments can be built as one long waveform and then split into the required number of segments by using this command to download a binary table of segment sizes. \When using this method there is no need to define and download waveforms to individual segments.

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Using this command, segment table data is loaded to the 3152B using binary transfer like when downloading waveform data using the trace command. Binary transfer allows any 8-bit byte (including extended ASCII code) to be transmitted in a message.

This command is particularly useful when a large number of segments are required. As an example, the next command generates three segments with 12 bytes of data containing segment size information.

```
SEGment#212<binary_block>
```

This command causes the transfer of 12 bytes of data (3 segment definitions) into the segment table buffer. The <header> is interpreted this way:

The ASCII "#" ($23) designates the start of the binary data block.
"2" designates the number of digits that follow.
"12" is the number of bytes to follow. This number must divide by 4.

The generator accepts binary data as 32-bit integers, which are sent in two-byte words. Therefore, the total number of bytes is always 4 times the number of segments. For example, 36 bytes are required to download 9 segments to the segment table. The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data format is demonstrated in Figure 5-1. The transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0dH) and line feed (LF – 0aH) characters can be used as segment table data points and will not cause unexpected termination of the arbitrary block data.

Figure 5-4 shows the organization of the 32-bit word for the segment start address and size. There are a number of points you should be aware of before you organize the data:

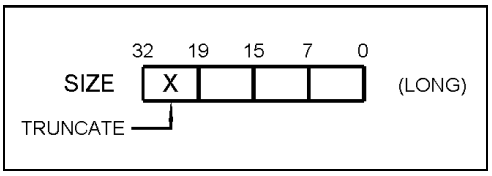


Figure 5-4, Segment Address and Size Example

1. The minimum number of segments is 1 and the maximum number of segments is 16k.
2. Maximum segment size depends on your installed option. With the basic 3152B you can program a segment of up to 1 Meg points.
3. Segment table data has 32-bit values of which are used for segment size. Therefore, data for each segment must have 4 bytes
4. The number of bytes in a complete segment table must divide by 4. The 3152B has no control over data sent to its segment table during data transfer. Therefore, wrong data and/or incorrect number of bytes will cause erroneous memory partitioning.

Parameters

Name	Type	Description
<binary_block>	Binary	Block of binary data that contains information on the segment table.

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The Apply Control Commands

The APPLy commands combine popular commands into a macro command that contains control of all parameters of a specific standard waveform function. For example, to program a sine waveform that has a certain frequency, amplitude and offset, you have to use five different commands:

```
FUNC:MODE FIX
FUNC:SHAP SIN
FREQ <FREQ>
AMPL <AMPL>
OFFS <OFFS>
```

Alternatively, you can select the sine function and immediately assign all of the required parameters when using the apply command. The five lines above will be replaced by a simple line as follows:

```
APPL:SIN <FREQ>,<AMPL>, <OFFS>
```

There are certain rules you must follow when using the apply commands and these are summarized below.

Using the Apply Commands

The apply commands provide a high level method of programming pre-defined standard and arbitrary waveforms. Selection can be made for function, frequency, amplitude, offset and other parameters which are associated with the selected function. For example, the following statement outputs a 2 Vp-p square wave at 1 MHz with a 0 V offset and 10% duty cycle:

```
APPL:SQU 1e6, 2, 0, 10
```

It is not necessary to enter every parameter with the APPLy command. If only the frequency and offset need to be changed, omit the other parameters while keeping the commas. The other parameters will be set to the power-up default values:

```
APPL:SQU 10e6,,1
```

Alternatively, if just the first parameters need to be changed, omit the commas. The other parameters will be set to the power-up default values:

```
APPL:SQU 4e6,2
```

Queries can also be made on all parameters associated with a standard function using the appl:<function_shape>? query. For example, if the instrument was programmed using the above appl:squ command, query the square wave parameters using the following query:

```
APPL:SQU?
```

Table 5-7 lists the complete set of apply commands, followed by a description of each command separately.

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Table 5-7, Apply Control Commands

Keyword	Parameter Form	Default	3152A	HS
[:SOURce]				
:APPLy	FREQ,AMPL,OFFS		✓	0300C
:SINusoid	FREQ,AMPL,OFFS,PHAS,POW		✓	0301E
:TRIangle	FREQ,AMPL,OFFS,PHAS,POW		✓	0302E
:SQUare	FREQ,AMPL,OFFS,DCY		✓	0303D
:PULSe	FREQ,AMPL,OFFS,DEL,WID,LEE,TRE		✓	0304G
:RAMP	FREQ,AMPL,OFFS,DEL,LEE,TRE		✓	0305F
:SINC	FREQ,AMPL,OFFS,CYC		✓	0310D
:GAUssian	FREQ,AMPL,OFFS,EXP		✓	0306D
:EXPonential	FREQ,AMPL,OFFS,EXP		✓	0307D
:DC	DC_AMPL		✓	0308A
:USER	SEG<n>,SCLK,AMPL,OFFS		✓	0309D

APPLy <freq>,<ampl>,<offs>(?)

HS Syntax: 0300C<float>,<float,<float>(?)

Description

This command changes the waveform function to standard and programs the frequency, amplitude, and offset for the selected standard waveform. This command affects the output regardless of the current output function. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the currently selected standard waveform with values of frequency, amplitude and offset as specified by this command.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard waveform in units of Hz.
<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the standard waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard waveform in units of Volts.

Response

The 3152B returns the current frequency, amplitude and offset setting as in the following example: 1e6,5,0.

APPLy:SINusoid <freq>,<ampl>,<offs>,<phas>,<power>(?)

HS Syntax: 0301E<float>,<float,<float>,<float>,<integer>(?)

Description

This command changes the waveform function to standard sine and programs the frequency, amplitude, offset, start phase, and power exponent simultaneously. This command affects the output regardless of the currently selected operating mode. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the currently selected standard waveform with parametric values as specified by this command.

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Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard sine waveform in units of Hz.
<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the standard sine waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard sine waveform in units of Volts.
<phas>	0 to 360	Numeric	0	Programs the phase start of the standard sine waveform in units of percent.
<power>	1 to 9	Numeric (integer only)	0	Programs the power exponent of the standard sine waveform.

Response

The 3152B returns the current frequency, amplitude, offset, phase, and power exponent settings as in the following example: 1e6,5,0,0,1.

APPLy:TRIangle <freq>,<ampl>,<offs>,<phas>,<power>(?)

HS Syntax: 0302E<float>,<float,<float>,<float>,<integer>(?)

Description

This command changes the waveform function to standard triangle and programs the frequency, amplitude, offset, start phase, and power exponent simultaneously. This command affects the output regardless of the current output function. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the currently selected standard waveform with parametric values as specified by this command.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard triangle waveform in units of Hz.
<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the standard triangle waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard triangle waveform in units of Volts.
<phas>	0 to 360	Numeric	0	Programs the phase start of the standard triangle waveform in units of percent.
<power>	1 to 9	Numeric (integer only)	0	Programs the power exponent of the standard triangle waveform.

Response

The 3152B returns the current frequency, amplitude, offset, phase, and power exponent settings similar to the following example: 1e6,5,0,0,1.

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APPLy:SQUare <freq>,<ampl>,<offs>,<dcycle>(?)

HS Syntax: 0303D<float>,<float,<float>,<float>(?)

Description

This command changes the waveform function to standard square and programs the frequency, amplitude, offset, and duty cycle simultaneously. This command affects the output regardless of the current output function. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the standard square waveform with parametric values as specified by this command.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard square waveform in units of Hz.
<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the standard square waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard square waveform in units of Volts.
<dcycle>	0 to 99.99	Numeric	50	Programs the duty cycle of the standard square waveform in units of percent.

Response

The 3152B returns the current frequency, amplitude, offset, and duty cycle settings as in the following example: 1e6,5,0,50.

APPLy:PULSe <freq>,<ampl>,<offs>,<del>,<wid>,<lee>,<tre>(?)

HS Syntax: 0304G<float>,<float,<float>,<float>,<float,<float>,<float>(?)

Description

This command changes the waveform function to standard pulse and programs the frequency, amplitude, offset, delay time, pulse width and leading and trailing edges simultaneously. This command affects the output regardless of the current output function. For example, if you generate arbitrary waveforms, the 3152B will stop generating arbitrary waveforms, will revert to the standard pulse waveform and will update the pulse parameters, as specified by this command.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard pulse waveform in units of Hz.
<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the standard pulse waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard pulse waveform in units of Volts.
<del>	0 to 99.99	Numeric	10	Programs the delay time of the standard pulse waveform in units of percent.
<wid>	0 to 99.99	Numeric	10	Programs the pulse width of the standard pulse waveform in units of percent.
<lee>	0 to 99.99	Numeric	10	Programs the leading edge transition time of the standard pulse waveform in units of percent.

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<tre>	0 to 99.99	Numeric	10	Programs the trailing edge transition time of the standard pulse waveform in units of percent.

Response

The 3152B returns the current frequency, amplitude, offset, delay time, pulse width and leading and trailing edges settings similar to the following example: 1e6,5,0,10,10,10,10.

APPLy:RAMP<freq>,<ampl>,<offs>,<del>,<lee>,<tre>(?)

HS Syntax: 0305F<float>,<float,<float>,<float,<float>,<float>(?)

Description

This command changes the waveform function to standard ramp and programs the frequency, amplitude, offset, delay time, pulse width, and leading and trailing edges simultaneously. This command affects the output regardless of the current output function. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the standard ramp waveform with parametric values as specified by this command.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard ramp waveform in units of Hz.
<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the standard ramp waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard ramp waveform in units of Volts.
<del>	0 to 99.99	Numeric	10	Programs the delay time of the standard ramp waveform in units of percent.
<lee>	0 to 99.99	Numeric	10	Programs the leading edge transition time of the standard ramp waveform in units of percent.
<tre>	0 to 99.99	Numeric	10	Programs the trailing edge transition time of the standard ramp waveform in units of percent.

Response

The 3152B returns the current frequency, amplitude, offset, delay time, pulse width and leading and trailing edges settings similar to the following example: 1e6,5,0,10,10,10.

APPLy:SINC <freq>,<ampl>,<offs>,<cycles>(?)

HS Syntax: 0310D<float>,<float,<float>,<integer>(?)

Description

This command changes the waveform function to standard sinc and programs the frequency, amplitude, offset, and “0” crossing cycles simultaneously. This command affects the output regardless of the current output function. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the standard sinc waveform with parametric values as specified by this command.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard sinc waveform in units of Hz.

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<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the standard sinc waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard sinc waveform in units of Volts.
<cycles>	4 to 100	Integer	10	Programs the “0” crossing number of cycles of the standard sinc waveform in units of percent.

Response

The 3152B returns the current frequency, amplitude, offset, and number of “0” crossing cycles settings as in the following example: 1e6,5,0,10.

APPLy:GAUSsian <freq>,<ampl>,<offs>,<exp>(?)

HS Syntax: 0306D<float>,<float,<float>,<integer>(?)

Description

This command changes the waveform function to standard gaussian and programs the frequency, amplitude, offset, and exponent simultaneously. This command affects the output regardless of the current output function. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the standard Gaussian waveform with parametric values as specified by this command.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard gaussian waveform in units of Hz.
<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the standard gaussian waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard gaussian waveform in units of Volts.
<exp>	4 to 100	Integer	10	Programs the exponent of the standard gaussian waveform.

Response

The 3152B returns the current frequency, amplitude, offset and exponent settings as in the following example: 1e6,5,0,10.

APPLy:EXPonential <freq>,<ampl>,<offs>,<exp>(?)

HS Syntax: 0307D<float>,<float,<float>,<integer>(?)

Description

This command changes the waveform function to standard exponential and programs the frequency, amplitude, offset and exponent simultaneously. This command affects the output regardless of the current output function. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the standard exponential waveform with parametric values as specified by this command.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the standard exponential waveform in units of Hz.
<ampl>	10e-3 to	Numeric	5	Programs the amplitude of the standard exponential

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	16			waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the standard exponential waveform in units of Volts.
<exp>	-100 to 100	Integer	100	Programs the exponent of the standard exponential waveform.

Response

The 3152B returns the current frequency, amplitude, offset and exponent settings similar to the following example: 1e6,5,0,100.

APPLy:DC <ampl>(?)

HS Syntax: 0308A<float>(?)

Description

This command changes the waveform function to standard DC and programs the amplitude. This command affects the output regardless of the current output function. For example, if the 3152B is in FM mode, the 3152B will stop generating FM and will revert to the standard DC waveform with parametric values as specified by this command.

Parameters

Name	Range	Type	Default	Description
<dc_ampl>	-100 to 100	Numeric	100	Programs the amplitude of the standard dc waveform in units of percent.

Response

The 3152B returns the current amplitude setting of DC as in the following example: 100.

APPLy:USER <seg_#><sclk>,<ampl>,<offs>(?)

HS Syntax: 0309D<integer>,<float>,<float,<float> (?)

Description

This command changes the waveform function to arbitrary and programs the active segment, sample clock,, amplitude, and offset simultaneously. This command affects the output regardless of the current output function. For example, if the 3152B is in standard waveform mode, the 3152B automatically switches to arbitrary waveform mode and updates the arbitrary waveform parameters as specified by this command.

Parameters

Name	Range	Type	Default	Description
<seg_#>	1 to 10k	Integer	1	Selects the segment number of the active arbitrary waveform.
<sclk>	10e-6 to 250e6	Numeric	1e6	Programs the sample clock frequency of the arbitrary waveform in units of S/s.
<ampl>	10e-3 to 16	Numeric	5	Programs the amplitude of the arbitrary waveform in units of Volts.
<offs>	-7.992 to 7.992	Numeric	0	Programs the offset of the arbitrary waveform in units of Volts.

Response

The 3152B returns the current segment number, sample clock, amplitude, and offset settings as in the following example: 1,1e6,5,0.

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Sequenced Waveform Control Commands

This group is used to control sequenced waveforms and their respective parameters. This will allow you to create multiple sequence tables and to modify segment loops and links. Also use these commands to add or delete sequences from your instrument.

Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Generating Sequenced Waveforms

Sequenced waveforms are made of a number of arbitrary waveforms, which can be linked and looped in user-programmable order. Sequenced waveforms are generated from waveforms stored in the 3152B as memory segments. Therefore, before a sequence can be used, download waveform segments to the arbitrary memory using TRAC# or block transfer methods. Information on how to partition the memory and how to download waveforms is given in Chapter 3 in the section titled **Generating Arbitrary Waveforms**.

Examples of how sequenced waveforms work are given in figures 1-7 through 1-9. The sequence generator lets you link and loop segments in a user-defined order. Figure 1-10 shows a sequence of waveforms that were stored in three different memory segments.

There are a number of tools that you can use to build a sequence table. The easiest way is to use the ArbConnection program. Information on how to use the ArbConnection program is given in chapter 4. In addition, SCPI programming and the driver also allow you to program sequences at a lower level.

In general, sequences can be built one step at a time using the SEQ:DEF command. This method is slower than the table download method but has the advantage of allowing better control for the sequence novice. Advanced users can download a complete sequence table using the binary sequence download option. The latter option is much faster for applications requiring large sequence tables. Use the information below to understand sequence commands and how to implement them in your application.

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Table 5-8, Sequence Control Commands

Keyword	Parameter Form	Default	3152A	HS
[:SOURce]				
:SEQuence				
[:DATA]	<data_array>			13401#
:ADVance	AUTOmatic | STEP | MIXed	AUTO	✓	1300A
:SELect	1 to 10	1		
:DEFine	<step>,<seg_#>,<repeat>,<adv_mode_x>,<sync_bit_x>			13103
:DELete				
[:NAME]	1 to 4096		✓	13201
:ALL			✓	13210
:SYNC				
[:TYPe]	LCOMplete | BIT	LCOM		0106A

SEQuence#<header><binary_block>

HS Syntax: 13401#<string>

Description

This command builds a complete sequence table in one binary download. With this method, there is no need to define and download individual sequence steps. Using this command, sequence table data is loaded into the 3152B using binary blocktransfer in a way similar to that of downloading waveform data using the trace command. Binary block transfer allows any 8-bit bytes (including extended ASCII code) to be transmitted in a message. This command is particularly useful for long sequences that use a large number of segment and sequence steps. As an example, the next command will generate a three-step sequence with 16 bytes of data that contain segment number, repeats (loops), and mixed mode flags.

```
SEQuence#216<binary_block>
```

This command causes the transfer of 16 bytes of data (2-step sequence) to the sequence table buffer. The <header> is interpreted this way:

- The ASCII "#" ($23) designates the start of the binary data block.
- "2" designates the number of digits that follow.
- "16" is the number of bytes to follow. This number must divide by 8.

The generator accepts binary data as 64-bit integers, which are sent in two-byte words. Therefore, the total number of bytes is always eight times the number of sequence steps. For example, 16 bytes are required to download 2 sequence steps to the sequence table. The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data format is demonstrated in Figure 5-1. The transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0dH) and line feed (LF – 0aH) characters can be used as sequence data and will not cause unexpected termination of the arbitrary block data. Figure 5-5 shows how to prepare the 64-bit word for the sequence step, repeat, mixed mode and sync bit.

Figure 5-6 shows how to organize the 64-bit word for the sequence step, repeat, and mixed mode flag.

There are a number of points you should be aware of before you start preparing the data:

1. The minimum number of sequencer steps is 1 and the maximum number is 4096.

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2. The number of bytes in a complete sequence table must divide by 8. The 3152B has no control over data sent to its sequence table during data transfer. Therefore, wrong data and/or an incorrect number of bytes will cause erroneous sequence partitioning to occur.
3. The least significant bit is the only bit used in the advance mode byte. This bit affects the operation of the sequence only when Mixed Step Advance mode is active. With the LSB bit set to “0”, the sequence generator advances to the next step automatically. With the LSB bit set to “1”, the sequence generator advances to the next step only when a valid trigger signal is sensed at the trigger input.
4. The SYNC state bit is valid only when the sync type is BIT

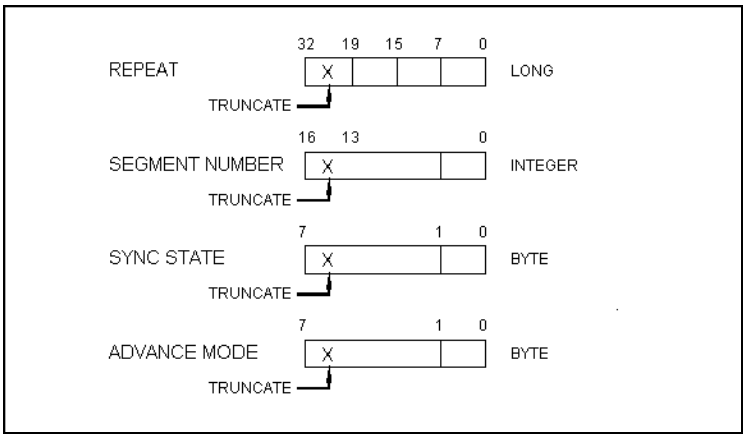


Figure 5-5, 64-bit Sequence Table Download Format

Parameters

Name	Type	Description
<binary_block>	Binary	Block of binary data that contains information on the sequence table.

SEQuence:ADVance {AUTOmatic|STEP|MIXed}(?)

***HS Syntax:* 1300A<0|2|3>**

Description

This command selects the sequence advance mode which is the way in which the instrument advances through a sequence.

Parameters

Name	Type	Default	Description
AUTOmatic	Discrete	AUTO	Specifies continuous advance where the generator steps continuously to the end of the sequence table and repeats the sequence from the start. For example, if a sequence is made of three segments 1, 2 and 3, the sequence will generate an infinite number of 1,2,3,1,2,3,1,2,3…waveforms. Each sequence step can be programmed with its own number of repeats.
STEP	Discrete		In stepped advance mode, the sequence is advanced to the next waveform only when a valid trigger is received. The output of the 3152B generates the first segment continuously until a trigger signal advances the

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		sequencer to the next sequence step.
MIXed	Discrete	Mixed mode is a special mode that combines automatic sequence advance with stepped sequence advance in a sequence. There are three conditions for the sequence generator to operate in this mode: 1) The 3152B is set to operate in continuous mode. 2) The MIX sequence advance mode is selected. 3) The mixed mode bits for each sequence step in the SEQ:DEF command or sequence table used. "0" programs normal advance, "1" programs triggered advance. Steps with a "0" MIX bit assigned to them advance automatically to the next step after the specified loops are complete. Steps with a "1" assigned to them execute the programmed number of loops and then idle at the last point until a valid trigger signal is received, at which point the sequencer advances to the next step..

Response

The 3152B returns the AUTO, TRIG, STEP, or MIX depending on the current sequence advance mode setting.

SEQuence:SELect <sequence_#>(?)

HS Syntax: <integer>(?)

Description

This command selects the active sequence to be generated by the 3152B when in sequenced mode. By selecting the active sequence, successive :SEQ commands will affect the selected sequence only.

Parameters

Name	Range	Type	Default	Description
<sequence_# >	1 to 10	Numeric (integer only)	1	Selects the active sequence number.

Response

The 3152B returns the active sequence number.

SEQuence:DEFine <step>,<seg_#>,<repeat>,<adv_mode>,<sync_bit>(?)

***HS Syntax:* 13103<integer,long,long,0|1,0|1>**

Description

This command builds a step in a sequence table. It defines all of the parameters that are associated with the sequence step such as segment number, link, loop, advance mode, and sync mode.

Parameters

Name	Range	Type	Description
<step>	1 to 4096	Numeric (integer only)	Programs the step in the sequence table. Steps are indexed from 1 to 4096 and must be programmed in an ascending order. Empty step locations in a sequence table are not

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			permitted.
<seg_#>	1 to 10k	Numeric (integer only)	Assigns a segment to a specific step number. When encountered in the sequence table, the segment number that is associated with the step will be generated.
<repeat>	1 to 1M	Numeric integer only)	Programs the number of repeat loops that a specific step will play before advancing to the next step in a sequence.
<adv_mode>	0-1	Boolean	This parameter is not compatible with legacy 3152A code. For 3152B programming only, a “0” programs automatic advance and a “1” programs a triggered advance. Steps with a “0” bit assigned to them advance automatically to the next step. If a “1” is assigned to a step, the instrument generates this step continuously and only a valid trigger signal causes the sequence to advance to the next step.
<sync_bit>	0-1	Boolean	This parameter is not compatible with legacy 3152A code. For 3152B programming only, a “1” programs the sync bit present at a specific sequence step. This feature is useful for applications requiring multiple sync bits in a single sequence. Note that the normal sync output source during sequence mode is LCOM.

NOTE

Although trigger signals are used to advance mixed mode, mixed mode operates in continuous mode only. The <mode> parameter will be ignored if you use TRIG as advance mode for the sequence table.

TIP

Every time you use the SEQ:DEF command while the 3152B is in sequenced operating mode, the instrument attempts to rebuild the sequence table and restart the sequence. Therefore, sending this command in sequenced mode slows down execution of test programs. Using the SEQ:DEF command while in FIX or USER mode decreases execution time.

SEQuence:DELete <sequence_# >

HS Syntax: **13201<integer>**

Description

This command deletes a step in the selected sequence table. Before using this command, be sure that the correct sequence for deleting is selected.

Parameters

Name	Range	Type	Default	Description
<sequence_# >	1 to 4096	Numeric (integer only)	1	Selects the sequence number that will be deleted.

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SEQuence:DELete:ALL

HS Syntax: **13210**

Description
This command deletes the entire sequence table.

OUTPut:SYNC:TYPE {LCOMplete|BIT }(?)

HS Syntax: 0108A**<0|1>(?)**

Description
Programs the 3152B SYNC output source for sequenced mode.

Parameters

Name	Type	Default	Description
LCOMplete	Discrete	LCOM	The sync output transitions to high at the beginning of the selected sequence step and transitions to low at the end of the sequence minus 16 waveform periods.
BIT	Discrete		The sync output generates a pulse at the beginning of the selected segment regardless of how many times the segment appears in the sequence. The width of the sync pulse is 16 waveform points.

Response
The 3152B returns LCOM or BIT depending on the current SYNC type.

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Modulated Waveform Global Control Commands

This group is used to set up the instrument to output modulated waveforms and to access the global modulation parameters. Note that modulation can be turned off to create a continuous carrier waveform (CW). The following modulation schemes can be selected and controlled: AM, FM, Sweep, FSK, ASK, PSK, Amplitude and Frequency hopping, and 3D. The modulated waveform global control commands are summarized in Table 5-9. Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Table 5-9, Modulated Waveform Global Commands

Keyword	Parameter Form	Default	3152A	HS
[:SOURce]				
:MODulation				
:TYPE	OFF | AM | FM | SWE | FSK | ASK | PSK | FHOPping | AHOPping | 3D	OFF		0051A
:CARRier				
[:FREQuency]	10 to 100e6	1e6		0049A
:BASeline	CARRier | DC	CARR		0048A

MODulation:TYPE {OFF|AM|FM|SWEeep|FSK|ASK|PSK|FHOPping|AHOPping|3D}(?)

***HS Syntax: 0051A*<0|1|2|3|4|5|6|7|8|9>(?)**

Description

This command selects the modulation type to be used. All modulation types are internal, thus external signals are not required for the production of modulation.

Parameters

Name	Type	Default	Description
OFF	Discrete	OFF	Modulation off is a special mode where the output generates a continuous, unmodulated, sinusoidal carrier waveform (CW).
AM	Discrete		This turns on the AM function. Program the AM parameters to fine tune the function for your application.
FM	Discrete		This turns on the FM function. Program the FM parameters to fine tune the function for your application.
SWEep	Discrete		This turns on the sweep function. Program the sweep parameters to fine tune the function for your application.
FSK	Discrete		This turns on the FSK function. Program the FSK parameters to fine tune the function for your application.
ASK	Discrete		This turns on the ASK function. Program the ASK parameters to fine tune the function for your application.
PSK	Discrete		This turns on the PSK function. Program the PSK parameters to fine tune the function for your application.
FHOPping	Discrete		This turns on the frequency hopping function. Program

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		the frequency hopping parameters to fine tune the function for your application.
AHOPping	Discrete	This turns on the amplitude hopping function. Program the amplitude hopping parameters to fine tune the function for your application.
3D	Discrete	This turns on the 3D function. Program the 3D parameters to fine tune the function for your application.

Response

The 3152B returns OFF, AM, FM, SWE, FSK, ASK, PSK, FHOP, AHOP, or 3D depending on the current modulation type setting.

MODulation:CARRier <frequency>(?)

***HS Syntax: 0049A*<float>(?)**

Description

Programs the CW frequency. Note that the CW waveform is sine only and its frequency setting is separate from the standard sine waveform. The CW frequency setting is valid for all modulation types.

Parameters

Name	Range	Type	Default	Description
<frequency>	10e-3 to 100e6	Numeric	1e6	Programs the frequency of the carrier waveform in units of Hz. Note that the CW waveform is a sine only and its frequency setting is independent of the standard sine waveform frequency.

Response

The 3152B returns the current carrier frequency value.

MODulation:CARRier:BASeline {CARRier|DC}(?)

***HS Syntax: 0048A*<0|1>(?)**

Description

Programs the carrier baseline when the modulation is used in triggered mode.

Parameters

Name	Type	Default	Description
CARRier	Discrete	CARR	This selects the carrier as the baseline for the modulation function, when operating in one of the interrupted run modes. The 3152B will generate a continuous, unmodulated sinusoidal waveform (CW) until triggered. Upon receipt of a valid trigger, it generates the modulated waveform and then resumes generating continuous CW.
DC	Discrete		This selects DC level as the baseline for the modulation function, for operation in one of the interrupted run modes. The 3152B generates continuous DC until triggered. Upon receipt of a valid trigger, it generates the modulated waveform and then resumes generating a continuous DC level.

Response

The 3152B returns CARR or DC depending on the current carrier baseline setting.

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Modulation Control Commands

This group is used to control parameters for individual modulation schemes. Control parameters are available for AM, FM, Sweep, FSK, ASK, PSK, Amplitude and Frequency hopping, and 3D. The modulation control commands are summarized in Table 5-10. Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Table 5-10, Modulated Waveform Control Commands

Keyword	Parameter Form	Default	3152A	HS
:AM				
:FUNCtion				
:SHAPe	SINusoid | TRIangle* | SQUare* | RAMP*	SIN		0057A
:INTernal			✓	
:FREQuency	10e-3 to 1e6	100	✓	0781A
:DEPTh	0 to 100	50	✓	0780A
:EXEcute		(= MOD:TYPE AM)	✓	07820
:FM				
:DEViation	10.0e-3 to 100e6	100e3		0075A
:FUNCtion				
:SHAPe	SINusoid | TRIangle | SQUare | RAMP | ARB	SIN		0078A
:FREQuency	10e-3 to 350e3	10e3		0076A
:RASTer	1 to 2.5e6	1e6		0077A
:MARKer				
[:FREQuency]	10e-3 to 100e6	1e6		0079A
:DATA	<data_array>			00741#
:SWEep				
:FREQuency				
[:STARt]	10 to 100.0e6	10e3	✓	1610A
:STOP	10 to 100e6	1e6	✓	1611A
:RASTer	10e-6 to 250e6 | MINimum | MAXimum	1e6	✓	1612A
:FUNCtion	SINusoidal | TRIangle(*) | SQUare(*)	SIN (*) Computed	✓	1604A
:TIME	1.4e-6 to 40.0	1e-3	✓	1600A
:DIRection	UP | DOWN	UP	✓	1601A
:SPACing	LINear | LOGarithmic	LIN	✓	1602A
:STEP	10 to 2000	20	✓	1603A
:MARKer				
[:FREQuency]	10 to 100e6	505e3	✓	1613A
:FSK				
:FREQuency				
:SHIFted	10e-3 to 100e6	100e3		0082A
:BAUD	1 to 10e6	10e3		0080A
:MARKer	1 to 4000	1		0083A
:DATA	<data_array>			00811#

* Computed and placed into arbitrary waveform memory in segments and re-played as a sequenced waveform.

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Table 5-10, Modulated Waveform Control Commands (continued)

Keyword	Parameter Form	Default	3152A	HS
:ASK				
[:AMPLitude]				
[:STARt]	0 to 16	5		0064A
:SHIFted	0 to 16	1		0065A
:BAUD	1 to 10e6	10e3		0066A
:MARKer	1 to 1000	1		0068A
:DATA	<data_array>			00671#
:PSK				
:PHASe				
[:STARt]	0 to 360	0		0091A
:SHIFted	0 to 360	180		0092A
:RATE	1 to 10e6	10e3		0093A
:DATA	<data_array>			00891#
:MARKer	1 to 4000	1		0090A
:FHOPping				
:DWELl				
:MODe	FIXed | VARiable	FIX		0069A
[:TIMe]	200e-9 to 20	200e-9		0070A
:FIXed				
:DATA	<data_array>			00711#
:VARiable				
:DATA	<data_array>			00731#
:MARKer	1 to 5000	1		0072A
:AHOPping				
:DWELl				
:MODe	FIXed | VARiable	FIX		0061A
[:TIMe]	200e-9 to 20	200e-9		0062A
:FIXed				
:DATA	<data_array>			00591#
:VARiable				
:DATA	<data_array>			00631#
:MARKer	1 to 5000	1		0060A
:3D				
:DATA	<data_array>			00521#
:MARKer	1 to 30000			0053A
:RASTer	1 to 2.5e6	1e6		0054A

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AM Programming

Use the following commands for programming the AM parameters. AM control is internal. The commands for programming the amplitude modulation function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

AM:FUNCtion:SHAPe(SINusoid|TRIangle|SQUare|RAMP}(?)

HS Syntax: 0057A<1|2|3|4>(?)

Description

This command selects one of the waveform shapes as the active modulating waveform.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects the sine shape as the modulating waveform
TRIangle	Discrete		Select the triangular shape as the modulating waveform
SQUare	Discrete		Select the square shape as the modulating waveform
RAMP	Discrete		Selects the ramp shape as the modulating waveform

Response

The 3152B returns SIN, TRI, SQU, or RAMP depending on the selected function shape setting.

AM:INTernal:FREQuency<am_freq>(?)

HS Syntax: 0781A<float>(?)

Description

This command sets the modulating wave frequency for the built-in standard modulating waveform library.

Parameters

Name	Range	Type	Default	Description
<am_freq>	10e-3 to 1e6	Numeric	10e3	Programs the frequency of the modulating waveform in units of Hz. The frequency of the built-in standard modulating waveforms only is affected.

Response

The 3152B returns the current modulating waveform frequency value. The returned value will be in scientific notation (for example: 100mHz would be returned as 100e-3).

AM:DEPth<depth>(?)

HS Syntax: 0780A<float>(?)

Description

This command sets the modulating wave frequency for the built-in standard modulating waveform library.

Parameters

Name	Range	Type	Default	Description
<depth>	0 to 100	Numeric	50	Programs the depth of the modulating waveform in units of percent.

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Response
The 3152B returns the current modulating depth value.

AM:EXEcute

HS Syntax: 07820

Description
This command computes the AM waveform and starts AM generation. Note that this command is available for compatibility with the legacy 3152A. For new applications, use the MOD:TYPE AM command.

FM Modulation Programming

Use the following commands for programming the FM parameters. FM modulation is internal. There are two types of waveforms that can be used as the modulating waveforms: Standard and Arbitrary. The standard waveforms are built in a library of waveforms and could be used anytime without external control. The arbitrary waveforms must be loaded into a special FM arbitrary waveform memory and only then can be used as a modulating waveform.

FM:DEViation <deviation>(?)

HS Syntax: 0075A<float>(?)

Description
This programs the deviation range around the carrier frequency. The deviation range is always symmetrical about the carrier frequency. If you need a non-symmetrical deviation range then you can use the arbitrary FM composer screen or an external utility to design such a waveform.

Parameters

Name	Range	Type	Default	Description
<deviation>	10e-3 to 100e6	Numeric	100e3	Programs the deviation range around the carrier frequency in units of Hz.

Response
The 3152B returns the current frequency deviation value. The returned value will be in scientific notation (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FM:FUNCtion:SHAPe {SINusoid|TRIangle|SQUare|RAMP|ARB}(?)

HS Syntax: 0078A<1|2|3|4|5>(?)

Description
This command selects one of the following waveform shapes as the active modulating waveform.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects the sine shape as the modulating waveform
TRIangle	Discrete		Select the triangular shape as the modulating waveform.
SQUare	Discrete		Select the square shape as the modulating waveform.

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RAMP	Discrete	Selects the ramp shape as the modulating waveform.
ARB	Discrete	Selects an arbitrary waveform as the modulating shape. The waveform must be designed and downloaded to the FM arbitrary modulation waveform memory before one can use this option. Information on how to create and download arbitrary FM waveforms is given later in this chapter.

Response
The 3152B returns SIN, TRI, SQU, RAMP, or ARB depending on the selected function shape setting.

FM:FREQuency <fm_freq>(?)

HS Syntax: 0076A<float>(?)

Description
This command sets the modulating wave frequency for the built-in standard modulating waveform library.

Parameters

Name	Range	Type	Default	Description
<fm_freq>	10e-3 to 350e3	Numeric	10e3	Programs the frequency of the modulating waveform in units of Hz. The frequency of the built-in standard modulating waveform only is affected.

Response
The 3152B returns the current modulating waveform frequency value. The returned value will be in scientific notation (for example: 100mHz would be returned as 100e-3).

FM:FREQuency:RASTer <arb_fm_freq>(?)

HS Syntax: 0077A<float>(?)

Description
This command sets the sample clock frequency for the arbitrary modulation waveform. Arbitrary modulation waveforms must be created with an external utility and downloaded to the arbitrary FM waveform memory before this function can be used.

Parameters

Name	Range	Type	Default	Description
<arb_fm_freq>	1 to 2.5e6	Numeric	1e6	Programs the sample clock frequency of the arbitrary modulating waveform in units of S/s.

Response
The 3152B returns the current sample clock of the arbitrary modulation waveform. The returned value will be in scientific notation (for example: 100mHz would be returned as 100e-3).

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FM:MARKer <frequency>(?)

HS Syntax: 0079A<float>(?)

Description

This function programs marker frequency position. The FM marker can be placed within the following range: (carrier frequency ± deviation frequency / 2). The marker pulse is output from the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<frequency>	10e-3 to 100e6	Numeric	1e6	Programs the marker frequency position in units of Hz.

Response

The 3152B returns the current marker frequency value.

FM:DATA#<header><binary_block>

HS Syntax: 00741#<string>

Description

This command downloads an FM modulation waveform to the arbitrary FM memory. Arbitrary modulation waveform table data is downloaded to the 3152B using binary block transfer. Binary block transfer allows any 8-bit bytes (including extended ASCII code) to be transmitted in a message. Downloading data to the arbitrary FM waveform memory differs from downloading arbitrary waveform data. Arbitrary waveform data is for the time domain, therefore, every point programs an amplitude level. On the other hand, FM modulating waveform data programs frequency domain therefore, every point sets different sample clock frequency.

```
FM:DATA#3100<binary_block>
```

This command causes the transfer of 10 bytes of data to the arbitrary FM waveform memory. The <header> is interpreted this way:

- The ASCII "#" ($23) designates the start of the binary data block.
- "3" designates the number of digits that follow.
- "100" is the number of bytes to follow. This number must divide by 4.

The generator accepts binary data as 32-bit integers, which are sent in five-byte words. Therefore, the total number of bytes is always three times the number of arbitrary FM waveform points. For example, 100 bytes are required to download 20 arbitrary FM waveform points. The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data format is demonstrated in Figure 5-1 (refer to the TRACe subsystem). The transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0dH) and line feed (LF – 0aH) characters can be used as sequence data and will not cause unexpected termination of the arbitrary block data.

Downloading data to the arbitrary FM waveform memory is very different than loading arbitrary waveform data. Waveform data programs amplitude domain therefore, every point programs an amplitude level. On the other hand, FM modulating waveform data programs frequency domain therefore, every point sets different frequency. The FM modulating waveform data is made of 32-bit words. However, the GPIB link has 8 data bas lines and accepts 8-bit words only. Therefore, the data has to be prepared as 32-bit words and rearranged as five 8-bit words before it can be used by the 3152B as FM modulating waveform data. Figure 5-8 shows how to prepare the 32-bit word for the FM modulating waveform.

There are a number of points you should be aware of before you start preparing the data:

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1. The number of bytes in a complete FM modulating waveform data must divide by 4. The 3152B has no control over data sent to its FM waveform during data transfer. Therefore, wrong data and/or incorrect number of bytes will cause errors
2. The LSBit on the last byte sets marker position. “0” = sets no marker and “1” sets marker. You can set as many markers as you want.
3. The SYNC output serves as marker output when you have the 3152B set to operate in FM mode. Normal SYNC level is TTL low. The SYNC output is set to TTL high at the position of the marker. This way you can use the SYNC output to mark frequency occurrences during FM operation.
4. Data download is terminated with the MSBit of the last byte set to 1.

The following sequence should be used for downloading arbitrary FM Waveforms:

1. Prepare your FM waveform data points using the following relationship:

   N = Frequency[Hz] x 14.31655765

2. Use an I/O routine such as ViMoveAsync (from the VISA I/O library) to transfer binary blocks of data to the generator.

Parameters

Name	Type	Description
<binary_block>	Binary	Block of binary data that contains information on the arbitrary modulating waveform.

Sweep Programming

Use the following command for programming the sweep parameters. Sweep control is internal. The frequency will sweep from start to stop frequencies at an interval determined by the sweep time value and controlled by a step type determined by the sweep step parameter.

There are two sweep modes: Linear, where the step of which the generator increments from start to stop frequency is linear and Logarithmic, where the step of which the generator increments from start to stop frequency is logarithmic

The commands for programming the frequency sweep function are described below.

SWEep:FREQuency <start_freq>(?)

HS Syntax: 1610A<float>(?)

Description

This specifies the sweep start frequency. The 3152B will normally sweep from the start to the stop frequency, however, if the sweep direction is reversed, the 3152B will sweep from the stop to the start frequency. The start and stop frequencies may be programmed freely throughout the frequency range of the instrument.

Parameters

Name	Range	Type	Default	Description
<start_freq>	10e-3 to 100e6	Numeric	10e3	Programs the sweep start frequency. Sweep start is programmed in units of Hz.

Response

The 3152B returns the current sweep start frequency value.

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SWEep:FREQuency:STOP <stop_freq>(?)

HS Syntax: 1611A<float>(?)

Description

This specifies the sweep stop frequency. The 3152B normally sweeps from the start to the stop frequency, however, if the sweep direction is reversed, the 3152B will sweep from the stop to the start frequency. The start and stop frequencies may be programmed freely throughout the frequency range of the instrument.

Parameters

Name	Range	Type	Default	Description
<stop_freq>	10e-3 to 100e6	Numeric	1e6	Programs the sweep stop frequency. Sweep stop is programmed in units of Hz.

Response

The 3152B returns the current sweep stop frequency value.

SWEep:FREQuency:RASTer <sclk_freq>(?)

HS Syntax: 1612A<float>(?)

Description

This programs the sample clock frequency for the swept waveform. Program this parameter only if you fully understand the effect on the waveform otherwise let the instrument determine the sample clock setting as required to successfully complete the setting of the sweep.

Parameters

Name	Range	Type	Default	Description
<sclk_freq>	10e-3 to 250e6	Numeric	1e6	Programs the sample clock frequency in units of samples per second.

Response

The 3152B returns the current sweep sample clock frequency value.

SWEep:FUNCtion {SINusoid|TRIangle|SQUare}(?)

HS Syntax: 1604A<1|2|3>(?)

Description

This specifies the swept function. There are three functions that can be swept: Sine, Triangle and Square. The sine sweep is generated by the DDS but the triangle and the square are computed and placed into arbitrary waveform memory in segments and re-played as a sequenced waveform.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects sine as the swept waveform
TRIangle	Discrete		Selects triangle as the swept waveform
SQUare	Discrete		Selects square as the swept waveform

Response

The 3152B returns SIN, TRI, or SQU depending on the selected waveform setting.

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SWEep:TIMe <time>(?)

HS Syntax: 1600A<float>(?)

Description

This specifies the time that will take the 3152B to sweep from start to stop frequencies. The time does not depend on the sweep boundaries as it is automatically adjusted by the software to the required interval. At the end of the sweep cycle the output waveform maintains the sweep stop frequency setting except if the 3152B is in continuous run mode where the sweep repeats itself continuously.

Parameters

Name	Range	Type	Default	Description
<time>	1.4e-6 to 40	Numeric	1e-3	Programs the sweep time. Sweep time is programmed in units of s.

Response

The 3152B returns the current sweep time.

SWEep:DIRection {UP|DOWN}(?)

HS Syntax: 1601A<0|1>(?)

Description

This specifies if the 3152B sweeps from start-to-stop (UP) or from stop-to-start (DOWN) frequencies. Sweep direction does not affect the sweep time or frequency. At the end of the sweep cycle, the output waveform normally maintains the sweep stop frequency setting but will maintain the start frequency, if the DOWN option is selected except if the 3152B is in continuous run mode where the sweep repeats itself continuously.

Parameters

Name	Type	Default	Description
UP	Discrete	UP	Selects the sweep up direction
DOWN	Discrete		Select the sweep down direction

Response

The 3152B returns UP or DOWN depending on the selected direction setting.

SWEep:SPACing {LINear|LOGarithmic}(?)

HS Syntax: 1602A<0|1>(?)

Description

This specifies the sweep step type. Two options are available: logarithmic or linear. In linear, the incremental steps between the frequencies are uniform throughout the sweep range. Logarithmic type defines logarithmic spacing throughout the sweep start and stop settings.

Parameters

Name	Type	Default	Description
LINear	Discrete	LIN	Selects the linear sweep spacing
LOGarithmic	Discrete		Select the logarithmic sweep spacing

Response

The 3152B returns LIN or LOG depending on the selected spacing setting.

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SWEep:STEP <#_steps>(?)

HS Syntax: 1603A<integer>(?)

Description

This programs the number of steps for the swept waveform. Program this parameter only if you fully understand the effect on the waveform otherwise let the instrument determine the number of steps as required to successfully complete the setting of the sweep.

Parameters

Name	Range	Type	Default	Description
<#_steps>	10 to 2000	Numeric (integer only)	1e6	Programs the number of steps in a sweep. This number affects the swept triangle and square only.

Response

The 3152B returns the current number of sweep steps value.

SWEep:MARKer<frequency>(?)

HS Syntax: 1613A<float>(?)

Description

This function programs marker frequency position. Sweep marker can be placed in between the start and the stop frequencies. The marker pulse is output from the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<frequency>	10 to 100e6	Numeric	505e3	Programs the marker frequency position in units of Hz.

Response

The 3152B returns the current marker frequency value. The returned value will be in scientific notation(for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FSK Modulation Programming

Use the following commands for programming the FSK parameters. FSK control is internal. The frequency will shift from carrier to shifted frequency setting at a rate determined by the baud value and controlled by a sequence of bits in the FSK data table. The commands for programming the frequency shift keying function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

FSK:FREQuency:SHIFted <shift_freq>(?)

HS Syntax: 0082A<float>(?)

Description

This programs the shifted frequency. The frequency shifts when the pointer in the data array points to “1”.

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Parameters

Name	Range	Type	Default	Description
<shift_freq>	10e-3 to 100e6	Numeric	100e3	Programs the shifted frequency value in units of Hz.

Response

The 3152B returns the current shifted frequency value. The returned value will be in scientific notation(for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FSK:FREQuency:BAUD<baud>(?)

HS Syntax: 0080A<float>(?)

Description

This allows the user to select the FSK word rate. The word rate is the interval of which the bit streams in the FSK data array are clocked causing the output frequency to hop from carrier to shifted frequency values and vice-versa.

Parameters

Name	Range	Type	Default	Description
<baud>	1 to 10e6	Numeric	10e3	Programs the rate of which the frequency shifts from carrier to shifted frequency in units of Hz.

Response

The 3152B returns the current baud value.

FSK:FREQuency:MARKer <index>(?)

HS Syntax: 0083A<integer>(?)

Description

Programs the location on the data stream that the 3152B will generate a marker pulse, designated as an FSK marker or index point. The marker pulse is generated at the SYNC output connector. Note that if you intend to program marker position, you must do it before you load the FSK data list.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 4000	Numeric (integer only)	1	Programs a marker pulse at an index bit position.

Response

The 3152B returns the current marker position.

FSK:DATA <fsk_data>

HS Syntax: 00811#<string>(?)

Description

Loads the data stream that will cause the 3152B to hop from carrier to shifted frequency and vice-versa. Data format is a string of "0" and "1" which define when the output generates carrier frequency and when it shifts frequency to the FSK value. "0" defines carrier frequency,"1" defines shifted frequency. Note that if you intend to program marker position, you must do it before you load the FSK data list.

Below you can see how an FSK data table is constructed. The sample below shows a list of 10 shifts. The

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3152B will step through this list, outputting either carrier or shifted frequencies, depending on the data list: A Zero will generate the carrier frequency and a One will generate shifted frequency. Note that the waveform is always a sine wave and that the last cycle is always completed.

Sample FSK Data Array

0 1 1 1 0 1 0 0 0 1

Parameters

Name	Type	Description
<fsk_data>	ASCII	Block of ASCII data that contains information for the generator about when to shift from carrier to shifted frequency and vice-versa.

ASK Modulation Programming

Use the following commands for programming the ASK parameters. ASK control is internal. The amplitude will toggle between two amplitude settings at a rate determined by the baud value and controlled by a sequence of bits in the ASK data table. The commands for programming the amplitude shift keying function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

ASK <amplitude>(?)

HS Syntax: 0064A<float>(?)

Description

This programs the normal amplitude setting. The amplitude shifts when the pointer in the data array points to a “1”.

Parameters

Name	Range	Type	Default	Description
<amplitude>	0 to 16	Numeric	5	Programs the amplitude setting in units of Volts.

Response

The 3152B returns the current amplitude value.

ASK:SHIFted <shift_ampl>(?)

HS Syntax: 0065A<float>(?)

Description

This programs the shifted amplitude. The amplitude shifts when the pointer in the data array points to a “1”.

Parameters

Name	Range	Type	Default	Description
<shift_ampl>	0 to 16	Numeric	1	Programs the shifted amplitude setting in units of Volts.

Response

The 3152B returns the current shifted amplitude value.

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ASK:BAUD <rate>(?)

HS Syntax: 0066A<float>(?)

Description

This allows the user to select ASK word rate. The word rate is the interval of which the bit streams in the ASK data array are clocked causing the output amplitude to hop from one level to shifted amplitude level values and vice-versa.

Parameters

Name	Range	Type	Default	Description
<rate>	1 to 10e6	Numeric	10e3	Programs the rate at which the frequency shifts from carrier to the shifted frequency in units of Hz.

Response

The 3152B returns the current baud value.

ASK:FREQuency:MARKer <index>(?)

HS Syntax: 0068A<integer>(?)

Description

Programs where in the data stream the 3152B generates a pulse designated as an ASK marker or index point. The marker pulse is generated at the SYNC output connector. Note that if you intend to program the marker position, you must do it before you load the ASK data list.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 1000	Numeric (integer only)	1	Programs a marker pulse at an index bit position.

Response

The 3152B returns the current marker position.

ASK:DATA <ask_data>

HS Syntax: 00671#<string>(?)

Description

Loads the data stream that will cause the 3152B to hop from one amplitude level to a shifted amplitude level and vice-versa. Data format is a string of "0" and "1" which define when the output generates the base level and when it shifts amplitude to the ASK value. A "0" specifies the base level amplitude and a "1" specifies a shifted amplitude level. Note that if you intend to program marker position, you must do it before you load the ASK data list.

Below you can see how an ASK data table is constructed. The sample below shows a list of 10 shifts. The 3152B will step through this list, outputting either the base or shifted amplitudes, depending on the data list: A Zero will generate the base level and a One will generate the shifted amplitude. Note that the waveform is always a sine wave and that the last cycle is always completed.

Sample ASK Data Array

0 1 1 1 0 1 0 0 0 1

Parameters

Name	Type	Description
<ask_data>	ASCII	Block of ASCII data that contains information for the generator when to shift from base to shifted amplitude and vice-versa.

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PSK Modulation Programming

Use the following commands for programming the PSK parameters. The PSK function can shift from start to shifted phase setting, within the range of 0 to 360°, at a frequency determined by the rate value and controlled by a sequence of bits in the PSK data table. The commands for programming the phase shift keying function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

PSK:PHASe <start_phase>(?)

HS Syntax: 0091A<float>(?)

Description

This programs the start phase of the carrier waveform. The start phase shifts when the pointer in the data array points to “0”.

Parameters

Name	Range	Type	Default	Description
<start_phase>	0 to 360	Numeric	0	Programs the start phase for the carrier waveform in units of degrees.

Response

The 3152B returns the current start phase value.

PSK:PHASe:SHIFted <shift_phase>(?)

HS Syntax: 0092A<float>(?)

Description

This programs the shifted phase. The phase shifts when the pointer in the data array points to “1”.

Parameters

Name	Range	Type	Default	Description
<shift_phase>	0 to 360	Numeric	180	Programs the shift phase for the carrier waveform in units of degrees.

Response

The 3152B returns the current shift phase value.

PSK:RATE <rate>(?)

HS Syntax: 0093A<float>(?)

Description

This allows the user to select PSK word rate. The word rate is the interval of which the bit streams in the PSK data array are clocked, causing the output phase to hop from start to shifted phase values and vice-versa. Note that this command is dedicated for programming the PSK modulation function only.

Parameters

Name	Range	Type	Default	Description
<baud>	1 to 10e6	Numeric	10e3	Programs the rate of which the phase shifts from start to shifted frequency in units of Hz.

Response

The 3152B returns the current baud value.

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PSK:DATA <psk_data>

HS Syntax: 0891#<string>(?)

Description

Loads the data stream that will cause the 3152B to hop from phase to phase. Data format is a string of "0" and "1" which define when the output generates the various phases. The size of the data word depends on the PSK function.

Below you can see how a PSK data table is constructed. The PSK data table sample below shows a list of 10 shifts. The 3152B will step through this list, outputting either start or shifted phases, depending on the data list: Zero will generate start phase and One will generate shifted phase. Note that the output waveform is always sinewave and that the last cycle is always completed. The

Sample PSK Data Array

0 1 1 1 0 1 0 0 0 1

Parameters

Name	Type	Description
<psk_data>	ASCII	Block of ASCII data that contains information for the generator when to step from one phase setting to another.

PSK:MARKer <index>(?)

HS Syntax: 0090A<integer>(?)

Description

Programs where on the data stream the 3152B will generate a pulse, designated as PSK marker, or index point. The marker pulse is generated at the SYNC output connector. Note that if you intend to program marker position, you must do it before you load the PSK data list. The PSK:MARK command is common to all PSK modulation functions.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 4000	Numeric (integer only)	1	Programs a marker pulse at an index bit position.

Response

The 3152B returns the current marker position.

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Frequency Hopping Modulation Programming

Use the following commands for programming the frequency hop parameters. Hop control is internal. The frequency will hop from frequency to frequency at a rate determined by the dwell time value and controlled by a sequence of frequencies in the HOP data table.

There are two hop modes: Fixed Dwell, where the rate at which the generator hops from frequency to frequency is constant and Variable Dwell, where the rate at which the generator hops from frequency to frequency is programmable for each hop.

The commands for programming the frequency hopping function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

FHOP:DWELl:MODe {FIXed|VARiable}(?)

HS Syntax: 0069A<0|1>(?)

Description

This selects between fixed or variable dwell-time for the frequency hops. Select the fixed option if you want each frequency to dwell equally on each step. The variable option lets you program different dwell times for each frequency hop. The 3152B output hops from one frequency to the next according to a sequence given in a hop table. The variable dwell time table contains dwell time data for each step, however, the fixed dwell time table does not contain any dwell time information and therefore, if you select the fixed option, make sure your dwell time is programmed as required.

Parameters

Name	Type	Default	Description
FIXed	Discrete	FIX	Selects the fixed dwell time frequency hops mode
VARiable	Discrete		Select the variable dwell time frequency hops mode

Response

The 3152B returns FIX or VAR depending on the selected dwell setting.

FHOP:DWELl <dwell_time>(?)

HS Syntax: 0070A<float>(?)

Description

This selects the dwell time for frequency hops when the selected mode is Fixed dwell time hops. The dwell time table in this case does not contain the dwell time per step parameters and therefore, the value which is programmed with this command remains constant for the entire hop sequence.

Parameters

Name	Range	Type	Default	Description
<dwell_time>	200e-9 to 20	Numeric	200e-9	Programs dwell time for the fixed dwell-time frequency hop function. The same dwell time will be valid for each frequency hop. Dwell time is programmed in units of s.

Response

The 3152B returns the current dwell time value.

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FHOP:FIX:DATA <fix_hop_data>

HS Syntax: 00711#<string>(?)

Description

This command will download the data array that will cause the instrument to hop through the frequency list. The dwell time for each frequency list item is fixed and can be programmed using the HOP:DWEL command. Note that if you intend to program marker position, you must do it first and then load the frequency hopping list.

Below you can see how a hop table is constructed. The file sample below shows a list of 10 frequencies. The 3152B will hop through this list, outputting the next frequency each time it hops. Note that the carrier waveform is always sinewave and that the last cycle is always completed even if the dwell time is shorter than the period of the waveform. For example, if you program dwell time of 1ms and the frequency step has frequency of 1Hz (1s period), the frequency step will last 1 second although the dwell time is 1ms.

Sample Frequency Hops Data Array

1e+6 2e+6 3e+3 4e+6 5e+5 6e+2 7e+1 8e+6 9e+3 10e+5

Parameters

Name	Type	Description
<fix_hop_data>	Double	Block of binary data that contains information of frequency values.

FHOP:FIX:DATA<var_hop_data>

HS Syntax: 00731#<string>(?)

Description

This command will download the data array that will cause the instrument to hop through the frequency list. The dwell time for each frequency list item is variable and is supplied in the variable hop table data array. Note that the HOP:DWEL command has no effect on this sequence. Also note that if you intend to program marker position, you must do it first and then load the frequency hops list.

Below you can see how a hop table is constructed. The file sample below shows a list of 10 frequencies and their associated dwell times. The 3152B will hop through this list, outputting the next frequency each time it hops. Note that the carrier waveform is always sinewave and that the last cycle is always completed even if the dwell time is shorter than the period of the waveform. For example, if you program dwell time of 1ms and the frequency step has frequency of 1Hz (1s period), the frequency step will last 1 second although the dwell time is 1ms.

Sample Frequency Hops Data Array

1e+6 100 2e+6 2000 3e+3 3e4 4e+6 40 5e+5 5e3 6e+2 6000 7e+1 0.7 8e+8e2 6 9e+3 90 10e+51000

In the above example, the first number is the frequency value and the second number is its dwell time. Therefore, only even number of sets can be located in this table.

Parameters

Name	Type	Description
<var_hop_data>	Double	Block of binary data that contains information of frequency hop values and their respective dwell time.

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FHOP:MARKer<index>(?)

HS Syntax: 0072A<integer>(?)

Description

Programs where on the frequency list the 3152B will generate a pulse, designated as Hop marker, or index point. The marker pulse is generated at the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 5000	Numeric (integer only)	1	Programs a marker pulse at an index frequency hop position.

Response

The 3152B returns the current marker position.

Amplitude Hopping Modulation Programming

Use the following commands for programming the amplitude hop parameters. Hop control is internal. The amplitude will hop from amplitude level to amplitude level at a rate determined by the dwell time value and controlled by a sequence of amplitudes in the HOP data table.

There are two hop modes: Fixed Dwell, where the rate of which the generator hops from amplitude level to amplitude level is constant and Variable Dwell, where the rate of which the generator hops from amplitude level to amplitude level is programmable for each hop.

The commands for programming the amplitude hopping function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

AHOP:DWELl:MODe {FIXed|VARiable}(?)

HS Syntax: 0061A<0|1>(?)

Description

This selects between fixed or variable dwell-time for the amplitude hops. Select the fixed option if you want each amplitude level to dwell equally on each step. The variable option lets you program different dwell times for each amplitude hop. The 3152B output level hops from one amplitude level to the next according to a sequence given in a hop table. The variable dwell time table contains dwell time data for each step however, the fixed dwell time table does not contain any dwell time information and therefore, if you select the fixed option, make sure your dwell time is programmed as required.

Parameters

Name	Type	Default	Description
FIXed	Discrete	FIX	Selects the fixed dwell time amplitude hops mode
VARiable	Discrete		Select the variable dwell time amplitude hops mode

Response

The 3152B returns FIX or VAR depending on the selected dwell setting.

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AHOP:DWELl <dwell_time>(?)

HS Syntax: 0062A<float>(?)

Description

This selects the dwell time for amplitude hops when the selected mode is Fixed dwell time hops. The dwell time table in this case does not contain the dwell time per step parameters and therefore, the value which is programmed with this command remains constant for the entire hop sequence.

Parameters

Name	Range	Type	Default	Description
<dwell_time>	200e-9 to 20	Numeric	200e-9	Programs dwell time for the fixed dwell-time amplitude hop function. The same dwell time will be valid for each amplitude hop. Dwell time is programmed in units of s.

Response

The 3152B returns the current dwell time value.

AHOP:FIX:DATA <fix_hop_data>

HS Syntax: 00591#<string>(?)

Description

This command will download the data array that will cause the instrument to hop through the amplitude list. The dwell time for each amplitude list item is fixed and can be programmed using the HOP:DWEL command. Note that if you intend to program marker position, you must do it first and then load the amplitude hops list.

Below you can see how a hop table is constructed. The file sample below shows a list of 10 amplitudes. The 3152B will hop through this list, outputting the next amplitude each time it hops. Note that the carrier waveform is always sinewave and that the last cycle is always completed even if the dwell time is shorter than the period of the waveform. For example, if you program dwell time of 1ms and the amplitude step has frequency of 1Hz (1s period), the frequency step will last 1 second although the dwell time is 1ms.

Sample Amplitude Hops Data Array

0 1e0 2e0 3e0 4e+0 5e+0 100e-3 200e-3 300e-3 400e-3 500e-3

Parameters

Name	Type	Description
<fix_hop_data>	Double	Block of binary data that contains information of amplitude values.

AHOP:FIX:DATA <var_hop_data>

HS Syntax: 00631#<string>(?)

Description

This command will download the data array that will cause the instrument to hop through the amplitude list. The dwell time for each amplitude list item is variable and is supplied in the variable hop table data array. Note that the HOP:DWEL command has no effect on this sequence. Also note that if you intend to program marker position, you must do it first and then load the amplitude hops list.

Below you can see how a hop table is constructed. The file sample below shows a list of 10 amplitudes and their associated dwell times. The 3152B will hop through this list, outputting the next amplitude each time it hops. Note that the carrier waveform is always sinewave and that the last cycle is always completed even if

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the dwell time is shorter than the period of the waveform. For example, if you program dwell time of 1ms and the amplitude step has frequency of 1Hz (1s period), the amplitude step will last 1 second although the dwell time is 1ms.

Sample Amplitude Hops Data Array

1e0 100 2e0 2000 3e0 3000 4e0 4000 5e0 5000 6e0 6000 7e0 7000 8e0 8000 9e0 9000 10e0 10000

In the above example, the first number is the amplitude value and the second number is its dwell time. Therefore, only even number of sets can be located in this table.

Parameters

Name	Type	Description
<var_hop_data>	Double	Block of binary data that contains information of amplitude hop values and their respective dwell time.

AHOP:MARKer <index>(?)

HS Syntax: 0060A<integer>(?)

Description

Programs where on the amplitude list the 3152B will generate a pulse, designated as Hop marker, or index point. The marker pulse is generated at the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 5000	Numeric (integer only)	1	Programs a marker pulse at an index amplitude hop position.

Response

The 3152B returns the current marker position.

3D Modulation Programming

Use the following commands for programming the 3D modulation parameters. 3D modulation requires an external utility to download the modulation coordinates into the 3D memory location. In case you intend to build your own 3D profiles, use the examples as given in the IVI drivers that are supplied with the 3152B.

The commands for programming the 3D function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

3D:DATA <data_array>

HS Syntax: 00521#<string>(?)

Parameters

Name	Type	Description
<data_array>	Double	Block of binary data that contains information on the 3D profile. Data contains amplitude sweeps for both channels as well as frequency and phase sweep parameters for the 3D waveform.

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3D:MARKer <index>(?)

HS Syntax: 0053A<integer>(?)

Description

Programs where on the 3D profile the 3152B will generate a pulse, designated as 3D marker or index point. The marker pulse is generated at the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 30000	Numeric (integer only)	1	Programs a marker pulse at an index 3D position.

Response

The 3152B returns the current marker position.

3D:RASTer<3D_freq>(?)

HS Syntax: 0054A<float>(?)

Description

This command sets the sample clock frequency for the 3D modulation profiler. The 3D waveforms must be created using an external utility and downloaded to the 3D memory before this function can be used.

Parameters

Name	Range	Type	Default	Description
<3D_freq>	1 to 2.5e6	Numeric	1e6	Programs the sample clock frequency of the 3D modulating waveform in units of S/s.

Response

The 3152B returns the current sample clock of the 3D modulating waveform value.

Digital Pulse Programming

Use the following commands for programming pulse parameters. The pulse is created digitally, however, it closely simulates an analog pulse generator so pulse parameters are programmed just as they would be programmed on a dedicated pulse generator instrument. Bear in mind that since this is a digital instrument, there are some limitations to the pulse design that evolve from the fact that the best resolution is one sample clock interval and also, keep in mind that the pulse is created digitally in the arbitrary memory and therefore, its smallest incremental step has a maximum value limitation as specified in Appendix A. The digital pulse commands are summarized in Table 5-11.

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Table 5-11, Digital Pulse Commands Summary

Keyword	Parameter Form	Default	3152A	HS
:DPULse				
:DELay	0 to 10	0		0143A
:DOUBle				
[:STATe]	OFF | ON | 0 | 1	0		0144A
:DELay	0 to 1e3	1e-3		0145A
:LEVel				
:HIGH	-7.992 to 8	5		0147A
:LOW	-8 to 7.992	0		0148A
:HIGH	0 to 1e3	1e-3		0146A
:POLarity	NORMal | COMPlement | INVerted	NORM		0186A
:PERiod	80e-9 to 1e6 (80e-9 to 2/4e6 with option 1/2)	10e-3		0149A
:TRANsition				
[:LEADing]	0 to 1e3	1e-3		0151A
:TRAiling	0 to 1e3	1e-3		0152A

DPULse:DELay <delay>(?)

HS Syntax: 0143A<float>(?)

Description

Programs the delayed interval of which the output idles on the low level amplitude until the first transition to high level amplitude.

Parameters

Name	Range	Type	Default	Description
<delay>	0 to 10	Numeric	0	Sets the delay time interval in units of seconds. Note that the sum of all parameters, including the pulse delay time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed first and then all other pulse parameters.

Response

The 3152B returns the pulse delay value in units of seconds.

DPULse:DOUBle {OFF|ON|0|1}(?)

HS Syntax: 0144A<0|1>(?)

Description

This command turns the double pulse mode on and off. The double pulse mode duplicates the first pulse parameters at a delayed interval set by the double pulse delay value.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Sets the double pulse mode on and off

Response

The 3152B returns 0 or 1 depending on the current double mode setting.

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DPULse:DOUBle:DELay <d_delay>(?)

HS Syntax: 0145A<float>(?)

Description

Programs the delay between two adjacent pulses when double pulse mode is selected. Otherwise, the double pulse delay has no effect on the pulse structure.

Parameters

Name	Range	Type	Default	Description
<d_delay>	0 to 1e3	Numeric	1e-3	Sets the delay between two adjacent pulses for the double pulse mode in units of seconds. Note that the sum of all parameters, including the pulse delay time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed before all other pulse parameters.

Response

The 3152B returns the current double pulse delay value in units of seconds.

DPULse:LEVel:HIGH <high>(?)

HS Syntax: 0147A<float>(?)

Description

Programs the high level for the pulse shape. Note that the same level is retained for the second pulse in the double pulse mode.

Parameters

Name	Range	Type	Default	Description
<high>	-7.992 to 8	Numeric	5	Sets the pulse high level in units of Volts. Note that the high level setting must be higher than the low level setting. Also note that high to low level value must be equal or larger than 8 mV.

Response

The 3152B returns the current low level value in unit of Volts.

DPULse:LEVel:LOW <low>(?)

HS Syntax: 0148A<float>(?)

Description

Programs the low level for the pulse shape. Note that the same level is retained for the second pulse in the double pulse mode.

Parameters

Name	Range	Type	Default	Description
<low>	-8 to 7.992	Numeric	0	Sets the pulse low level in units of Volts. Note that the low level setting must be smaller than the high level setting. Also note that low to high level value must be equal or larger than 8 mV.

Response

The 3152B returns the current high level value in unit of Volts.

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DPULse:HIGH <high>(?)

HS Syntax: 0146A<float>(?)

Description

Programs the interval the pulse will dwell on the high level value. Although they may sound similar, the high time and pulse width are significantly different. The standard terminology of pulse width defines the width of the pulse at the mid-point of its peak-to-peak amplitude level. Therefore, if you change the rise and fall time, the pulse width changes accordingly. The digital pulse high time parameter defines how long the pulse will dwell on the high level so even if you change the rise and fall times, the high time remains constant. The pulse high time is programmed in units of seconds.

Parameters

Name	Range	Type	Default	Description
<high>	0 to 1e3	Numeric	1e-3	Sets the width of the high time for the pulse shape in units of seconds. Note that the sum of all parameters, including the high time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed before all other pulse parameters.

Response

The 3152B returns the current high time value in units of seconds

DPULse:POLarity {NORMal|COMPlemented|INVerted (?)

HS Syntax: 0186A<0|1|2|>(?)

Description

Programs the polarity of the pulse in reference to the base line level. The polarity options are: Normal, where the pulse is generated exactly as programmed; Inverted, where the pulse is inverted about the 0 level base line; and Complemented, where the pulse is inverted about its mid amplitude level.

Parameters

Name	Type	Default	Description
NORMal	Discrete	NORM	Programs normal pulse output
COMPlemeted	Discrete		Programs complemented pulse output
INVerted	Discrete		Programs an inverted pulse output

Response

The 3152B returns NORM, COMP or INV depending on the current polarity setting

DPULse:PERiod <period>(?)

HS Syntax: 0149A<float>(?)

Description

Programs the pulse repetition rate (period). Note that the sum of all parameters, including the pulse delay, rise, high and fall times must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed first before all other pulse parameters. Note that by selecting the double pulse mode, the pulse period remains unchanged.

Parameters

Name	Range	Type	Default	Description
<period>	80e-9 to 1e6	Numeric	10e-3	Programs the period of the pulse waveform in units of seconds.

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Response
The 3152B returns the current pulse period value in units of seconds.

DPULse:TRANsition <rise>(?)

HS Syntax: 0151A<float>(?)

Description
Programs the interval it will take the pulse to transition from its low to high level settings. The parameter is programmed in units of seconds.

Parameters

Name	Range	Type	Default	Description
<rise>	0 to 1e3	Numeric	1e-3	Sets the rise time parameter. Note that the sum of all parameters, including the rise time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed before all other pulse parameters.

Response
The 3152B returns the current rise time value in units of seconds.

DPULse:TRANsition:TRAiling <fall>(?)

HS Syntax: 0152A<float>(?)

Description
Programs the interval it will take the pulse to transition from its high to low level settings. The parameter is programmed in units of seconds.

Parameters

Name	Range	Type	Default	Description
<fall>	0 to 1e3	Numeric	1e-3	Sets the fall time parameter. Note that the sum of all parameters, including the fall time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed before all other pulse parameters.

Response
The 3152B returns the current fall time value in units of seconds.

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Half Cycle Control Commands

Use the following commands for programming the half cycle functions and their associated parameters. There are three half cycle functions: Sine, Triangle and Square. The specifications and limitations of the half cycle functions are specified in Appendix A. The half cycle commands are summarized in Table 5-12.

Table 5-12, Half Cycle Commands Summary

Keyword	Parameter Form	Default	3152A	HS
:HALFcycle				
:DELay	200e-9 to 20	1e-6		0139A
:DCYCle	0 to 99.99	50		0138A
:FREQuency	10e-3 to 1e6	1e6		0140A
:PHASe	0 to 360	0		0141A
:SHAPe	SINusoid | TRIangle | SQUare	SIN		0142A

HALFcycle:DELay <delay>(?)

HS Syntax: 0139A<float>(?)

Description

Programs the interval of which the output idles between half cycles. The idle level is normally 0 V except if programmed otherwise with the VOLT:OFFS command.

Parameters

Name	Range	Type	Default	Description
<delay>	200e-9 to 20	Numeric	1e-6	Sets the delay time interval between half cycles in units of seconds.

Response

The 3152B returns the half cycle delay value in units of seconds.

HALFcycle:DCYCle <duty_cycle>(?)

HS Syntax: 0138A<float>(?)

Description

Programs the duty cycle of the square waveform when the half cycle square shape is selected. Note that this command has no effect on the standard square wave duty cycle.

Parameters

Name	Range	Type	Default	Description
<duty_cycle>	0 to 99.99	Numeric	50	Sets the delay time interval between half cycles in units of seconds.

Response

The 3152B returns the square wave duty cycle value in units of percent.

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HALFcycle:FREQuency <freq>(?)

HS Syntax: 0140A<float>(?)

Description

Programs the frequency of the half cycle waveforms in units of hertz (Hz). It has no affect on the frequency of other waveform functions.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 1e6	Numeric	1e6	Sets the frequency of the half cycle waveform in units of Hz. This parameter does not affect the frequency of other waveform functions.

Response

The 3152B returns the current half cycle frequency value.

HALFcycle:PHASe <phase>(?)

HS Syntax: 0141A<float>(?)

Description

Programs the start phase of the half cycle sine and triangle waveform. This command has no affect on other waveform functions.

Parameters

Name	Range	Type	Default	Description
<phase>	0 to 360	Numeric	0	Programs the start phase parameter for the half cycle sine and triangle waveforms in units of degrees. The phase can be programmable with resolution of 0.05° throughout the entire frequency range of the half cycle function.

Response

The 3152B returns the current start phase value.

HALFcycle:SHAPe {SINusoid|TRIangle|SQUare}(?)

HS Syntax: 0142A<float>(?)

Description

This command defines the type of half cycle waveform that will be available at the output connector.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects the half cycle sine waveform.
TRIangle	Discrete		Selects the half cycle triangular waveform.
SQUare	Discrete		Selects the half cycle square waveform.

Response

The 3152B returns SIN, TRI, or SQU depending on the current 3152B setting

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Counter Control Commands

Use the following commands for programming the counter/timer measuring function and its associated parameters. The counter/timer function is created digitally however, it closely simulates a stand-alone instrument so its functions are programmed just as they would be programmed on a dedicated instrument. The specifications and limitations of the counter/timer are specified in Appendix A. The counter commands are summarized in Table 5-13.

Table 5-13, Counter Commands Summary

Keyword	Parameter Form	Default	3152A	HS
:COUNter				
:FUNCtion	FREQuency | PERiod | APERiod | PULSe | TOTalize	FREQ		0135A
:DISPlay				
:MODE	NORMal | HOLD	NORM		0133A
:GATE				
:TIME	100e-6 to 1	1		0134A
:RESet				01370
:READ				0136@

COUNter:FUNCtion {FREQuency|PERiod|APERiod|PULSe|ITOTalize|GTOTalize(?)

HS Syntax: 0135A<0|1|2|3|4|5>(?)

Description

Programs the measurement function for the counter/timer. Each measurement can be set up with its gate time (where applicable) and display mode.

Parameters

Name	Type	Default	Description
FREQuency	Discrete	FREQ	Will select the frequency measurement function. Frequency is measured on continuous signal only. The result of the frequency measurement has gate-dependent resolution. The 3152B displays 7 digits of frequency reading in one second of gate time. If the gate time is decreased, the number of displayed digits decreases proportionally to the gate time interval. Reduce the gate time when you want to accelerate the reading process however, always make sure that the period of the signal is smaller than the gate time setting.
PERiod	Discrete		Will select the period measurement function. Period can be measured on either continuous or non-repetitive signals. Since the period of the signal is directly proportional to the gating time, the number of displayed digits decreases proportionally to the period of the signal. If you need to have more resolution and you signal is repetitive, use the period averaged measurement function. The best resolution in period measurements is 100 ns.

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APERiod	Discrete	Will select the period averaged measurement function. Period averaged can be measured continuous signals only. In fact, this is the inverse function of frequency and therefore, gate time determines the resolution of the reading. Reduce the gate time when you want to accelerate the reading process however, always make sure that the period of the signal is smaller than the gate time setting.
PULSe	Discrete	Will select the pulse width measurement function. Pulse width can be measured on either continuous or non-repetitive signals. Since the width of the signal is directly proportional to the gating time, the number of displayed digits decreases proportionally to the pulse width of the signal. The best resolution in period measurements is 10 ns.
ITOTalize	Discrete	Will select the totalize measurement function. In this mode, the gate opens when the first valid signal is sensed at the counter input and remains open until programmed otherwise. Pulse are counted and displayed continuously until intervened externally. The counter can accumulate 8 digits before it will overflow. An overflow indication is available.

Response

The 3152B returns FREQ, PER, APER, PULS, or ITOT depending on the current measurement function setting.

COUNter:DISPlay:MODe {NORMal|HOLD(?)

HS Syntax: 0133A<0|1>(?)

Description

Programs the display time mode for the counter/timer. The two modes are normal for continuous display readings and hold for single reading after arming the counter input.

Parameters

Name	Type	Default	Description
NORMal	Discrete	NORM	Will select the continuous reading mode. In this case, the counter input is self-armed, which means that every valid signal that is sensed at the trigger input connector will be counted and measured processed and results placed on the interface port.
HOLD	Discrete		Will select the single reading mode. In this case, the counter input is armed first and the first valid signal that is sensed at the trigger input connector will be counted and measured and its result processed and placed on the interface port.

Response

The 3152B returns NORM, INV, or COMP depending on the current polarity setting

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COUNter:GATe <time>(?)

HS Syntax: 0134A<float>(?)

Description

Programs the gate time interval for frequency, period averaged and totalize in gated mode. Measurements will be taken only after the input has been armed and valid signal available at the input connector. Notice however, that the gate time internal must be larger than the period of the measure signal.

Parameters

Name	Range	Type	Default	Description
<time>	100e-6 to 1	Numeric	1	Programs the gate time interval in units of seconds. In continuous mode, the counter is self-armed and therefore every valid signal at the counter input will open the gate and initiate a measurement cycle. In hold mode, the counter must be armed before the gate can open. Always make sure the programmed gate time interval is larger than the period of the measured signal.

Response

The 3152B returns the current gate time value in units of seconds.

COUNter:RESet

HS Syntax: 01370<float>(?)

Description

This command will reset the counter/timer and arm the instrument for its next reading.

COUNter:READ

HS Syntax: 0136@

Description

This command will interrogates the counter/timer for a reading. Note that the read command must follow a valid gate time interval or the reading will not be available and the interface bus will be held until the measurement cycle has been completed and a result is available to be read.

Response

The 3152B returns the result of the current measurement function reading.

Synchronization Commands

Synchronization commands control phase locking to an external source. The source is applied via the front panel TRIG/PLL IN connector, or from another module in the same VXI chassis through the Local Bus, TTL Trigger Bus, or ECL Trigger bus.

Note that synchronization through the VXI Local Bus (LBUS0-7) is available only in Modern Mode, and does not use the legacy commands discussed in this section. To set up and control Local Bus synchronization, refer to the INSTrument:COUPle commands in the Instrument and Output Control Commands section of this chapter.

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When locking the 3152B to an external source applied to the TRIG/PLL IN connector, the auto-detection circuit sets up the lock-in range and prepares the PLL circuits for a final phase lock. After phase lock has been achieved, the 3152B duplicates the frequency and start phase of the external source. A front-panel LED illuminates when the external source signal is valid and the instrument has locked onto it.

When phase locking to a signal on the TRIG/PLL IN connector, phase adjustment commands allow phase shifting of the locked signal from -180° to +180° referenced to the input signal. In addition, the phase can be shifted by applying a signal to the front-panel PM IN connector, where DC to 10 KHz voltage levels can phase-modulate the locked instrument.

The ECLTrig bus in the VXI chassis allows synchronizing multiple 3152Bs inside the same VXIbus chassis without external connections. The ECLT0 and ECLT1 lines provide the necessary signals to achieve lock between modules. Using this method, one instrument is configured as master and the rest of the instruments are configured as slaves. They do not need to be in adjacent chassis slots. When synchronized, the slave instruments are initially locked to the start phase of the master but later can be configured to have phase offsets relative to the master. Phase offset is programmable from 0° to 360°.

Although signals synchronized through the ECLTrig bus are limited in frequency to 60 MHz maximum, this method is included for backward compatibility with the legacy 3152A.

When synchronizing through the ECLTrig bus or TTLTrig bus, phase offset is programmable from 0° to 360°. Phase offset resolution depends on the number of waveform samples. For instance, if there are 1,000 waveform samples, the phase offset is adjustable in 0.36° increments, since 360° / 1,000 samples = 0.36° per sample.

As another example, if there are only ten waveform samples, the smallest phase offset increment is 360° / 10 samples, or 36°.

The phase offset discussed above is known as the coarse phase offset. To improve the resolution for waveforms having fewer samples, a separate fine phase adjustment takes the resolution down to 0.01°. The fine phase adjustment and can be used in conjunction with any valid coarse phase offset setting.

Synchronization commands are summarized in Table 5-14.

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Table 5-14, Synchronization Command Summary

Keyword	Parameter Form	Default	3152A	HS
[:SOURce]				
:PHASe				
:LOCK				
[:STATe]	OFF | ON | 0 | 1	0	✓	0820A
:ADJust	0° to 360°	0	✓	0810A
:NULL		Error, not supported	✓	08500
:SOURce	MASTer | SLAVe	MAST	✓	0800A
:PHASe2		(=PLL)		
:LOCK				
[:STATe]	OFF | ON | 0 | 1	0	✓	0920A
:SOURce	EXTernal | ECLTrg1 | TTLTrg<n>	EXT	✓	0930A
:ADJust	-180° to 180°	0	✓	0900A
:FINe	-36° to 36°	0	✓	0910A

PHASe:LOCK {OFF|ON|0|1}(?)

HS Syntax: 0820A<0|1>(?)

Description

This command will turn the backplane synchronization sequence on and off. This command requires that another 3152B is plugged in the same chassis. The location of the two instruments is not critical for them to synchronize. Using this synchronization method, the sample clock is placed on the ECLTrg0 line and the synchronization signal is place on ECLTrg1 and therefore, if you intend to use this synchronization method, make sure that these two backplane lines are not used by other modules.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Turns the backplane synchronization on and off

Response

The 3152B returns 0 or 1 depending on the current backplane synchronization setting.

PHASe:ADJust <phase>(?)

HS Syntax: 0810A<float>(?)

Description

Programs the phase offset between the master and the slave units where the master is the reference waveform and the phase of the slave instruments are shifted in reference to the master instrument.

Parameters

Name	Range	Type	Default	Description
<phase>	0 to 360	Numeric	0	Programs the phase offset between the slave and the master instrument. The phase is programmed in units of degrees (°). Note however, that the phase offset resolution depends on the number of points that create the waveform. For example, waveform that is made of 1024 points can be shifted with increments of 0.35°, but another waveform that has only 100 points can be shifted with increments of 3.6°.

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Response
The 3152B returns the current phase offset value in units of degrees.

PHASe:NULL

HS Syntax: 08500

Description
This command is not supported by the 3152B. Legacy codes that program this command will be prompted with an error.

PHASe:LOCK {MASTer|SLAVe}(?)

HS Syntax: 0800A<1|0>(?)

Description
By definition, all 3152B units are turned on as masters. This does not interfere with normal operation because the electrical circuits are designed to handle shared nodes. This means that for synchronization purpose, slave units must be programmed to slave state. The sequence to synchronize then is: first, determine who is master and who is slave using this command and then, switch synchronization on using the phas:lock 1 command.

Parameters

Name	Type	Default	Description
MASTer	Discrete	MAST	Will select the master unit in a multi-instrument system. The master feeds the sample clock and the synchronization signals through the ECLTrg 0-1 lines.
SLAVe	Discrete		Will select the slave unit(s) in a multi-instrument system. The slave instruments receive the sample clock and the synchronization signals from the ECLTrg 0-1 lines.

Response
The 3152B returns MAST or SLAV depending on the current backplane synchronization setting.

PHASe2:LOCK {OFF|ON|0|1}(?)

HS Syntax: 0920A<0|1>(?)

Description
This command will turn the PLL (phase lock loop) function on and off. The reference signal is applied to a front panel input (PLL IN) and the 3152B locks onto it automatically using a smart frequency/phase sensing sequence. After lock, the phase of the 3152B can be shifted in reference to the input signal. The PLL operates in standard and arbitrary waveform modes, locking to external signals ranging from, as low as, 100 Hz to over 10 MHz. When placed in PLL mode, the LED near its input connector blinks until achieving full lock. When locked, the LED lights constantly as an indication that the signal is locked to an external reference.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Turns the PLL function on and off

Response
The 3152B returns 0, or 1 depending on the current PLL function setting.

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PHASe2:LOCK:SOURce {EXTernal|ECLTrg1|TTLTrg<n>|}(?)

HS Syntax: 0930A<integer>(?)

Description

This command will select the source for the PLL function. Source options are: External signal, applied to the front panel PLL IN connector; Trigger signals, applied through the backplane trigger lines; or, trigger signal applied through the ECLT0 line. While the last two options have fixed logic levels, the front panel input may accept various levels, including such levels that reside on offsets.

Parameters

Name	Range	Type	Default	Description
EXTernal	0	Discrete	EXT	Will select the front panel PLL IN input as the reference signal. The input can be programmed for trigger level, to adjust the threshold and for slope, to define the reference slope.
ECLTrg1	1	Discrete		Will select the backplane ECLTrg0 line as the reference input.
TTLTrg<n>	2 to 9	Discrete		Will select one of the backplane trigger lines (TTLTrg 0 through 7) as the reference input.

Response

The 3152B returns EXT, TTLT<n>, or ECLT0 depending on the selected PLL reference source setting.

PHASe2:ADJust <phase>(?)

HS Syntax: 0900A<float>(?)

Description

Programs the phase offset between the reference input and the 3152B output. The output start phase is shifted in reference to the external signal.

Parameters

Name	Range	Type	Default	Description
<phase>	-180 to 180	Numeric	0	Programs the phase offset between the reference and the output waveform. The phase is programmed in units of degrees (°). Note however, that the phase offset resolution depends on the number of points that create the waveform. For example, waveform that is made of 1024 points can be shifted with increments of 0.35°, but another waveform that has only 100 points can be shifted with increments of 3.6°.

Response

The 3152B returns the current phase offset value in units of degrees.

PHASe2:FINE <fine_phase>(?)

HS Syntax: 0910A<float>(?)

Description

Programs the phase offset between the reference input and the 3152B output in smaller increments. The output start phase is shifted in reference to the external signal.

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Parameters

Name	Range	Type	Default	Description
<phase>	-36 to 36	Numeric	0	Programs the phase offset between the reference and the output waveform in smaller increments. The phase is programmed in units of degrees (°). Note however, that the phase offset resolution depends on the number of points that create the waveform. For example, waveform that is made of 1024 points can be shifted with increments of 0.35°, but another waveform that has only 100 points can be shifted with increments of 3.6°.

Response

The 3152B returns the current fine phase offset value in units of degrees.

LXI System Configuration Commands

The LXI system configuration commands are available with the Model 3100M only (Message Based carrier) that has the LAN connector installed on its front panel. Use these commands to configure module address and other LAN parameters. It is strongly recommended that this be done with a computer specialist because wrong programming may place the instrument in an unknown configuration which may lock the LAN operation completely and only hard reset will be necessary to restore the instrument to its original defaults.

NOTE

Last LAN configuration settings will remain as long as the instrument is turned on. New LXI configuration settings will take effect only after the instrument has been powered off and on.

Keyword	Parameter Form	Default	3152A	HS
:SYSTem				
:IP				
[:ADDRess]	<IP_address>			0167A
:MASK	<mask>			0171A
:GATeway	<gate_way>			0169A
:BOOTp	OFF | ON | 0 | 1	0		0168A
HOSTname:	<host_name>			0170A
:KEEPalive				
:STATe	OFF | ON | 0 | 1	1		0173A
:TIMEout	2 to 300	45		0174A
:PROBes	2 to 10	2		0172A

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SYSTem:IP <ip_adrs>(?)

HS Syntax: 0176A<string>(?)

Description

Programs the IP address for LAN operation. The programming must be performed from either USB or GPIB controllers.

Parameters

Name	Range	Type	Description
<ip_adrs>	0 to 255	String	Programs the IP address for LAN operation. Programming must be performed from USB or GPIB interfaces. Current IP address can be observed on LAN Properties front panel display.

Response

The 3152B returns the current IP address value similar to the following: 192.168.0.6

SYSTem:IP:MASK<mask_adrs>(?)

HS Syntax: 0171A<string>(?)

Description

Programs the subnet mask address for LAN operation. The programming must be performed from either USB or GPIB controllers.

Parameters

Name	Range	Type	Description
<mask_adrs>	0 to 255	String	Programs the subnet mask address for LAN operation. Programming must be performed from USB or GPIB interfaces. Current subnet mask address can be observed on LAN Properties front panel display.

Response

The 3152B returns the current IP address value similar to the following: 255.255.255.0

SYSTem:IP:BOOTp {OFF|ON|0|1}(?)

HS Syntax: 0169A<0|1>(?)

Description

Use this command to toggle BOOTP mode on and off.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Toggles BOOTP mode on and off. When on, the IP address is administrated automatically by the system

Response

The 3152B returns 0 or 1 depending on the current BOOTP setting.

SYSTem:IP:GATeway <gate_adrs>(?)

HS Syntax: 0168A<string>(?)

Description

Programs the gateway address for LAN operation. The programming must be performed via the VXI interface.

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Parameters

Name	Range	Type	Description
<gate_adrs>	0 to 255	String	Programs the gateway address for LAN operation. Programming must be performed from the VXI interface. Current gateway address can be observed on LAN Properties front panel display.

Response

The 3152B returns the current IP address value similar to the following: 0.0.0.0

SYSTem:IP:HOSTname <name>(?)

HS Syntax: 0170A<string>(?)

Description

Programs the host name address for LAN operation. The programming is performed in the factory and it is highly suggested that users do not change the host name without first consulting an Astronics Test Systems customer service personnel.

Parameters

Name	Type	Description
<name>	String	Programs the host name for LAN operation.

Response

The 3152B returns a string containing the host name. String length is 16 characters.

SYSTem:KEEPalive:STATe {OFF|ON|0|1}(?)

HS Syntax: 0173A<0|1>(?)

Description

Use this command to toggle the keep alive mode on and off. The keep alive mode assures that LAN connection remains uninterrupted throughout the duration of the LAN interfacing.

Parameters

Range	Type	Default	Description
0-1	Discrete	1	Toggles the keep alive mode on and off. When on, the 2572 constantly checks for smooth LAN connection at intervals programmed by the syst:keep:time command. The LAN will be probed as many times as programmed by syst:keep:prob parameter to check if there is an interruption in the LAN communication. When communication fails, the 3152B reverts automatically to local (front panel) operation.

Response

The 3152B returns 0, or 1 depending on the current keep alive setting.

SYSTem:KEEPalive:TIMEout <time_out>(?)

HS Syntax: 0174A<float>(?)

Description

Programs the keep alive time out. The keep alive mode assures that LAN connection remains uninterrupted throughout the duration of the LAN interfacing.

Parameters

Name	Range	Type	Default	Description
<time_out>	2 to 300	Numeric	45	Programs the keep alive time out in units of seconds.

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The time out period is initiated when the LAN is idle for more than the time out period. The LAN will be probed as many times as programmed by syst:keep:prob parameter to check if there is an interruption in the LAN communication. When communication fails, the 3152B reverts automatically to local (front panel) operation.

Response

The 3152B returns the current keep alive time out value.

SYSTem:KEEPalive:PROBes <probes>(?)

HS Syntax: 0172A<integer>(?)

Description

Programs the number of probes that are used by the keep alive sequence. The keep alive mode assures that LAN connection remains uninterrupted throughout the duration of the LAN interfacing.

Parameters

Name	Range	Type	Default	Description
<probes>	2 to 10	Numeric	2	Programs the number of probes that are used by the keep alive sequence. The time out period is initiated when the LAN is idle for more than the time out period and the LAN will be probed as many times as programmed by this parameter to check if there is an interruption in the LAN communication. When communication fails, the 3152B reverts automatically to local (front panel) operation.

Response

The 3152B returns the current keep alive number of probes.

System Commands

The system-related commands are not related directly to waveform generation but are an important part of operating the generator. These commands can reset or test the instrument, or query the instrument for system information.

Table 5-15, System Commands Summary

Keyword	Parameter Form	Default	3152A	HS
:RESet			✓	14200
:SYSTem				
:ERRor?			✓	1430@?
:VERSion?			✓	1440@?
:INFOrmation				
:CALibration?				0175A?
:MODel?				0176@?
:SERial?				0177A?
:SMEMory				
:MODe	READ | WRITe	READ	✓	1200A
[:STATe]	OFF | ON | 0 | 1	0	✓	1210A
:TEST				
[:ALL]?			✓	1400@?

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RESet, or *RST

HS Syntax: 14200

Description
This command will reset the 3152B to its factory defaults.

SYSTem:ERRor?

HS Syntax: 1430@?

Description
Query only. This query will interrogate the 3152B for programming errors.

Response
The 3152B returns error code. Error messages are listed later in this manual.

SYSTem:VERSion?

HS Syntax: 1440@?

Description
Query only. This query will interrogate the 3152B for its current firmware version. The firmware version is automatically programmed to a secure location in the flash memory and cannot be modified by the user except when performing firmware update.

Response
The 3152B returns the current firmware version code in a format similar to the following: 1.35

SYSTem:INFormation:CALibration?

HS Syntax: 0175A?

Description
Query only. This query will interrogate the instrument for its last calibration date.

Response
The generator will return the last calibration date in a format similar to the following: 24 Oct 2006 (10 characters maximum).

SYSTem:INFormation:MODel?

HS Syntax: 0176@?

Description
Query only. This query will interrogate the instrument for its model number in a format similar to the following: 3152B. The model number is programmed to a secure location in the flash memory and cannot be modified by the user.

Response
The generator will return its model number: 3152B.

SYSTem:INFormation:SERial?

HS Syntax: 0177A?

Description

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Query only. This query will interrogate the instrument for its serial number. The serial number is programmed to a secure location in the flash memory and cannot be modified by the user.

Response

The generator will return its serial number in a format similar to the following: 000000451 (10 characters maximum).

SMEMory {READ|WRITe}(?)

HS Syntax: 1200A<0|1>(?)

Description

Programs read and write switches for the 3152B shared memory block. Shared memory transfer is the fastest way to get waveforms into the 3152B. In shared memory mode, the 3152B's CPU disconnects from the waveform memory and passes access to the VXIbus. The internal data bus is connected directly to the VXIbus, and data is downloaded into the memory in binary blocks using A24 memory space. Byte and bit order are the same as with the Arbitrary Block transfers as described in the Arbitrary Waveform Commands section. After the data is loaded into the instrument, control is returned to the CPU. In shared memory mode, the 3152B's memory acts similar to Direct Memory Access (DMA). The instrument has to be told when to receive data, send data, surrender or gain control. The 3152B has an auto-increment address counter and therefore, the slot 0 controller must define the base address for both write and read cycles.

Parameters

Name	Type	Default	Description
READ	Discrete	READ	Will prepare the shared memory to place data on the backplane data bus. Data will not be shared before this function is turned on using smem 1.
WRITe	Discrete		Will prepare the shared memory to accept data from the backplane data bus. Data will not be shared before this function is turned on using smem 1.

Response

The 3152B returns WRIT or READ depending on the selected shared memory setting.

SMEMory {OFF|ON|0|1}(?)

HS Syntax: 1210A<0|1>(?)

Description

Use this command to toggle the shared memory function on and off. Use smem:mode writ to prepare the instrument for DMA data load from the backplane data bus.

Parameters

Range	Type	Default	Description
0-1	Discrete	1	Toggles the shared memory function on and off. When place in on position, the instrument cannot accept normal data until the data transfer has been completed. Programming examples are given in the driver code.

Response

The 3152B returns 0, or 1 depending on the current shared memory setting.

TEST?

HS Syntax: 1400@?

Description

Use this command to test the functionality of the 3152B. Bear in mind that this test does not replace the

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performance checks but comes to provide basic confidence that the instrument operates and responds correctly to basic commands and functions.

Response

The 3152B returns 0 when no error is detected. Non-zero response implies problems in one or more of the tested circuits that requires further investigation by a qualified test engineer.

IEEE-STD-488.2 Common Commands and Queries

Since most instruments and devices in an ATE system use similar commands that perform similar functions, the IEEE-STD-488.2 document specifies a common set of commands and queries that all compatible devices must use. This avoids situations where devices from various manufacturers use different sets of commands to enable functions and report status. The IEEE-STD-488.2 treats common commands and queries as device dependent commands. For example, *TRG is sent over the bus to trigger the instrument. Some common commands and queries are optional, but most of them are mandatory.

Table 5-16, Common Commands Summary

Keyword	Parameter Form	Default	3152A	HS
*CLS			✓	15000
*ESE	1 to 255	1	✓	1501A
*ESE?			✓	1501@?
*ESR?			✓	1504@?
*IDN?			✓	1506@?
*OPC			✓	15020
*OPC?			✓	1502@?
*OPT?	(0=1Meg; 2=4Meg)			0185@?
*RST			✓	14200
*SRE	1 to 255	1	✓	1503A
*SRE?			✓	1503@?
*STB?			✓	1508@?
*TRG			✓	11000
*TST?			✓	1500@?

*CLS

HS Syntax: 15000

Description

Use this command to clear the Status Byte summary register, error register and all event registers. This command has no effect on parameter settings.

*ESE <enable_bits>

HS Syntax: 1501A<n>

Description

Use this command to enable bits in the Standard Event enable register. The selected bits are then reported to

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the status byte. Information on the standard event register is given in the following.

Parameters

Name	Range	Default	Description
<enable_bits>	0-255	0	Programs the event that will cause the register to report a problem. Setting of “0” disables this feature.

*ESE?

HS Syntax: 1501A@?

Description

Use this command to query the programmed bits in the Standard Event enable register.

Response

The generator returns a decimal value in the range of 0 to 255, which corresponds to the binary-weighted sum of all bits, set in the register.

*ESR?

HS Syntax: 1504@?

Description

Use this command to query the response of the Standard Event enable register. Information on the standard event register is given in the following.

Response

The generator returns a decimal value in the range of 0 to 255, which corresponds to the binary-weighted sum of all bits, set in the register.

*IDN?

HS Syntax: 1506@?

Description

Use this command to query the identity of the 3152B.

Response

The generator returns data organized into four fields, separated by commas. The generator responds with its manufacturer and model number in the first two fields, and may also report its serial number and options in fields three and four. If the latter information is not available, the device must return an ASCII 0 for each. For example, 3152B response to *IDN? is: EADS,3152B,0,1.0

*OPC

HS Syntax: 15020

Description

Use this command to set the "operation complete" bit (bit 0) in the Standard Event register after the previous commands have been executed.

*OPC?

HS Syntax: 1502@?

Description

Use this command to synchronize between a controller and the instrument using the MAV bit in the Status Byte or a read of the Output Queue. The *OPC? query does not affect the OPC Event bit in the Standard Event Status Register (ESR). Reading the response to the ***OPC?** query has the advantage of removing the complication of dealing with service requests and multiple polls to the instrument. However, both the system

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bus and the controller handshake are in a temporary hold-off state while the controller is waiting to read the *OPC? query response.

Response

Returns "1" to the output buffer after all the previous commands have been executed.

*OPT?

HS Syntax: 1505@?

Description

Use this command to query the options that are installed in this specific module.

Response

Returns "0" if no option is installed or “2” for the 4 Meg memory option.

*RST

HS Syntax: 14200

Description

Use this command to reset the instrument to its default setting. Factory defaults are listed in the Default column in Table 5-1.

*SRE<enable_bits>

HS Syntax: 1503A<n>

Description

Use this command to enable bits in the Service Request Enable register. The selected bits are then reported to the status byte. Information on the service request register is given in the following.

Parameters

Name	Range	Default	Description
<enable_bits>	0-63, 128-191	0	Programs the event that will cause the register to request service. Setting of “0” disables this feature.

*SRE?

HS Syntax: 1503A@?

Description

Use this command to query the programmed bits in the Service Request Enable register.

Response

The generator returns a decimal value in the range of 0 to 63 or 128 to 191 since bit 6 (RSQ) cannot be set. The binary-weighted sum of the number represents the value of the bits of the Service Request enable register.

*STB?

HS Syntax: 1508A@?

Description

Use this command to query the Status Byte for reported errors or events..

Response

The generator returns a summary of the Status Byte register. The *STB? command is similar to a serial poll sequence but is processed like any other instrument command. The *STB? command returns the same result as a serial poll, except the "request service" bit (bit 6) is not cleared if a serial poll has occurred.

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*TRG

HS Syntax: 11000

Description

Use this command from a remote interface as a soft trigger in lieu of an external generator. This command affects the generator if it is first placed in the Trigger or Burst mode of operation and the trigger source is set to "BUS".

*TST?

HS Syntax: 1500@?

Description

Use this command to test the functionality of the 3152B. Bear in mind that this test does not replace the performance checks but comes to provide basic confidence that the instrument operates and responds correctly to basic commands and functions.

Response

The 3152B returns 0 when no error is detected. Non-zero response implies problems in one or more of the tested circuits that requires further investigation by a qualified test engineer.

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The SCPI Status Registers

The 3152B uses the Status Byte register group and the Standard Event register group to record various instrument conditions. Figure 5-7 shows the SCPI status system.

An Event Register is a read-only register that reports defined conditions within the generator. Bits in an event register are latched. When an event bit is set, subsequent state changes are ignored. Bits in an event register are automatically cleared by a query of that register or by sending the *CLS command. The *RST command or device clear does not clear bits in an event register. Querying an event register returns a decimal value, which corresponds to the binary-weighted sum of all bits, set in the register.

An Event Register defines which bits in the corresponding event register are logically ORed together to form a single summary bit. The user can read from and write to an Enable Register. Querying an Enable Register will not clear it. The *CLS command does not clear Enable Registers but it does clear bits in the event registers. To enable bits in an enable register, write a decimal value that corresponds to the binary-weighted sum of the bits required to enable in the register.

The Status Byte Register (STB)

The Status Byte summary register contains conditions from the other registers. Query data waiting in the generator's output buffer is immediately reported through the Message Available bit (bit 4). Bits in the summary register are not latched. Clearing an event register will clear the corresponding bits in the Status Byte summary register. Description of the various bits within the Status Byte summary register is given in the following:

Bit 0 - Decimal value 1. Not used, always set to 0.

Bit 1 - Decimal value 2. Not used, always set to 0.

Bit 2 - Decimal value 4. Not used, always set to 0.

Bit 3 - Decimal value 8. Not used, always set to 0.

Bit 4 - Decimal value 16. Message Available Queue Summary Message (MAV). The state of this bit indicates whether or not the output queue is empty. The MAV summary message is true when the output queue is not empty. This message is used to synchronize information exchange with the controller. The controller can, for example, send a query command to the device and then wait for MAV to become true. If an application program begins a read operation of the output queue without first checking for MAV, all system bus activity is held up until the device responds.

Bit 5 - Decimal value 32. Standard Event Status Bit (ESB) Summary Message. This bit indicates whether or not one or more of the enabled ESB events have occurred since the last reading or clearing of the Standard Event Status Register.

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Bit 6 - Decimal value 64. Master Summary Status (MSS)/Request Service (RQS) Bit. This bit indicates if the device has at least one condition to request service. The MSS bit is not part of the IEEE-STD-488.1 status byte and will not be sent in response to a serial poll. However, the RQS bit, if set, will be sent in response to a serial poll.
Bit 7 - Decimal value 128. Not used, always set to 0.

Reading the Status Byte Register

The Status Byte summary register can be read with the *STB? common query. The *STB? common query causes the generator to send the contents of the Status Byte register and the MSS (Master Summary Status) summary message as a single <NR1 Numeric Response Message> element. The response represents the sum of the binary-weighted values of the Status Byte Register. The *STB? common query does not alter the status byte.

Clearing the Status Byte Register

Removing the reasons for service from Auxiliary Status registers can clear the entire Status Byte register. Sending the *CLS command to the device after a SCPI command terminator and before a Query clears the Standard Event Status Register and clears the output queue of any unread messages. With the output queue empty, the MAV summary message is set to FALSE. Methods of clearing other auxiliary status registers are discussed in the following paragraphs.

Service Request Enable Register (SRE)

The Service Request enable register is an 8-bit register that enables corresponding summary messages in the Status Byte Register. Thus, the application programmer can select reasons for the generator to issue a service request by altering the contents of the Service Request Enable Register.

The Service Request Enable Register is read with the *SRE? common query. The response to this query is a number that represents the sum of the binary-weighted value of the Service Request Enable Register. The value of the unused bit 6 is always zero.

The Service Request Enable Register is written using the *SRE command followed by a decimal value representing the bit values of the Register. A bit value of 1 indicates an enabled condition. Consequently, a bit value of zero indicates a disabled condition. The Service Request Enable Register is cleared by sending *SRE0. The generator always ignores the value of bit 6. Summary of *SRE commands is given in the following.

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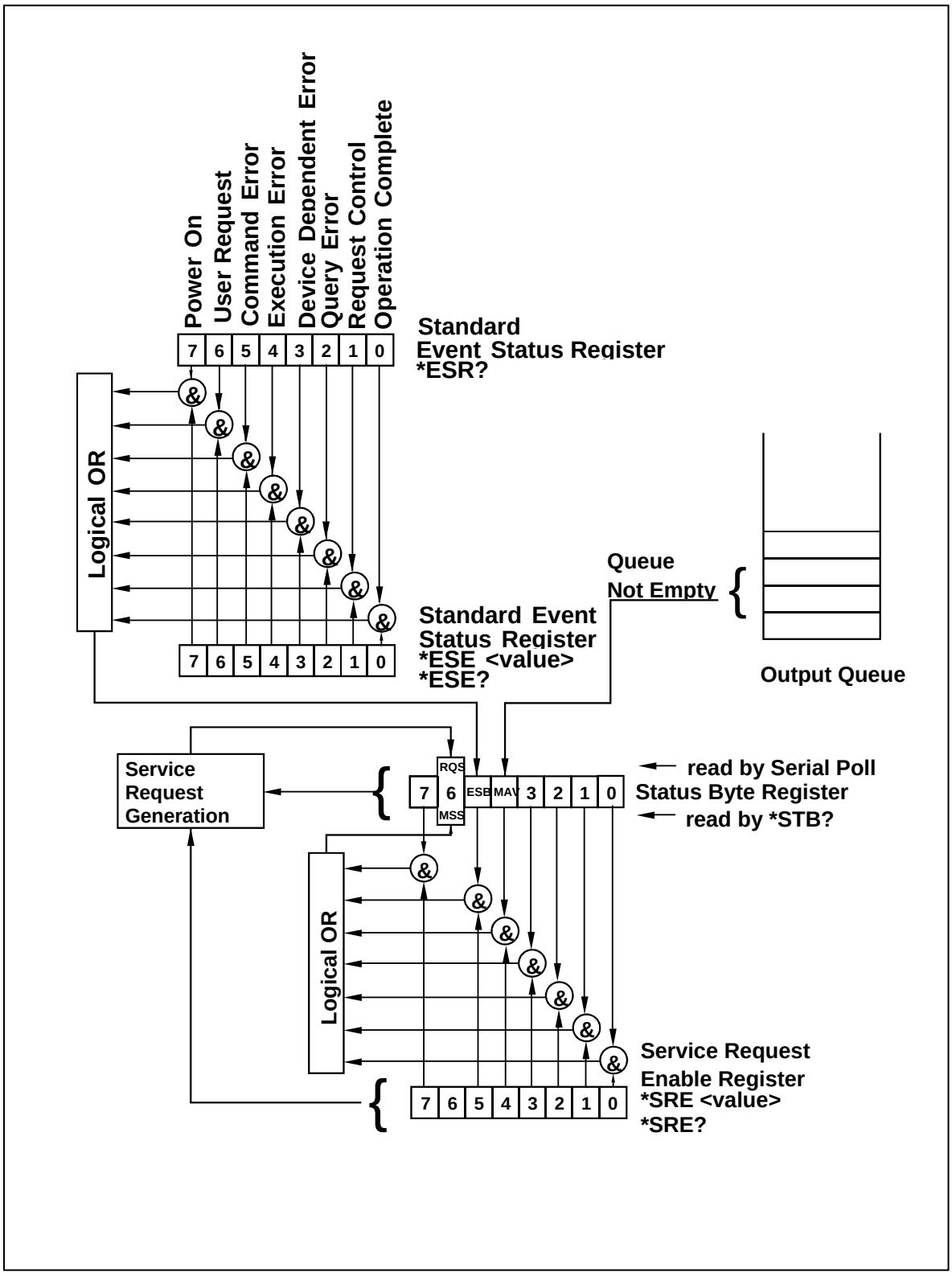


Figure 5-7, The SCPI Status Model

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***SRE0** - Clears all bits in the register.

***SRE1** - Not used.

***SRE2** - Not used.

***SRE4** - Not used.

***SRE8** - Not used.

***SRE16** - Service request on MAV.

***SRE32** - Service request on ESB summary bit.

***SRE128** - Not used.

Standard Event Status Register (ESR)

The Standard Event Status Register reports status for special applications. The 8 bits of the ESR have been defined by the IEEE-STD-488.2 as specific conditions, which can be monitored and reported back to the user upon request. The Standard Event Status Register is destructively read with the *ESR? common query. The Standard Event Status Register is cleared with a *CLS common command, with a power-on and when read by *ESR?.

The arrangement of the various bits within the register is firm and is required by all GPIB instruments that implement the IEEE-STD-488.2. Description of the various bits is given in the following:

Bit 0 - Operation Complete. Generated in response to the *OPC command. It indicates that the device has completed all selected and pending operations and is ready for a new command.

Bit 1 - Request Control. This bit operation is disabled on the 3152B.

Bit 2 - Query Error. This bit indicates that an attempt is being made to read data from the output queue when no output is either present or pending.

Bit 3 - Device Dependent Error. This bit is set when an error in a device function occurs. For example, the following command will cause a DDE error:

```
VOLTage 5;:VOLTage:OFFSet 2
```

Both of the above parameters are legal and within the specified limits, however, the generator is unable to generate such an amplitude and offset combination.

Bit 4 - Execution Error. This bit is generated if the parameter following the command is outside of the legal input range of the generator.

Bit 5 – Command Error. This bit indicates the generator received a command that was a syntax error or a command that the device does not implement.

Bit 6 - User Request. This event bit indicates that one of a set of local controls had been activated. This event bit occurs regardless of the remote or local state of the device.

Bit 7 - Power On. This bit indicates that the device's power source was cycled since the last time the register was read.

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Standard Event Status Enable Register (ESE)

The Standard Event Status Enable Register allows one or more events in the Standard Event Status Register to be reflected in the ESB summary message bit. The Standard Event Status Enable Register is an 8-bit register that enables corresponding summary messages in the Standard Event Status Register. Thus, the application programmer can select reasons for the generator to issue an ESB summary message bit by altering the contents of the ESE Register.

The Standard Event Status Enable Register is read with the *ESE? Common query. The response to this query is a number that represents the sum of the binary-weighted value of the Standard Event Status Enable Register.

The Standard Event Status Enable Register is written using the *ESE command followed by a decimal value representing the bit values of the Register. A bit value one indicates an enabled condition. Consequently, a bit value of zero indicates a disabled condition. The Standard Event Status Enable Register is cleared by setting *ESE0. Summary of *ESE messages is given in the following.

***ESE0** – No mask. Clears all bits in the register.
***ESE1** – ESB on Operation Complete.
***ESE2** – ESB on Request Control.
***ESE4** – ESB on Query Error.
***ESE8** – ESB on Device Dependent Error.
***ESE16** – ESB on Execution Error.
***ESE32** – ESB on Command Error.
***ESE64** – ESB on User Request.
***ESE128** – ESB Power on.

Error Messages

In general, whenever the 3152B receives an invalid SCPI command, it automatically generates an error. Errors are stored in a special error queue and may be retrieved from this buffer one at a time. Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. When you have read all errors from the queue, the generator responds with a 0,"No error" message.

If more than 30 errors have occurred, the last error stored in the queue is replaced with -350, “Queue Overflow”. No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the generator responds with 0,"No error".

The error queue is cleared when power has been shut off or after a *CLS command has been executed. The *RST command does not clear the error queue. Use the following command to read the error queue:

```
SYSTem:ERRor?
```


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Errors have the following format (the error string may contain up to 80 characters):

-102,"Syntax error"

A complete listing of the errors that can be detected by the generator is given below.

-100,"Command error". When the generator cannot detect more specific errors, this is the generic syntax error used.

-101,"Invalid Character". A syntactic element contains a character, which is invalid for that type.

-102,"Syntax error". Invalid syntax found in the command string.

-103,"Invalid separator". An invalid separator was found in the command string. A comma may have been used instead of a colon or a semicolon. In some cases where the generator cannot detect a specific separator, it may return error -100 instead of this error.

-104,"Data type error". The parser recognized a data element different than allowed.

-108,"Parameter not allowed". More parameters were received than expected for the header.

-109,"Missing parameter". Too few parameters were received for the command. One or more parameters that were required for the command were omitted.

-128."Numeric data not allowed". A legal numeric data element was received, but the instrument does not accept one in this position.

-131,"Invalid suffix". A suffix was incorrectly specified for a numeric parameter. The suffix may have been misspelled.

-148,"Character data not allowed". A character data element was encountered where prohibited by the instrument.

-200,"Execution error". This is the generic syntax error for the instrument when it cannot detect more specific errors. Execution error as defined in IEEE-488.2 has occurred.

-221,"Setting conflict". Two conflicting parameters were received which cannot be executed without generating an error. Listed below are events causing setting conflicts.

1. Sum of pulse or ramp parameters is more than 100 percent. Corrective action: Change parameters to correct the problem.
2. ampl/2 + |offset| is more than 16 Vp-p. Corrective action: Reduce offset to 0, then change amplitude-offset values to correct the problem.
3. Activating filters when the 3152B is set to output the built-in sine waveform, or activating the built-in sine waveform when one of the 3152B filters is turned on. Corrective action: If in sine, select another function and activate the filter(s).
4. Activating burst mode when the 3152B is set to sequence mode,

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or activating sequence mode when the 3152B is set to burst mode. Corrective action: Remove the 3152B from burst or sequence and then selected the desired mode.

5. Changing operating mode from triggered to continuous when the 3152B is set to single sequence advance, or changing the operating mode from continuous to triggered when the 3152B is set to automatic sequence advance mode. Corrective action: Observe the 3152B advance mode while setting sequence advance.

There are other setting conflict errors, which are exclusively dedicated for the pulse function. These errors are listed and described in Chapter 3, under the pulse function description

-222,"Data out of range". Parameter data, which followed a specific header, could not be used because its value is outside the valid range defined by the generator.

-224,"Illegal parameter value". A discrete parameter was received which was not a valid choice for the command. An invalid parameter choice may have been used.

-300,"Device-specific-error". This is the generic device-dependent error for the instrument when it cannot detect more specific errors. A device- specific error as defined in IEEE-488.2 has occurred.

-311,"Memory error". Indicates that an error was detected in the instrument's memory.

-350,"Queue Overflow". The error queue is full because more than 30 errors have occurred. No additional errors are stored until the errors from the queue are removed. The error queue is cleared when power has been shut off, or after a *CLS command has been executed.

-410,"Query INTERRUPTED". A command was received which sends data to the output buffer, but the output buffer contained data from a previous command (the previous data is not overwritten). The output buffer is cleared when power is shut off or after a device clear has been executed.

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Chapter 6
Performance Checks

What's in This Chapter

This chapter provides the performance tests necessary to troubleshoot the 3152B VXIbus Arbitrary Waveform Generator.



WARNING

The procedures described in this section are for use only by qualified service personnel. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.



CAUTION

ALWAYS PERFORM PERFORMANCE TESTS IN A STATIC SAFE WORKSTATION.

Performance Checks

The following performance checks verify proper operation of the instrument and should normally be used:

1. as a part of the incoming inspection of the instrument specifications
2. as part of the troubleshooting procedure
3. after any repair or adjustment before returning the instrument to regular service

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Environmental Conditions

Tests should be performed under laboratory conditions having an ambient temperature of 25°C ±5°C and at relative humidity of less than 80%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure. Specifications are valid within an ambient temperature of 25°C ±5°C and at relative humidity of less than 80%. Below 20°C and above 30°C, the specifications are degraded by 0.1% for every ±1°C change.

Warm-up Period

Most equipment is subject to a small amount of drift when it is first turned on. To ensure accuracy, turn on the power to the 3152B and allow it to warm-up for at least 30 minutes before beginning the performance test procedure.

Initial Instrument Setting

To avoid confusion as to which initial setting is to be used for each test, it is required that the instrument be reset to factory default values prior to each test. To reset the 3152B to factory defaults, use the factory reset option in the System>General/Filters Panel. See Figure 4-16 in Chapter 4.

Recommended Test Equipment

Recommended test equipment for troubleshooting, calibration and performance checking is listed in Table 6-1 below. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

Table 6-1, Recommended Test Equipment

Equipment	Model No.	Manufacturer
Oscilloscope (with jitter package)	LC684D	LeCroy
Distortion Analyzer	6900B	Krohn Hite
Digital Multimeter	2000	Keithley
Freq. Counter	2202R	Racal Instruments
Spectrum Analyzer	E4411	HP
Pulse Generator (with manual trigger)	PM8571	Tabor Electronics
VXI Backplane trigger generator	3152B	Racal Instruments

Test Procedures

Use the following procedures to check the 3152B against the specifications. A complete set of specifications is listed in Appendix A. The following paragraphs show how to set up the instrument for each test, what the specifications for the tested function are, and what acceptable limits for the test are. If the instrument fails to perform within the specified limits, the instrument must be calibrated, or tested to find the source of the problem.

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Initial Instrument Setting

To avoid confusion as to what initial setting to use for each test, it is required that the instrument be reset to factory default values prior to each test.

Frequency Accuracy

The Frequency Accuracy test verifies the accuracy of the internal oscillator. The internal oscillator determines the accuracy and stability of the entire waveform generator. The accuracy of the frequency depends on the 10 MHz reference oscillator. Model 3152B defaults to CLK10 which has 100 PPM accuracy.

The frequency accuracy of the output tests the internal TCXO because its accuracy is much higher than the backplane CLK10. If both the internal TCXO and the backplane CLK10 are insufficient for accuracy purposes, an external 10 MHz reference clock can be applied to the 3151B.

The 10 MHz external reference input is not available for the legacy 3152B.

Frequency Accuracy, Internal Reference

Equipment: Counter

Preparation:

1. Configure the counter as follows:
   Termination: 50 Ω, DC coupled
2. Connect the 3152B output to the counter input – channel A.
3. Configure the 3152B as follows:
   Waveform: Square wave
   Amplitude: 2 V
   Output: On
   Frequency: As specified in Table 6-2

Test Procedure:

1. Perform frequency accuracy tests using Table 6-2.

Table 6-2, Frequency Accuracy

3152B Setting	Error Limits	Counter Reading	Pass	Fail
10.0000000 Hz	±10 µHz			
100.000000 Hz	±0.1 mHz			
1.00000000 kHz	±1 mHz			
10.0000000 kHz	±10 mHz			
100.000000 kHz	±100 mHz			
1.00000000 MHz	±1 Hz			
10.0000000 MHz	±10 Hz			
100.0000000 MHz	±100 Hz			

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Frequency Accuracy, External 10 MHz Reference

Equipment: 10 MHz reference (at least 0.1ppm), Counter

Preparation:

1. Leave counter setting and 3152B connections as in previous test.
2. Connect the 10 MHz reference oscillator to the 3152B 10 MHz reference input.
3. Configure the 3152B as follows:
   - 10 MHz: External
   - Waveform: Square wave
   - Amplitude: 2 V
   - Output: On
   - Frequency: As specified in Table 6-3

Test Procedure

1. Perform frequency accuracy tests using Table 6-3.

Table 6-3, Frequency Accuracy Using External 10 MHz Reference

3152B Setting	Error Limits	Counter Reading	Pass	Fail
10.000000000 MHz	±1 Hz			
50.000000000 MHz	±5 Hz			

Amplitude Accuracy

The Amplitude Accuracy test verifies the accuracy of the output amplifier and attenuators. The amplitude path is checked for both the DAC route (arbitrary and standard waveforms) and the DDS route (CW and modulated waveforms). The accuracy is also tested separately for 50 Ω and for 1 MΩ load impedances.

Amplitude Accuracy, DAC Output, 50 Ω Load Impedance

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   - Termination: 50 Ω feedthrough at the DMM input
   - Function: ACV
2. Connect 3152B Channel to the DMM input.
3. Configure the 3152B as follows:
   - Frequency: 1 kHz
   - Output: On
   - Amplitude: As specified in Table 6-4

Test Procedure

1. Perform amplitude accuracy tests using Table 6-4.

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Table 6-4, Amplitude Accuracy, DAC Output

3152B Amplitude Setting	Error Limits	DMM Reading	Pass	Fail
10.00 V	3.534 V ± 85 mV			
5.000 V	1.767 V ± 67 mV			
2.500 V	883.0 mV ± 59 mV			
1.000 V	353.4 mV ± 23 mV			
500 mV	176.7 mV ± 22 mV			
100.0 mV	35.34 mV ± 5.4 mV			
50.00 mV	17.67 mV ± 5.2 mV			

Amplitude Accuracy, DDS Output, 50 Ω Load Impedance

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Termination: 50 Ω feedthrough at the DMM input
   Function: ACV
2. Connect 3152B output to the DMM input.
3. Configure the 3152B as follows:
   Waveform: Modulated
   Modulation: OFF
   CW Frequency: 1 kHz
   Output: On
   Amplitude: As specified in Table 6-5

Test Procedure

1. Perform amplitude Accuracy tests using Table 6-5.

Table 6-5, Amplitude Accuracy, DDS Output

3152B Amplitude Setting	Error Limits	DMM Reading	Pass	Fail
10.00 V	3.534 V ± 85 mV			
5.000 V	1.767 V ± 67 mV			
2.500 V	883 mV ± 59 mV			
1.000 V	353.4 mV ± 23 mV			
500 mV	176.7 mV ± 22 mV			
100.0 mV	35.34 mV ± 5.4 mV			
50.00 mV	17.67 mV ± 5.2 mV			

Amplitude Accuracy, DAC Output, 1 MΩ Load Impedance

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Termination: Open circuit at the DMM input
   Function: ACV
2. Connect 3152B Channel to the DMM input.
3. Configure the 3152B as follows:

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outp:load:cal: 1M
Frequency: 1 kHz
Output: On
Amplitude: As specified in Table 6-6

Test Procedure
1. Perform amplitude accuracy tests using Table 6-6.

Table 6-6, Amplitude Accuracy, DAC Output

3152B Amplitude Setting	Error Limits	DMM Reading	Pass	Fail
10.00 V	7.071 V ± 170 mV			
5.000 V	3.535 V ± 135 mV			
2.500 V	1.767 V ± 117 mV			
1.000 V	707.1 mV ± 47 mV			
500 mV	353.5 mV ± 43 mV			
100.0 mV	70.71 mV ± 10.7 mV			
50.00 mV	35.35 mV ± 10.3 mV			

Amplitude Accuracy, DDS Output, 1 MΩ Load Impedance

Equipment: DMM

Preparation:
1. Configure the DMM as follows:
   Termination: Open circuit at the DMM input
   Function: ACV
2. Connect 3152B output to the DMM input
3. Configure the 3152B as follows:
   outp:load:cal: 1M
   Waveform: Modulated
   Modulation: OFF
   CW Frequency: 1 kHz
   Output: On
   Amplitude: As specified in Table 6-7

Test Procedure
1. Perform amplitude Accuracy tests using Table 6-7.

Table 6-7, Amplitude Accuracy, DDS Output

3152B Amplitude Setting	Error Limits	DMM Reading	Pass	Fail
10.00 V	7.071 V ± 170 mV			
5.000 V	3.535 V ± 135 mV			
2.500 V	1.767 V ± 117 mV			
1.000 V	707.1 mV ± 47 mV			
500 mV	353.5 mV ± 43 mV			
100.0 mV	70.71 mV ± 10.7 mV			
50.00 mV	35.35 mV ± 10.3 mV			

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Offset Accuracy

The offset accuracy test checks the accuracy of the offset generator. The offset path is checked for both the DAC route (arbitrary and standard waveforms) and the DDS route (CW and modulated waveforms). The accuracy is also tested separately for 50 Ω and for 1 M Ω load impedances.

Offset Accuracy, DAC Output, 50 Ω Load Impedance

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   - Termination: 50 Ω feedthrough at the DMM input
   - Function: DCV
2. Connect 3152B output to the DMM input
3. Configure the 3152B as follows:
   - Frequency: 1 MHz
   - Amplitude: 20 mV
   - Output: On
   - Offset: As specified in Table 6-8

Test Procedure

1. Perform Offset Accuracy tests using Table 6-8.

Table 6-8, Offset Accuracy, DAC Output – at 20 mV

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
+4.000 V	4.000 V ±45 mV			
+1.500 V	1.500 V ±20 mV			
0.000 V	0 V ±20 mV			
-1.500 V	-1.500 V ±20 mV			
-4.000 V	-4.000 V ±45 mV			

1. Modify 3152B Amplitude setting to 6 V and offset setting to 0 V.
2. Continue the Offset tests using Table 6-9.

Table 6-9, Offset Accuracy, DAC Output – at 6 V

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±65 mV			

1. Modify 3152B Amplitude setting to 1 V and offset setting to 0 V.
2. Continue the Offset tests using Table 6-10.

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Table 6-10, Offset Accuracy, DAC Output – at 1 V

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±10 mV			

Offset Accuracy, DDS Output, 50 Ω Load Impedance

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Termination: 50 Ω feedthrough at the DMM input
   Function: DCV
2. Connect 3152B output to the DMM input
3. Configure the 3152B as follows:
   Waveform: Modulated
   Modulation: OFF
   CW Frequency: 1 MHz
   Amplitude: 6 V
   Output: On

Test Procedure

1. Perform Offset Accuracy tests using Table 6-11.

Table 6-11, Offset Accuracy, DDS Output – at 6 V

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±65 mV			

1. Modify 3152B Amplitude setting to 1 V and offset setting to 0 V.
2. Continue the Offset tests using Table 6-12.

Table 6-12, Offset Accuracy, DDS Output – at 1 V

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±15 mV			

Offset Accuracy, DAC Output, 1 MΩ Load Impedance

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Termination: Open circuit at the DMM input
   Function: DCV
2. Connect 3152B output to the DMM input
3. Configure the 3152B as follows:
   outp:load:cal: 1M
   Frequency: 1 MHz
   Amplitude: 20 mV

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Output: On
Offset: As specified in Table 6-13

Test Procedure

1. Perform Offset Accuracy tests using Table 6-13.

Table 6-13, Offset Accuracy, DAC Output – at 20 mV

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
+4.000 V	8.000 V ±90 mV			
+1.500 V	3.000 V ±40 mV			
0.000 V	0 V ±40 mV			
-1.500 V	-3.000 V ±40 mV			
-4.000 V	-8.000 V ±90 mV			

2. Modify 3152B Amplitude setting to 6 V and offset setting to 0 V.
3. Continue the Offset tests using Table 6-14.

Table 6-14, Offset Accuracy, DAC Output – at 6 V

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±130 mV			

4. Modify 3152B Amplitude setting to 1 V and offset setting to 0 V.
5. Continue the Offset tests using Table 6-15.

Table 6-15, Offset Accuracy, DAC Output – at 1 V

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±30 mV			

Offset Accuracy, DDS Output, 1 MΩ Load Impedance

Equipment: DMM

Preparation:

4. Configure the DMM as follows:
   Termination: Open circuit at the DMM input
   Function: DCV
5. Connect 3152B output to the DMM input
6. Configure the 3152B as follows:
   outp:load:cal: 1M
   Waveform: Modulated
   Modulation: OFF
   CW Frequency: 1 MHz
   Amplitude: 6 V
   Output: On

Test Procedure

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1. Perform Offset Accuracy tests using Table 6-16.

Table 6-16, Offset Accuracy, DDS Output – at 6 V

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±130 mV			

2. Modify 3152B Amplitude setting to 1 V and offset setting to 0 V.
3. Continue the Offset tests using Table 6-17.

Table 6-17, Offset Accuracy, DDS Output – at 1 V

3152B Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±30 mV			

Square Wave Characteristics

This tests the characteristics of the square waveform including transition times, ringing, and overshoot.

Square Wave Checks

Equipment: Oscilloscope, 50 Ω, 20 dB attenuator feed through

Preparation:

1. Configure the Oscilloscope follows:
   - Termination: 50 Ω, 20 dB attenuator feed through at the oscilloscope input
   - Setup: As required for the test
2. Connect 3152B output to the oscilloscope input
3. Configure the 3152B as follows:
   - Frequency: 1 MHz
   - Waveform: Square wave
   - Amplitude: 6 V
   - Output: On

Test Procedure

1. Perform Square Wave Characteristics tests using Table 6-18.

Table 6-18, Square Wave Characteristics – at 6 V

Parameter Tested	Error Limits	Oscilloscope Reading	Pass	Fail
Rise/Fall Time	<5 ns			
Ringing	<6 % + 10 mV			
Over/undershoot	<6 % + 10 mV			

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Sine Wave Characteristics

This tests the characteristics of the sine waveform including distortion, spectral purity, and flatness. Tests are done for both the DAC route (arbitrary and standard waveforms) and the DDS route (CW and modulated waveforms).

Sine Wave Distortion, DAC Output

Equipment: Distortion Analyzer, Spectrum Analyzer, and ArbConnection

Preparation:

1. Connect 3152B output to the distortion analyzer input. Do not use a 50Ω load.
2. Configure the 3152B as follows:
   - SCLK: As required by the test
   - Waveform: Arbitrary
   - Amplitude: 5 V
   - Output: On
3. Using ArbConnection, prepare and download the following waveform:
   - Wavelength: As required by the test
   - Waveform: Sine wave

Test Procedure

1. Perform sine wave distortion tests using Table 6-19.

Table 6-19, Sine Wave Distortion, DAC Output Tests

3152B SCLK Settings	Sine Wave Points	3152B Frequency	Reading Limits	Distortion Reading	Pass	Fail
400 kS/s	4000	100.0 Hz	< 0.1%			
4 MS/s	4000	1.000 kHz	< 0.1%			
40 Ms/s	4000	10.00 kHz	< 0.1%			
100 Ms/s	2000	50.00 kHz	< 0.1%			
100 Ms/s	1000	100.00 kHz	< 0.1%			

Sine Wave Spectral Purity, DAC Output

Equipment: Spectrum Analyzer

Preparation:

1. Connect 3152B output to the spectrum analyzer input. Use a 50Ω and 20 dB feedthrough termination at the spectrum analyzer input.
2. Configure the 3152B as follows:
   - Amplitude: 5 V
   - Output: On
   - Frequency: As required by the test

Test Procedure

1. Perform sine wave spectral purity, DAC output tests using Table 6-20.

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Table 6-20, Sine Wave Spectral Purity, DAC Output Test – at 5 V

3152B Freq Settings	Reading Limits	Spectrum Analyzer Settings			Pass	Fail
		Start	Stop	Reading		
1 MHz	>45 dBc	100 kHz	10 MHz			
5 MHz	>45 dBc	1 MHz	20 MHz			
10 MHz	>40 dBc	1 MHz	100 MHz			
50 MHz	>35 dBc	10 MHz	200 MHz			
100 MHz	>28 dBc	10 MHz	250 MHz			

2. Change amplitude to 10 V and perform sine wave spectral purity, DAC waveforms tests using Table 6-21.

Table 6-21, Sine Wave Spectral Purity, DAC Output Test – at 10 V

3152B Freq Settings	Reading Limits	Spectrum Analyzer Settings			Pass	Fail
		Start	Stop	Reading		
1 MHz	>40 dBc	100 kHz	10 MHz			
5 MHz	>35 dBc	1 MHz	20 MHz			
10 MHz	>35 dBc	1 MHz	100 MHz			
50 MHz	>30 dBc	10 MHz	200 MHz			
100 MHz	>30 dBc	10 MHz	250 MHz			

Sine Wave Spectral Purity, DDS Output

Equipment: Spectrum Analyzer

Preparation:

1. Connect 3152B output to the spectrum analyzer input. Use a 50 Ω and 20 dB feedthrough termination at the spectrum analyzer input
2. Configure the 3152B as follows:
   - Waveform: Modulated
   - Modulation: OFF
   - Amplitude: 5 V
   - Output: On
   - CW Frequency: As required by the test

Test Procedure

1. Perform sine wave spectral purity, DDS Waveforms tests using Table 6-22.

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Table 6-22, Sine Wave Spectral Purity, DDS Output Tests – at 5 V

3152B Freq Settings	Reading Limits	Spectrum Analyzer Settings			Pass	Fail
		Start	Stop	Reading		
1 MHz	>45 dBc	100 kHz	10 MHz			
5 MHz	>45 dBc	1 MHz	20 MHz			
10 MHz	>35 dBc	1 MHz	100 MHz			
50 MHz	>30 dBc	10 MHz	200 MHz			

2. Change amplitude to 10 V and perform sine wave spectral purity, DAC waveforms tests using Table 6-23.

Table 6-23, Sine Wave Spectral Purity, DDS Output Tests – at 10 V

3152B Freq Settings	Reading Limits	Spectrum Analyzer Settings			Pass	Fail
		Start	Stop	Reading		
1 MHz	>35 dBc	100 kHz	10 MHz			
5 MHz	>35 dBc	1 MHz	20 MHz			
10 MHz	>30 dBc	1 MHz	100 MHz			
50 MHz	>25 dBc	10 MHz	200 MHz			

Sine Wave Flatness, DAC Output

Equipment: Oscilloscope

Preparation:

1. Configure the Oscilloscope follows:
   - Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   - Setup: As required for the test
2. Connect 3152B output to the oscilloscope input
3. Configure the 3152B as follows:
   - Amplitude: 5 V
   - Output: On
   - Frequency: Initially, 1 kHz then, as required by the test

Test Procedure

1. Adjust the vertical controls of the Oscilloscope to get 6 division of display.
2. Perform Sine flatness, DAC waveforms tests using Table 6-24.

Table 6-24, Sine Wave Flatness, DAC Output Test – at 5 V

3152B Sine Frequency	Error Limits	Oscilloscope Reading	Pass	Fail
1 kHz	6 Divisions	Reference	X	X
1 MHz	6 ±0.3 Divisions			
10 MHz	6 ±0.3 Divisions			
50 MHz	6 ±0.6 Divisions			
100 MHz	6 ±0.6 Divisions			

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3. Change amplitude to 10V and adjust the vertical controls of the Oscilloscope to get 6 division of display. Perform sine wave flatness, DAC waveforms tests using Table 6-25.

Table 6-25, Sine Wave Flatness, DAC Output Test – at 10 V

3152B Sine Frequency	Error Limits	Oscilloscope Reading	Pass	Fail
1 kHz	6 Divisions	Reference	X	X
1 MHz	6 ±0.3 Divisions			
10 MHz	6 ±0.3 Divisions			
50 MHz	6 ±0.6 Divisions			
100 MHz	6 ±0.6 Divisions			

Sine Wave Flatness, DDS Output

Equipment: Oscilloscope

Preparation:

1. Configure the Oscilloscope follows:
   - Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   - Setup: As required for the test
2. Connect 3152B output to the oscilloscope input
3. Configure the 3152B as follows:
   - Waveform: Modulated
   - Modulation: OFF
   - Amplitude: 5 V
   - Output: On

   CW Frequency: Initially, 1 kHz then, as required by the test

Test Procedure

1. Adjust the vertical controls of the Oscilloscope to get 6 division of display.
2. Perform Sine flatness, DDS waveforms tests using Table 6-26.

Table 6-26, Sine Wave Flatness Test, DDS Output – at 5 V

3152B Sine Frequency	Error Limits	Oscilloscope Reading	Pass	Fail
1 kHz	6 Divisions	Reference	X	X
1 MHz	6 ±0.2 Divisions			
10 MHz	6 ±0.3 Divisions			
50 MHz	6 ±0.6 Divisions			

3. Change amplitude to 10 V and adjust the vertical controls of the Oscilloscope to get 6 division of display. Perform sine wave flatness, DAC waveforms tests using Table 6-27.

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Table 6-27, Sine Wave Flatness Test, DDS Output – at 10 V

3152B Sine Frequency	Error Limits	Oscilloscope Reading	Pass	Fail
1 kHz	6 Divisions	Reference	X	X
1 MHz	6 ±0.3 Divisions			
10 MHz	6 ±0.3 Divisions			
50 MHz	6 ±0.9 Divisions			

Trigger Operational Characteristics

This tests the operation of the trigger circuit including tests for the triggered, gated, and counted burst run modes. It also tests the operation of the triggered advance options, the delayed trigger, the re-trigger functions, as well as the trigger input level and slope sensitivity.

Trigger, Gate, and Burst Characteristics

Equipment: Oscilloscope, function generator, counter

Preparation:

1. Configure the Oscilloscope as follows:
   - Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   - Setup: As required for the test
2. Configure the counter as follows:
   - Function: TOT B
   - Trigger Level: 100 mV
3. Connect 3152B output to the oscilloscope input
4. Configure the function generator as follows:
   - Frequency 1 MHz
   - Run Mode: As required by the test
   - Wave: 2 V Square
5. Connect the function generator output to the 3152B TRIG IN connector
6. Configure the 3152B as follows:
   - Frequency: 25 MHz
   - Waveform: Sine wave
   - Burst Count: 1e6 counts
   - Amplitude: 1 V
   - Trigger Source: External
   - Output: On

Test Procedure

1. Perform trigger and gate tests using Table 6-28.

Table 6-28, Trigger, Gate, and Burst Characteristics

3152B Run Mode	External Trigger Pulse	Oscilloscope/Counter Reading	Pass	Fail
Triggered	1 MHz, Continuous	Triggered waveform		
Gated – Transition	1 MHz, Continuous	Gated by transition Waveform		
Gated – Level	1 MHz, Continuous	Gated by level Waveform		
Burst	Single shot	Burst, 1e6 waveforms		

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Delayed Trigger Characteristics

Equipment: Function generator, 50 Ω "T" connector, Counter, ArbConnection

Preparation:

1. Configure the Function generator as follows:
   - Amplitude: 1 V
   - Frequency: 1 MHz
   - Trigger Mode: Trigger
   - Wave: Square wave
2. Place the "T" connector on the output terminal of the function generator. Connect one side of the "T" to the 3152B TRIG IN connector and the other side of the "T" to the channel A input of the counter
3. Connect the 3152B output to channel B input of the counter
4. Configure the counter to TI A to B measurements
5. Using ArbConnection prepare and download the following waveform:
   - Wavelength: 100 points
   - Waveform: Pulse, Delay = 0.1, Rise/Fall = 0, High Time = 99.99
6. Configure the 3152B, channel 1 only, as follows:
   - SCLK: 100 MS/s
   - Waveform: Arbitrary
   - Run Mode: Trigger
   - Trigger Level 0 V
   - Trigger Delay: On
   - Delay: As required for the test
   - Amplitude: 5 V
   - Trigger Source: External
   - Output: On

Test Procedure

1. Perform trigger delay tests using Table 6-29.

Table 6-29, Trigger Delay Tests

3152B Delay Setting	Error Limits	Counter Reading	Pass	Fail
1 μs	1 μs ±230 ns			
1 ms	1 ms ±50 μs			
1 s	1 s ±50 ms			
10 s	10 s ±500 ms			

Re-trigger Characteristics

Equipment: Counter, ArbConnection

Preparation:

1. Configure the counter as follows:
   - Function: Pulse Width Measurement
   - Ch A Slope: Negative
2. Connect the counter channel A to the 3152B output

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3. Using ArbConnection prepare and download the following waveform:
   - Wavelength: 100 points
   - Waveform: Pulse, Delay = 0.1, Rise/Fall = 0, High Time = 99.9
4. Configure the 3152B as follows:
   - SCLK 100 MS/s
   - Waveform: Arbitrary
   - Amplitude: 5 V
   - Run Mode: Trigger
   - Trigger Level 0 V
   - Re-trigger: On
   - Re-trigger Delay: As required by the test
   - Trigger Source: Bus
   - Output: On

Test Procedure

1. Manually trigger the instrument.
2. Perform trigger delay tests using Table 6-30.

Table 6-30, Re-Trigger Delay Tests

3152B Re-trigger Setting	Error Limits	Counter Reading	Pass	Fail
1 μs	1 μs ±85 ns			
1 ms	1 ms ±50 μs			
1 s	1 s ±50 ms			
10 s	10 s ±500 ms			

Trigger Slope

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope follows:
   - Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   - Setup: As required for the test
   - Trigger Source: External
2. Connect 3152B output to the oscilloscope input
3. Configure the function generator as follows:
   - Frequency 10 kHz
   - Run Mode: Continue
   - Waveform: 2 V Square
4. Connect the function generator TTL output to the 3152B TRIG IN connector
5. Connect the function generator main output to the 2nd channel of the oscilloscope
6. Configure the 3152B as follows:
   - Frequency: 1 MHz
   - Waveform: Sine wave
   - Run Mode: Triggered
   - Output: On

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Test Procedure

1. Toggle 3152B trigger slope from positive to negative visa versa
2. Verify on the oscilloscope that the 3152B transitions are synchronized with the slope of the trigger

Test Results	Pass		Fail	

Trigger Level

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope as follows:
   - Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   - Setup: As required for the test
2. Connect 3152B output to the oscilloscope input
3. Configure the function generator as follows:
   - Frequency 10 kHz
   - Run Mode: Continuous
   - Waveform: Square wave.
   - Amplitude: 1 V
4. Connect the function generator output to the 3152B TRIG IN connector
5. Configure the 3152B as follows:
   - Frequency: 1 MHz
   - Waveform: Sine wave
   - Run Mode: Trigger
   - Trigger level: 0 V
   - Ch1 Output: On

Test Procedure

1. Verify that the 3152B outputs triggered waveforms spaced at 0.1 ms
2. Modify the function generator offset to +2 V and change the 3152B trigger level to +4 V. Verify that the 3152B triggered waveforms are spaced 0.1 ms apart
3. Modify the function generator offset to -2 V and change the 3152B trigger level to -4 V. Verify that the 3152B triggered waveforms are spaced 0.1 ms apart

Test Results	Pass		Fail	

Backplane Trigger Source

Equipment: Oscilloscope, auxiliary 3152B in an adjacent slot

Preparation:

1. Configure the Oscilloscope as follows:

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Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
Setup: As required for the test

2. Connect the 3152B output to the oscilloscope input
3. Configure the 3152B as follows:
   Frequency: 2 MHz
   Run Mode: Trigger
   Trigger Source: As specified in Table 6-31
   Waveform: Sine wave
   Amplitude: 2 V
   Output: On
4. Configure the auxiliary 3152B as follows:
   Frequency: 1 MHz
   Waveform: Sine wave
   Run Mode: Continuous
   Trigger Output: As specified in Table 6-31
   Output: On

Test Procedure

1. For each test step (row) in Table 6-31, set the "Trigger Output" and "Trigger Source" as specified. Verify that the 3152B generates a single-cycle, 2 MHz sine wave at 1 μs intervals.

Table 6-31, Trigger Source Tests

Auxiliary 3152B "Trigger Output"	3152B "Trigger Source"	Oscilloscope Reading	Pass	Fail
TTLT0 ON	TTLT0	Single-cycle sine wave at 1 μs intervals		
TTLT0 OFF TTLT1 ON	TTLT1	Single-cycle sine wave at 1 μs intervals		
TTLT1 OFF TTLT2 ON	TTLT2	Single-cycle sine wave at 1 μs intervals		
TTLT2 OFF TTLT3 ON	TTLT3	Single-cycle sine wave at 1 μs intervals		
TTLT3 OFF TTLT4 ON	TTLT4	Single-cycle sine wave at 1 μs intervals		
TTLT4 OFF TTLT5 ON	TTLT5	Single-cycle sine wave at 1 μs intervals		
TTLT5 OFF TTLT6 ON	TTLT6	Single-cycle sine wave at 1 μs intervals		
TTLT6 OFF TTLT7 ON	TTLT7	Single-cycle sine wave at 1 μs intervals		

Sequence operation

This tests the operation of the sequence generators. This also checks the various sequence advance options.

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Automatic Advance

Equipment: Counter

Preparation:

1. Configure the Counter as follows:
   - Function: TOTB Measurement
2. Connect the counter channel B to the 3152B output
3. Configure the 3152B as follows:
   - SCLK 100 MS/s
   - Waveform: Sequence
   - Run Mode: Trigger
   - Trigger Source: BUS
   - Amplitude: 2 V
   - Output: On
4. Using ArbConnection prepare and download the following waveform:
   - Segments: 1 to 5
   - Wavelength: 128 points
   - Waveform: 1 cycle square
5. Using ArbConnection, build and download the following sequence table:
   - Step 1: Segment 1, loop 100,000
   - Step 2: Segment 2, loop 100,000
   - Step 3: Segment 3, loop 100,000
   - Step 4: Segment 4, loop 100,000
   - Step 5: Segment 5, loop 100,000

Test Procedure

1. From ArbConnection, click on the Manual Trigger button and observe that counter reading is 500,000 counts. Reset counter and repeat the test a few times. Every time the counter reading should be 500,000 counts exactly.

Test Results	Pass		Fail	

Step Advance

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope as follows:
   - Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   - Setup: As required for the test
2. Connect the 3152B output to the oscilloscope input.
3. Configure the function generator as follows:
   - Frequency 10 kHz
   - Run Mode: Triggered
   - Waveform: Square wave.
   - Amplitude: Adjust for TTL level on 50 Ω
4. Connect the function generator output to the 3152B TRIG IN connector.

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5. Connect the 3152B to the Oscilloscope input.
6. Configure the 3152B as follows:
   SCLK 100 MS/s
   Waveform: Sequence
   Seq. Advance: Step
   Amplitude: 2 V
   Trigger Source: External
   Output: On
7. Using ArbConnection prepare and download the following waveform:
   Segment 1: Sine, 1000 points
   Segment 2: Triangle, 1000 points
   Segment 3: Square, 1000 points
   Segment 4: Sinc, 1000 points
   Segment 5: Gaussian Pulse, 1000 points
8. Using ArbConnection, build and download the following sequence table:
   Step 1: Segment 1, loop 1
   Step 2: Segment 2, loop 1
   Step 3: Segment 3, loop 1
   Step 4: Segment 4, loop 1
   Step 5: Segment 5, loop 1

Test Procedure

1. From ArbConnection, click on the Manual Trigger and observe that the waveforms advance through the sequence table repeatedly.

Test Results	Pass		Fail	



Note

Leave the same setup for the next test

Single Advance

Equipment: Oscilloscope, function generator

Preparation: (Same preparation as for previous step, except change mode to single sequence advance)

1. Change Oscilloscope configuration to single.

Test Procedure

1. From ArbConnection, click on Manual Trigger and observe that one waveform cycle advances through the sequence table repeatedly with each external trigger signal. Note that you might need to reset the single-shot capture mode on the oscilloscope for each trigger advance.

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Test Results	Pass		Fail	

SYNC Output Operation

This tests the operation of the SYNC output. There are two synchronous output are being tested – BIT and LCOM. BIT normally operates with standard and arbitrary waveforms and LCOM is associated with sequenced and burst outputs. The sync output has a fixed TTL level amplitude into an open circuit.

SYNC Output - BIT

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: As required by the test
   - Amplitude: 2 V/div
2. Connect 3152B SYNC to the oscilloscope input.
3. Configure model 3152B as follows:
   - Waveform: Sine
   - Output: On
   - Sync Output: On

Test Procedure:

1. Verify that the trace on the oscilloscope shows synchronization pulses at 1 μs intervals.

Test Results	Pass		Fail	

SYNC Output - LCOM

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: As required by the test
   - Amplitude: 2 V/div
2. Connect the 3152B output to the oscilloscope input (1).
3. Connect the 3152B SYNC to the oscilloscope input (2).
4. Configure model 3152B channel as follows:
   - Waveform: Sine
   - Run Mode: Burst
   - Burst Count: 10
   - Re-trigger On
   - Re-trig period: 10 μs
   - Output: On
   - Sync Output: On

Test Procedure:

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1. From ArbConnection, click on the Manual Trigger button and verify that the trace on the oscilloscope shows synchronization pulses having 10 μs pulse widths. Verify that the SYNC pulse is high for the duration of the burst.

Test Results	Pass		Fail	

SYNC Output - HCL

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: As required by the test
   - Amplitude: 2 V/div
2. Connect the 3152B output to the oscilloscope input (1)
3. Connect the 3152B SYNC to the oscilloscope input (2)
4. Configure model 3152B channel as follows:
   - Waveform: Sine
   - Output: On
   - Sync Output: On
   - Sync Source: HCL

Test Procedure:

1. Observe that the SYNC output has a 50% duty cycle.

Test Results	Pass		Fail	

SYNC Output - Pulse

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: As required by the test
   - Amplitude: 2 V/div
2. Connect the 3152B output to the oscilloscope input (1)
3. Connect the 3152B SYNC to the oscilloscope input (2)
4. Configure model 3152B channel as follows:
   - Waveform: Sine
   - Output: On
   - Sync Output: On
   - Sync Source: Pulse
   - Sync Width: 8
   - Sync Position: 48

Test Procedure:

1. Observe that the SYNC output has a width of 8 sample clock cycles and that its position is shifted by 48 sample clock periods.

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Test Results	Pass		Fail	

SYNC Output – Zero

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: As required by the test
   - Amplitude: 2 V/div
2. Connect the 3152B output to oscilloscope input (1)
3. Connect the 3152B SYNC to oscilloscope input (2)
4. Configure model 3152B channel as follows:
   - Waveform: Sinc
   - '0' Crossing 10
   - Output: On
   - Sync Output: On
   - Sync Source: Zero

Test Procedure:

1. Observe that the SYNC output has 10 sinc cycles for each "0" crossing level.

Test Results	Pass		Fail	

PLL Operation

This tests the operation of the PLL function. Model 3152B locks automatically to an external trigger source. The frequency and the start phase of the external signals are applied to the 3152B TRIG/PLL input. After lock (as indicated by the LOCK LED), the start phase of the 3152B can be modified from -180° to 180°.

PLL Checks – Frequency Lock

Equipment: Counter, function generator

Preparation:

1. Configure the function generator as follows:
   - Waveform: Square
   - Amplitude: 1 Vp-p
   - Output: On
   - Frequency: As required (see Table 6-32)
2. Referring to Figure 6-1, connect the function generator output to a "T" connector at the counter CH A input. Connect the other side of the "T" connector to the 3152B TRIG/PLL IN connector. Use a 50 Ω fee`d-through terminator at the 3152B TRIG/PLL IN connector.
3. Configure the counter as follows:

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Function: Freq A/B
CH A Input: High impedance
CH B Input: 50 Ω

4. Connect the 3152B output to the counter CH B input.
5. Configure the 3152B as follows:
   Impedance: 1 MΩ
   Waveform: Sine
   Output: On
   PLL: On
   Trigger Level: 0 V
   Frequency: As required (see Table 6-32)

Test Procedure:

1. For each test step (row) in Table 6-32, set the function generator and 3152B frequencies as indicated.
2. Read and record the frequency ratio displayed by the counter and verify that it is within the low and high limits given in Table 6-32.

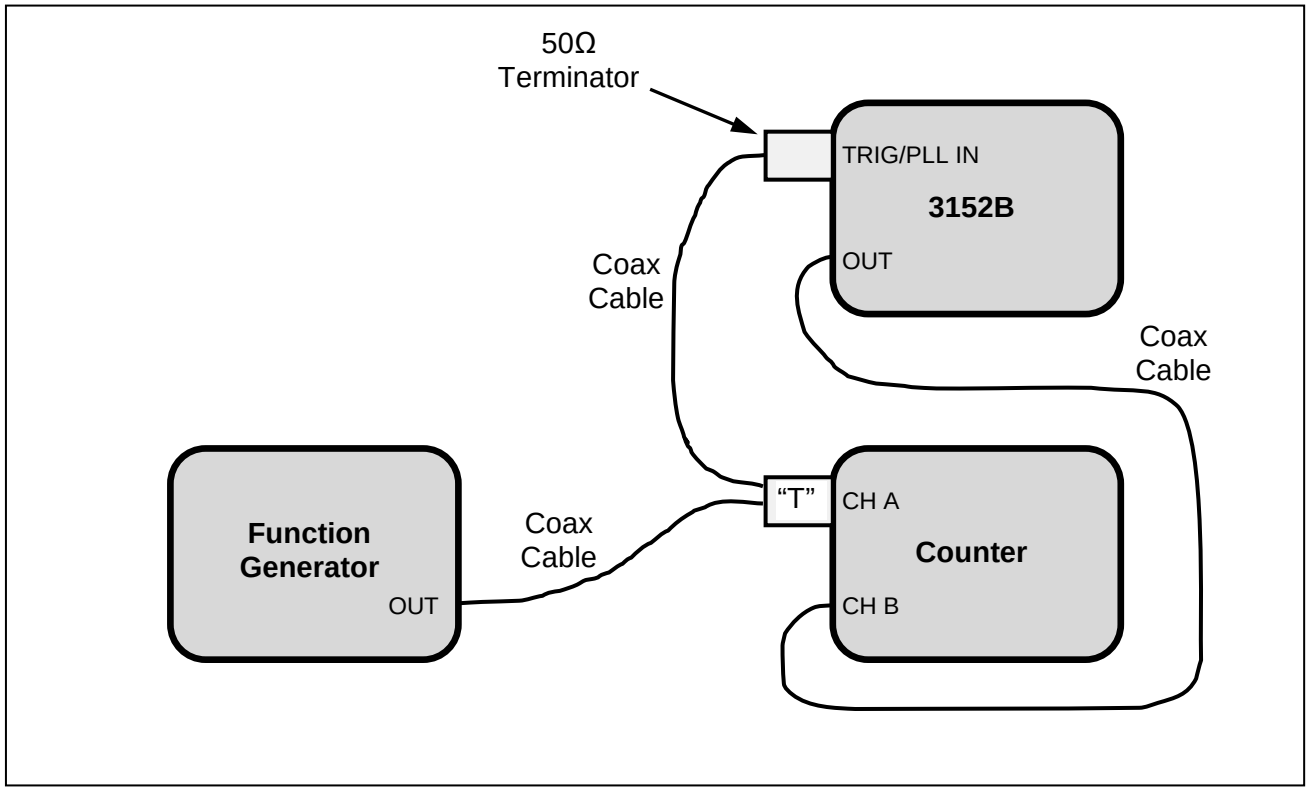


Figure 6-1, PLL Tests – Signal Connections

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Table 6-32, PLL Tests – Frequency

Function Generator Frequency Setting	3152B Frequency Setting	Low Limit	Counter Ratio Reading	High Limit	Pass	Fail
500 Hz	100 kHz	0.99		1.01		
5 kHz	100 kHz	0.99		1.01		
50 kHz	100 kHz	0.99		1.01		
500 kHz	1 MHz	0.99		1.01		
5 MHz	10 MHz	0.99		1.01		
10 MHz	10 MHz	0.99		1.01		

PLL Checks – Phase Offset

Equipment: Counter, function generator

Preparation:

1. Configure the function generator as follows:
   Waveform: Square
   Amplitude: 1 Vp-p
   Output: On
   Frequency: As required (see Table 6-32)
2. Referring to Figure 6-1 (above), connect the function generator output to a "T" connector at the counter CH A input. Connect the other side of the "T" connector to the 3152B TRIG/PLL IN connector. Use a 50 Ω feed-through terminator at the 3152B TRIG/PLL IN connector.
3. Configure the counter as follows:
   Function: ϕ A→B
   CH A Input: High impedance
   CH B Input: 50 Ω
4. Connect the 3152B output to the counter CH B input.
5. Configure the 3152B as follows:
   Function Mode: Arbitrary
   Wavelength: 200 points
   Output: On
   PLL: On
   Trigger Level: 0 V
   Phase Offset: As required (see Table 6-33)

Test Procedure:

1. For each test step (row) in Table 6-33, set the function generator frequency and 3152B phase as indicated.
2. Read and record the phase reading displayed by the counter and verify that it is within the low and high limits given in Table 6-33.

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Table 6-33, PLL Tests – Phase Offset

Function Generator Frequency Setting	3152B Phase Setting	Low Limit	Counter Ratio Reading	High Limit	Pass	Fail
50 kHz	5°	2°		8°		
50 kHz	90°	87°		93°		
50 kHz	169°	166°		172°		
500 kHz	-5°	352°		358°		
500 kHz	-90°	267°		273°		
500 kHz	-169°	188°		194°		

PM Operation

This tests the operation of the PM function. After the 3152B locks to an external trigger source, the start phase of the 3152B can be modified in reference to the external signal using dc levels. The DC levels are applied to the PM input and control phase shifts of 20°/V.

PM Checks

Equipment: Counter, DC supply source, function generator

Preparation:

1. Configure the function generator as follows:
   Waveform: Square
   Amplitude: 1 Vp-p
   Output: On
   Frequency: 1 kHz
2. Referring to Figure 6-1 (above), connect the function generator output to a “T” connector at the counter CH A input. Connect the other side of the “T” connector to the 3152B TRIG/PLL IN connector. Use a 50 Ω feed-through terminator at the 3152B TRIG/PLL IN connector.
3. Configure the counter as follows:
   Function: ϕ A→B
   CH A Input: High impedance
   CH B Input: 50 Ω
4. Connect the 3152B output to the counter CH B input.
5. Configure the DC source as follows:
   Amplitude: As required (see Table 6-34)
6. Connect the DC source to the 3152B PM input.
7. Configure the 3152B as follows:
   Function Mode: Arbitrary
   Waveform: Square
   Wavelength: 36 points
   Output: On
   PLL: On

Test Procedure:

1. For each test step (row) in Table 6-34, set the DC source amplitude as indicated.
2. Read and record the phase reading displayed by the counter

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and verify that it is within the low and high limits given in Table 6-34.

Table 6-34, PLL Tests – PM Phase Offset

Function Generator Frequency Setting	DC Source Amplitude	Low Limit	Counter Phase Reading	High Limit	Pass	Fail
10 kHz	2 V	305 °		335°		
10 kHz	4.5 V	255°		285°		
10 kHz	-2 V	25°		55°		
10 kHz	-4.5 V	75°		105°		

Arbitrary Waveform Memory Operation

This tests the integrity of the waveform memory. The waveform memory stores the waveforms that are being generated at the output connector and, therefore, flaws in the memory can cause distortions and impurities in the output waveform.

Waveform Memory

Equipment: Distortion Analyzer, ArbConnection

Preparation:

1. Connect 3152B output to the distortion analyzer input. Do not use a 50 Ω load.
2. Configure the 3152B as follows:
   - SCLK: As required by the test
   - Waveform: Arbitrary
   - Amplitude: 5 V
   - Output: On
3. Using ArbConnection prepare and download the following waveform:
   - Wavelength: 500 k points
   - Waveform: Sine wave
   - SCLK 100 MS/s

Test Procedure

1. Perform Sine wave distortion. It should be less than 0.1 %.

Test Results	Pass		Fail	

Modulated Waveform Operation

This tests the operation of the modulation circuits. It includes tests for the various modulation functions: FM, AM, FSK, PSK, Frequency Hopping, Amplitude Hopping, and Sweep. Since the modulation run modes are common to all modulation functions, they are being tested

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on the FM modulation function only.

FM - Standard Waveforms

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 50 µs
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure model 3152B controls as follows:
   Waveform: Modulated
   Modulation: FM
   Carrier Freq: 1 MHz
   Mod Frequency: 10 kHz
   Deviation: 500 kHz
   Sync: On
   Output: On

Test Procedure:

1. Verify FM operation on the oscilloscope as follows:
   Waveform: Sine
   Frequency: 10 kHz
   Max F: 1.25 MHz
   Min F: 750 kHz

Test Results	Pass		Fail	

2. Modify the 3152B modulating waveform to triangle, then square, and then ramp to verify all standard FM waveforms.

Test Results	Pass		Fail	

3. Move the 3152B marker position to 1.25MHz and verify the marker position.

Test Results	Pass		Fail	

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Triggered FM - Standard Waveforms

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: 0.2 ms
   - Sampling Rate: 50 MS/s at least.
   - Trace A View: Jitter, Type: FREQ, CLK.
   - Trigger source: Channel 2, positive slope
   - Amplitude: 1 V/div
2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure the function generator as follows:
   - Frequency 1 kHz
   - Run Mode: Continuous
   - Waveform: Square wave.
   - Amplitude: 2 V
5. Connect the function generator output connector to the 3152B TRIG IN connector.
6. Configure model 3152B controls as follows:
   - Waveform: Modulated
   - Modulation: FM
   - Mod Run Mode: Triggered
   - Carrier Freq: 1 MHz
   - Mod Frequency: 10 kHz
   - Deviation: 500 kHz
   - Sync: On
   - Output: On

Test Procedure:

1. Verify triggered FM – standard waveforms operation on the oscilloscope as follows:
   - Waveform: Triggered sine waves
   - Mod Frequency: 10 kHz
   - Trigger Period: 1 ms
   - Max Deviation: 1.25 MHz
   - Min Deviation: 750 kHz

Test Results	Pass		Fail	

FM Burst - Standard Waveforms

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: 0.2 ms
   - Sampling Rate: 50 MS/s at least.
   - Trace A View: Jitter, Type: FREQ, CLK.
   - Trigger source: Channel 2, positive slope
   - Amplitude: 1 V/div
2. Connect 3152B output to the oscilloscope input, channel 1.

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3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Confgure the function generator as follows:
   Frequency 1 kHz
   Run Mode: Continuous
   Waveform: Square wave.
   Amplitude: 2 V Square
5. Connect the function generator output connector to the 3152B TRIG IN connector.
6. Configure model 3152B controls as follows:
   Waveform: Modulated
   Modulation: FM
   Modulation Run Mode: Burst
   Burst: 5
   Carrier Freq: 1 MHz
   Mod Frequency: 10 kHz
   Deviation: 500 kHz
   Sync: On
   Output: On

Test Procedure:

1. Verify Burst FM – standard waveform operation on the oscilloscope as follows:
   Waveform: Burst of 5 Sine waveforms
   Mod Frequency: 10 kHz
   Burst Period: 1 ms
   Max Deviation: 1.25 MHz
   Min Deviation: 750 kHz

Test Results	Pass		Fail	

Gated FM - Standard Waveforms

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure the function generator as follows:
   Frequency 1 kHz
   Run Mode: Continuous
   Waveform: Square wave.
   Amplitude: 2 V
5. Connect the function generator output connector to the 3152B TRIG IN connector.
6. Configure model 3152B controls as follows:

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Waveform: Modulated
Modulation: FM
Mod Run Mode: Gated
Carrier Freq: 1 MHz
Mod Frequency: 10 kHz
Deviation: 500 kHz
Sync: On
Output: On

Test Procedure:

1. Verify Gated FM – standard waveform operation on the oscilloscope as follows:
   Waveform: Gated sine waveforms
   Mod Frequency: 10 kHz
   Gated Period: 1 ms
   Max Deviation: 1.25 MHz
   Min Deviation: 750 kHz

Test Results	Pass		Fail	

Re-triggered FM Bursts - Standard Waveforms

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure model 3152B controls as follows:
   Waveform: Modulated
   Modulation: FM
   Run Mode: Burst
   Burst Count: 5
   Carrier Freq: 1 MHz
   Mod Freq: 10 kHz
   Deviation: 500 kHz
   Sync: On
   Re-trigger: On
   Re-trig Delay: 200 μs
   Output: On

Test Procedure:

1. Verify re-triggered FM burst – standard waveform operation on the oscilloscope as follows:
   Waveform: Repetitive burst of 5-cycle sine waveforms

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Mod Frequency: 10 kHz
Re-trigger delay: 200 μs
Max Deviation: 1.25 MHz
Min Deviation: 750 kHz

Test Results	Pass		Fail	

FM - Arbitrary Waveforms

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure model 3152B controls as follows:
   Waveform: Modulated
   Modulation: FM
   Mod Waveform: Arbitrary
   Carrier Freq: 1 MHz
   FM SCLK: 2.5 MS/s
   Sync: On
   Output: On
5. Using ArbConnection, open the FM Composer and download the following waveform:
   Wavelength: 4000 points
   Waveform: 4 sine wave cycles
   Deviation: 0.5 MHz

Test Procedure:

1. Verify FM operation on the oscilloscope as follows:
   Waveform: Sine
   Mod Freq: 2.5 kHz
   Max Deviation: 1.25 MHz
   Min Deviation: 750 kHz

Test Results	Pass		Fail	

AM

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.5 ms
   Trigger source: Channel 2, positive slope

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Amplitude: 1 V/div

2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure model 3152B controls as follows:
   Waveform: Modulated
   Modulation: AM
   Carrier Freq: 1 MHz
   Mod Frequency: 1 kHz
   Mod Depth: 50 %
   Mod Wave Sine
   Sync: On
   Output: On

Test Procedure:

1. Verify AM operation on the oscilloscope as follows:
   Waveform: Amplitude modulated sine
   Mod depth: 50 % ±5 %

Test Results	Pass		Fail	

FSK

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div.
2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure model 3152B controls as follows:
   Waveform: Modulated
   Modulation: FSK
   Carrier Freq: 2 MHz
   Shift Frequency: 4 MHz
   Baud Rate: 10 kHz
   Marker Index: 1
   Sync: On
   Output: On
5. Using ArbConnection, prepare and download 10-step FSK list with alternating “0” and “1”

Test Procedure:

1. Verify FSK operation on the oscilloscope as follows:
   Waveform: Square wave
   Period: 0.2 ms
   Max Freq.: 4 MHz
   Min Freq.: 2 MHz

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Test Results	Pass		Fail	

PSK

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Amplitude: 1 V/div.
2. Connect the 3152B output to the oscilloscope input, channel 1
3. Connect the 3152B SYNC to the oscilloscope input, channel 2
4. Configure model 3152B controls as follows:
   Reset
   Waveform: Modulated
   Modulation: PSK
   Carrier Freq: 10 kHz
   Shift Phase: 180°
   Baud Rate: 10 kHz
   Sync: On
   Output: On
5. Using ArbConnection, prepare and download 10-step PSK list with alternating “0” and “1”

Test Procedure:

1. Verify PSK operation on the oscilloscope as follows:
   Waveform: Sine wave
   Period: 0.1 ms
   Phase: Every 0.1 ms change 180 degrees

Test Results	Pass		Fail	

ASK

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Amplitude: 1 V/div.
2. Connect the 3152B output to the oscilloscope input, channel 1
3. Connect the 3152B SYNC to the oscilloscope input, channel 2
4. Configure model 3152B controls as follows:
   Reset
   Waveform: Modulated
   Modulation: ASK
   Carrier Freq: 10 kHz
   Base Amplitude: 4 V
   Shift Amplitude: 2 V
   Baud Rate: 10 kHz
   Sync: On

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Output: On

5. Using ArbConnection, prepare and download 10-step ASK list with alternating “0” and “1”

Test Procedure:

1. Verify ASK operation on the oscilloscope as follows:
   Waveform: Sine wave
   Period: 0.1 ms
   Amplitude: Every 0.1 ms alternates between 2 V and 4V

Test Results	Pass		Fail	

Variable Dwell Time Frequency Hopping

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.5 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 3152B output to the oscilloscope input, channel 1
3. Connect the 3152B SYNC to the oscilloscope input, channel 2
4. Configure model 3152B controls as follows:
   Waveform: Modulated
   Modulation: Hop
   Hop Mode: Variable
   Sync: On
   Output: On
5. Using ArbConnection prepare, open the Hop Table composer and download the following table (both channels):

Frequency	***Dwell Time***
1.0e6	50e-6
1.2e6	100e-6
1.4e6	150e-6
1.6e6	200e-6
1.8e6	250e-6
2.0e6	300e-6
2.2e6	350e-6
2.4e6	400e-6
2.6e6	450e-6
2.8e6	500e-6

Test Procedure:

1. Verify Hop operation on the oscilloscope as follows:
   Waveform: Frequency steps, increasing dwell time from 50 μs to 500 μs
   Max A: 2.8 MHz
   Min A: 1.0 MHz
   Period: 2750 μs

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Test Results	Pass		Fail	

Fix Dwell Time Frequency Hopping

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: 0.1 ms
   - Sampling Rate: 50 MS/s at least.
   - Trace A View: Jitter, Type: FREQ, CLK.
   - Trigger source: Channel 2, positive slope
   - Amplitude: 1 V/div
2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure model 3152B controls as follows:
   - Waveform: Modulated
   - Modulation: Hop
   - Hop Mode: Fix
   - Dwell Time: 50 μs
   - Sync: On
   - Output: On
5. Using ArbConnection prepare, open the Hop Table composer and download the following table:

Frequency

1.0e6
1.2e6
1.4e6
1.6e6
1.8e6
2.0e6
2.2e6
2.4e6
2.6e6
2.8e6

Test Procedure:

1. Verify Hop operation on the oscilloscope as follows:
   - Waveform: Frequency steps, fixed dwell time of 50 μs
   - Max Hop Freq: 2.8 MHz
   - Min Hop Freq: 1.0 MHz
   - Period: 500 μs

Test Results	Pass		Fail	

Amplitude Hopping

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:

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Time Base: 50 μs
Sampling Rate: 50 MS/s at least.
Trigger source: Channel 2, positive slope
Amplitude: 5 V/div

2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2.
4. Configure the 3152B controls as follows:
   Waveform: Modulated
   Modulation: Amplitude Hopping
   Hop Mode: Fix
   Dwell Time: 50 μs
   Sync: On
   Output: On
5. Using ArbConnection, open and prepare the Hop Table composer and download the following table:

   Amplitude
   1
   2
   4
   8
   16

Test Procedure:

1. Verify 5 Hop operation on the oscilloscope as follows:
   Waveform: Amplitude steps, 50 μs fixed dwell time
   Min Amp: 1 V
   Max Amp: 16 V
   Period: 250 μs

Test Results	Pass		Fail	

Sweep

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 3152B output to the oscilloscope input, channel 1.
3. Connect the 3152B SYNC to the oscilloscope input, channel 2
4. Configure model 3152B controls as follows:
   Waveform: Modulated
   Modulation: Sweep
   Start Frequency: 1 MHz
   Stop Frequency: 2 MHz
   Sweep Time: 1 ms
   Sweep Type: Linear

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Sync: On
Output: On

Test Procedure:

1. Verify Sweep operation on the oscilloscope as follows:
   Waveform: Ramp up
   Frequency: 1 kHz
   Max Freq: 2 MHz
   Min Freq: 1 MHz

Test Results	Pass		Fail	

2. Move 3152B sweep marker position to 1.5 MHz and verify marker position at the middle of the ramp.

Test Results	Pass		Fail	

3. Reverse between Start and Stop frequencies and verify oscilloscope reading as before except the ramp is down.

Test Results	Pass		Fail	

4. Change sweep step to logarithmic and verify oscilloscope exponential down waveform with properties as in 3 above.

Test Results	Pass		Fail	

Auxiliary Counter/Timer Operation

This tests the operation of the auxiliary counter/timer function. Note that when you select the counter/timer function all other 3152B waveform generation is automatically purged and the instrument operational mode is transformed to a stand-alone counter/timer. Waveform generation is resumed as soon as the counter/timer function is turned off.

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Frequency

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   Frequency: As required by the test
   Wave: Square
   Amplitude 500 mV
2. Connect the function generator to the 3152B TRIG IN connector.
3. Configure the 3152B, as follows:
   Auxiliary Function: Counter/Timer
   Function: Frequency
   Trigger Level: 0 V

Test Procedure:

1. Perform Frequency Measurement Accuracy tests using Table 6-35.

Table 6-35, Frequency Measurement Accuracy

Function Generator Setting	Error Limits	3152B Counter Reading	Pass	Fail
1.000000 MHz	±2 Hz			
100.0000 MHz	±100 Hz			

Period, Period Averaged

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   Frequency: As required by the test
   Wave: Square
   Amplitude 500 mV
2. Connect the function generator to the 3152B TRIG IN connector
3. Configure the 3152B, as follows:
   Auxiliary Function: Counter/Timer
   Function: Period
   Trigger Level: 0 V

Test Procedure:

1. Perform Period Accuracy tests using Table 6-36.

Table 6-36, Period Measurement Accuracy

Function Generator Setting	Error Limits	3152B Counter Reading	Pass	Fail
10 kHz	100.0 µs ±100 ns			
100 kHz	10.00 µs ±100 ns			

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2. Change the counter/timer function to Period Averaged
3. With the last function generator setting in Table 31, verify that the period reading is 10.00000 μs ±50 ps

Test Results	Pass		Fail	

Pulse Width

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   - Frequency: As required by the test
   - Wave: Square
   - Duty Cycle: As required by the test
   - Amplitude 500 mV
2. Connect the function generator to the 3152B TRIG IN connector
3. Configure the 3152B, as follows:
   - Auxiliary Function: Counter/Timer
   - Function: Pulse Width
   - Trigger Level: 0 V

Test Procedure:

1. Perform Pulse Width Accuracy tests using Table 6-37.

Table 6-37, Pulse Width Measurement Accuracy

Function Generator Setting		Error Limits	3152B Counter Reading	Pass	Fail
Frequency	Duty Cycle				
100 kHz	50 %	5.000 μs ±100 ns			
100 kHz	70 %	7.07 μs ±100 ns			

2. Change the counter/timer slope to Negative.
3. With the last function generator setting in Table 30, change the function generator duty cycle to 70%.
4. Verify that the pulse width reading is 3.0 μs ±100 ns.

Test Results	Pass		Fail	

Totalize, Infinite

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   - Frequency: 100 MHz
   - Wave: Square
   - Amplitude 500 mV
   - Counted Burst: 1,000,000

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2. Connect the function generator to the 3152B TRIG IN connector
3. Configure the 3152B, as follows:
   Auxiliary Function: Counter/Timer
   Function: Totalize, Infinite
   Trigger Level: 0 V

Test Procedure:

1. Press the Reset/Arm button on the 3152B to reset and arm the totalize function.
2. Manually trigger the function generator and verify that the 3152B counter reading is 1,000,000 ±2.

Test Results	Pass		Fail	

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Chapter 7

Calibration and Firmware Update

What's in this Chapter

This chapter gives instructions for performing calibration and firmware updates of the 3152B VXIbus Arbitrary Waveform Generator.



WARNING

The procedures described in this section are for use only by qualified service personnel. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.



CAUTION

ALWAYS PERFORM DISASSEMBLY, REPAIR AND CLEANING AT A STATIC SAFE WORKSTATION.

Calibration

Calibration Types

There are two types of calibration for Model 3152B:

- **Factory Calibration:** Performed only on new instruments as part of the manufacturing process or after repair at an authorized service center.
- **Periodic Calibration:** Performed at recommended intervals to ensure that the instrument remains accurate over time.

Instructions for both calibration types are provided in this chapter.

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Recommended Test Equipment

Recommended equipment for calibration is listed in Table 7-1. Other test instruments may be used only if their specifications equal or exceed the required characteristics.

Table 7-1, Recommended Test Equipment

Equipment	Model No.	Manufacturer
Oscilloscope (with jitter package)*	LC684D	LeCroy
Digital Multimeter (DMM)	2000	Keithley
Frequency Counter (Rubidium reference)*	2202R	Racal Instruments
Function Generator (with manual trigger)*	WW2571A	Tabor Electronics
Accessories	BNC to BNC coaxial cables	
	BNC "T" connector (2 BNC females with 1 BNC male)*	
	Adapter, dual banana jacks with BNC male	
	Feed-through termination, 50Ω ± 0.1%, 5W	

* Required for Factory Calibration only.

Environment

Although Model 3152B can operate at ambient temperatures from 0°C to 50°C, calibration should be performed under laboratory conditions with an ambient temperature of 25°C ± 5°C and relative humidity of less than 80%.

Configuration

Calibration is performed with the 3152B installed in a VXIbus chassis. Either a register-based or message-based controller may be used, and the procedure is the same for both options. The ArbConnection software application must be installed and interfaced to the instrument.

Factory Calibration requires that the covers be removed during calibration. Periodic Calibration does not require removal of the covers, which should remain closed.

Periodic Calibration

Calibration Interval

To ensure continued accuracy, it is recommended that periodic calibration be performed at intervals of one year.

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Warm-up

Install the 3152B in a VXIbus chassis. Turn on the chassis power and allow the 3152B to warm up and stabilize for at least 30 minutes before calibrating. If the instrument has been subjected to temperatures outside the range of 25°C ± 5°C , allow at least one additional hour for the instrument to stabilize before calibrating.

Procedure

1. Using a BNC coaxial cable and BNC-to-banana-plug adapter, connect the 3152B front-panel output to the DMM input.
2. Set the DMM function to DC Volts.
3. Start the ArbConnection software. The Startup & Communication Options window will appear as shown in Figure 7-1.

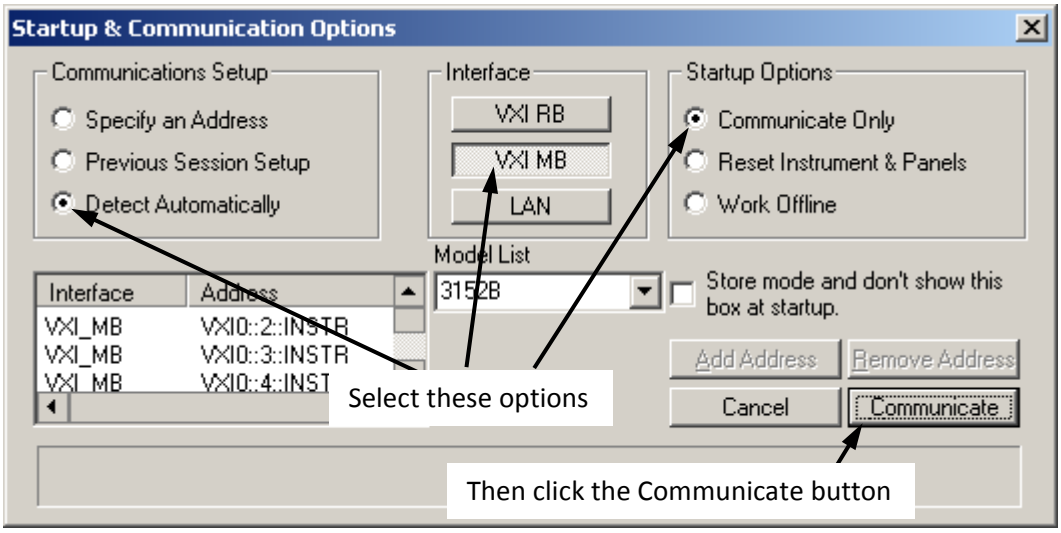


Figure 7-1, Startup & Communication Options Window

4. Use the mouse to select “Detect Automatically”, “VXI MB”, and “Communicate Only” as shown in Figure 7-1. Then click the “Communicate” button.
5. The ArbConnection main window will then appear (Figure 7-2).

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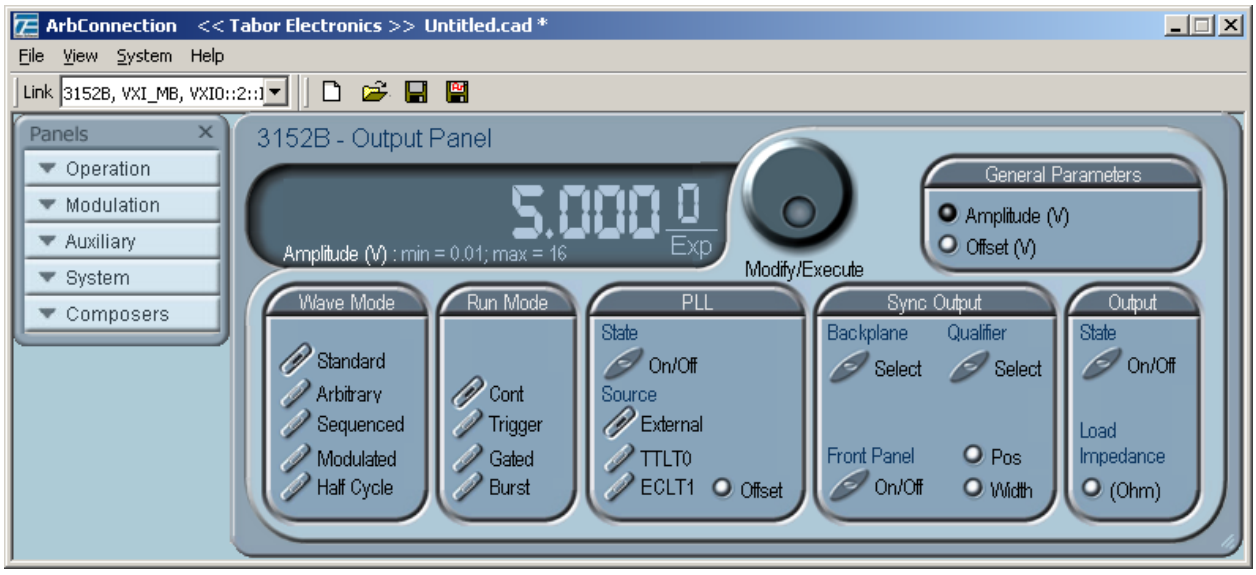


Figure 7-2, ArbConnection Main Window

6. If more than one instrument is installed, select the one you wish to calibrate. Click the mouse where shown in Figure 7-3 to drop down a list of instruments. Then select one by logical address.

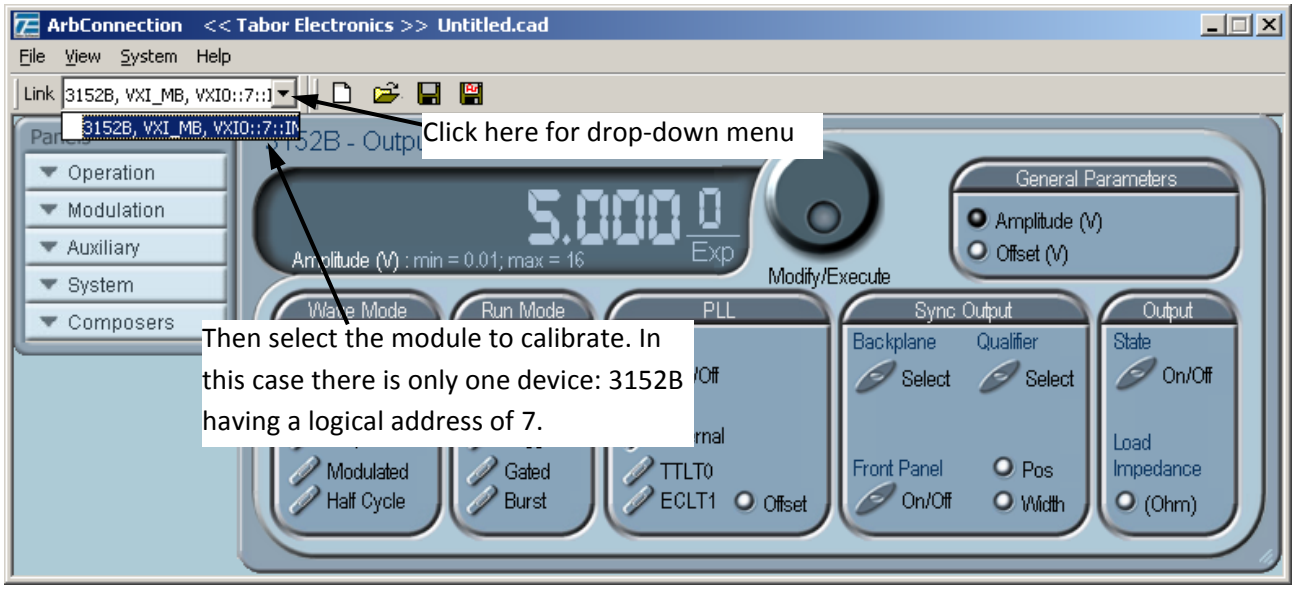


Figure 7-3, Selecting the Instrument to Calibrate

7. In the “Panels” group at the far left, select “System” (Figure 7-4). Then in the drop-down list, select “Calibration.” The Calibration Panel will then open (Figure 7-5).

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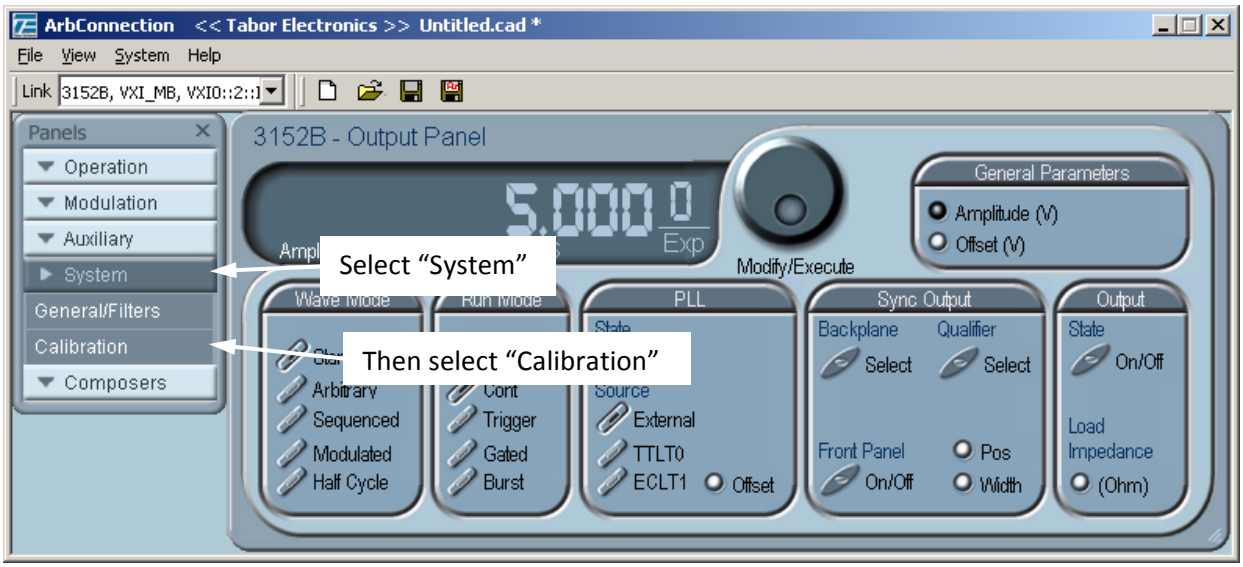


Figure 7-4, Selecting the Calibration Function

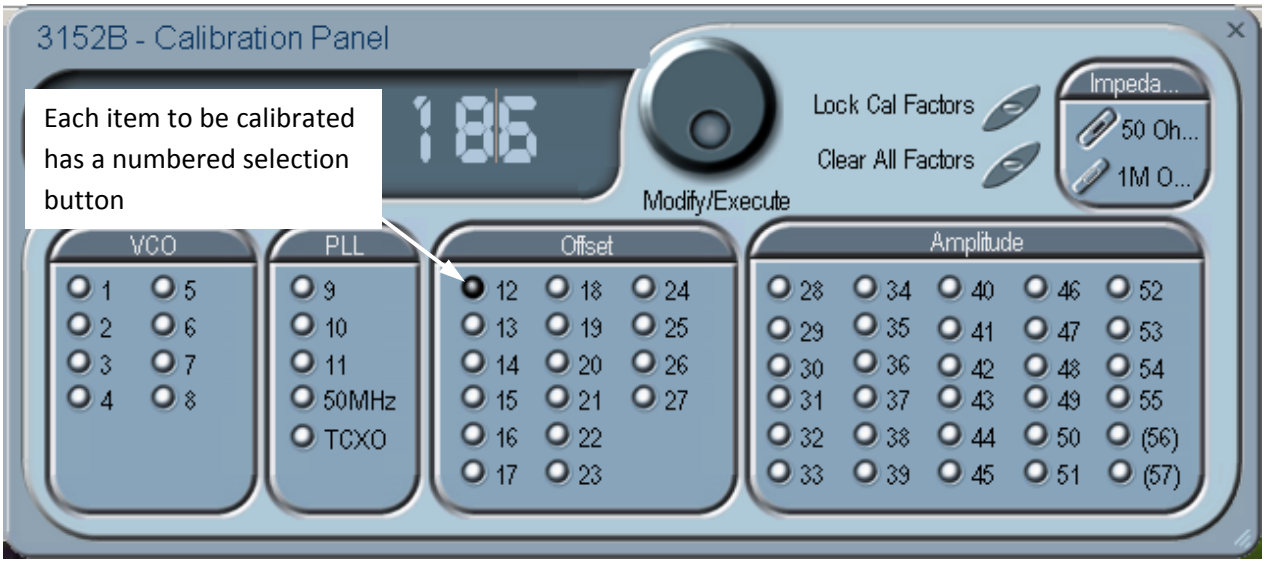


Figure 7-5, Calibration Panel

In the Calibration Panel, each calibration item has a selection button numbered from 1 to 57, except the 50MHz and TCXO adjustments. For Periodic Calibration, only items 12 through 55 should be adjusted.

For each row in Table 7-2, do the following.

8. Verify that the DMM is set to the function indicated in the table.
9. In the Calibration Panel, select the item indicated in Table 7-2.
10. Click the calibration adjustment number (Figure 7-6). Using the right arrow key on the computer keyboard, position the vertical cursor immediately to the left of the right-most digit as shown.

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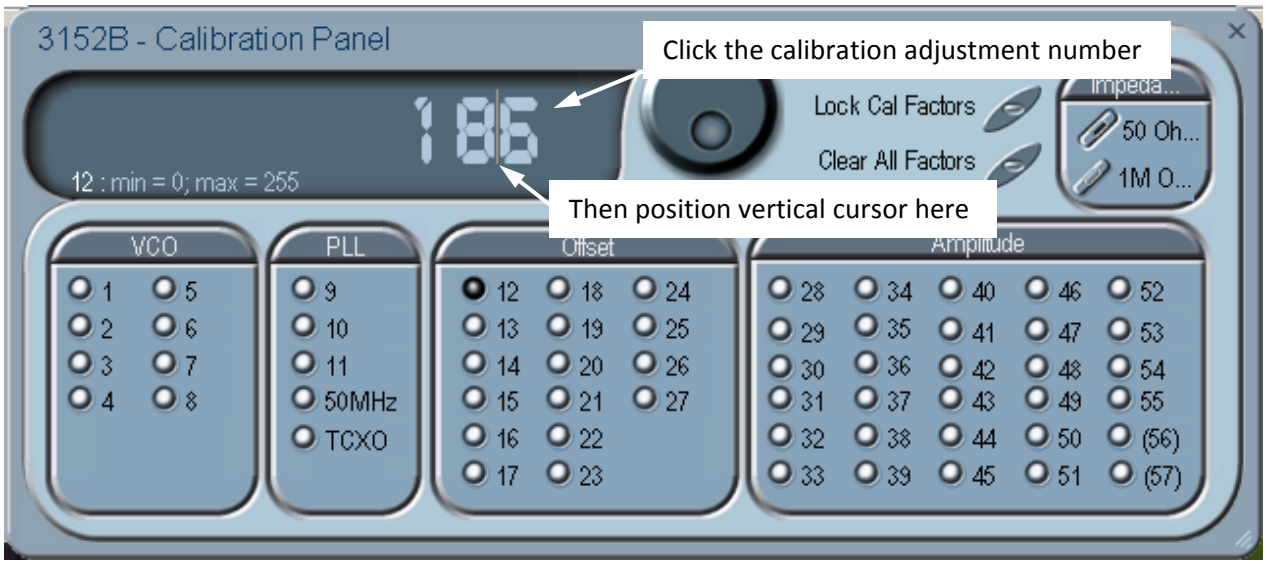


Figure 7-6, Making an Adjustment

11. Use the up-arrow and down-arrow keys on the computer keyboard to adjust the number up or down as required, while observing the reading on the DMM. Adjust the number until the DMM reading is as close as possible to the target value given in Table 7-2.
12. When finished, verify that the DMM reading is within the low and high limits given in Table 7-2. If you are not able to calibrate within the specified range, there is either a problem with the way you are measuring the parameter or a problem with the 3152B. In either case, do not leave any adjustment in its extreme setting but center the adjustment to 128 and contact your nearest service center for clarification and support.
13. Repeat steps 7 through 11 above for each row in Table 7-2.

Table 7-2, Calibration Values, 50Ω Load

Item in Cal Panel	DMM Function	Low Limit (Volts)	Target (Volts)	High Limit (Volts)
12	VDC	-0.020	0.00000	0.020
13	VDC	-0.005	0.00000	0.005
14	VDC	-0.020	0.00000	0.020
15	VDC	-0.005	0.00000	0.005
16	VDC	-0.020	0.00000	0.020
17	VDC	-0.005	0.00000	0.005
18	VDC	0.995	1.00000	1.005
19	VDC	2.985	3.00000	3.015
20	VDC	4.975	5.00000	5.025
21	VDC	6.965	7.00000	7.035
22	VDC	-1.005	-1.00000	-0.995

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Item in Cal Panel	DMM Function	Low Limit (Volts)	Target (Volts)	High Limit (Volts)
23	VDC	-3.015	-3.00000	-2.985
24	VDC	-5.025	-5.00000	-4.975
25	VDC	-7.035	-7.00000	-6.965
26	VDC	0.995	1.00000	1.005
27	VDC	-1.005	-1.00000	-0.995
Change DMM function to AC Volts				
28	VAC	3.50053	3.53553	3.57053
29	VAC	1.74777	1.76777	1.78777
30	VAC	0.35055	0.35355	0.35655
31	VAC	0.17478	0.17678	0.17878
32	VAC	0.03486	0.03536	0.03586
33	VAC	0.01718	0.01768	0.01818
34	VAC	0.35055	0.35355	0.35655
35	VAC	0.17478	0.17678	0.17878
36	VAC	0.03486	0.03536	0.03586
37	VAC	0.01718	0.01768	0.01818
38	VAC	1.05066	1.06066	1.07066
39	VAC	0.17478	0.17678	0.17878
40	VAC	0.03486	0.03536	0.03586
41	VAC	0.01718	0.01768	0.01818
42	VAC	3.50053	3.53553	3.57053
43	VAC	1.74777	1.76777	1.78777
44	VAC	0.35055	0.35355	0.35655
45	VAC	0.17478	0.17678	0.17878
46	VAC	0.03486	0.03536	0.03586
47	VAC	0.01568	0.01768	0.01968
48	VAC	0.35055	0.35355	0.35655
49	VAC	0.17478	0.17678	0.17878
50	VAC	0.03486	0.03536	0.03586
51	VAC	0.01718	0.01768	0.01818
52	VAC	1.05066	1.06066	1.07066
53	VAC	0.17478	0.17678	0.17878
54	VAC	0.03486	0.03536	0.03586
55	VAC	0.01718	0.01768	0.01818

14. Select 1 M impedance mode by using the selection button in the upper right hand corner of the calibration panel (Figure 7-7).

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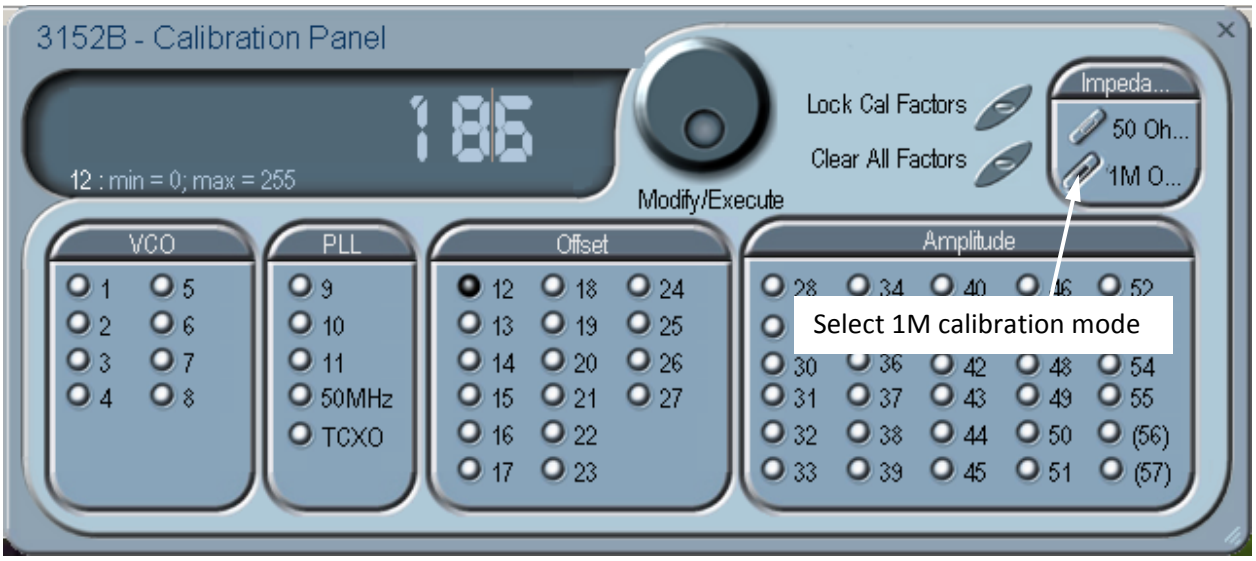


Figure 7-7, Selecting 1M Calibration Mode

15. Disconnect the 50Ω termination load and connect the 3152B output directly to the DMM input.
16. Set the DMM function to DC Volts.
17. In the same manner as described above, adjust each calibration item given in Table 7-3.Disconnect the 50Ω termination load and connect the 3152B output directly to the DMM input.

Table 7-3, Calibration Values, Unloaded (≥1MΩ)

Item in Cal Panel	DMM Function	Low Limit (Volts)	Target (Volts)	High Limit (Volts)
12	VDC	-0.040	0.00000	0.040
13	VDC	-0.010	0.00000	0.010
14	VDC	-0.040	0.00000	0.040
15	VDC	-0.010	0.00000	0.010
16	VDC	-0.040	0.00000	0.040
17	VDC	-0.010	0.00000	0.010
18	VDC	1.990	2.00000	2.010
19	VAC	5.970	6.00000	6.030
20	VAC	9.950	10.00000	10.050
21	VAC	13.930	14.00000	14.070
22	VAC	-2.010	-2.00000	-1.990
23	VAC	-6.030	-6.00000	-5.970
24	VAC	-10.050	-10.00000	-9.950
25	VAC	-14.070	-14.00000	-13.930
26	VAC	1.990	2.00000	2.010

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Item in Cal Panel	DMM Function	Low Limit (Volts)	Target (Volts)	High Limit (Volts)
27	VAC	-2.010	-2.00000	-1.990
Change DMM function to AC Volts				
28	VAC	7.00107	7.07107	7.14107
29	VAC	3.49553	3.53553	3.57553
30	VAC	0.70111	0.70711	0.71311
31	VAC	0.34955	0.35355	0.35755
32	VAC	0.06971	0.07071	0.07171
33	VAC	0.03436	0.03536	0.03636
34	VAC	0.70111	0.70711	0.71311
35	VAC	0.34955	0.35355	0.35755
36	VAC	0.06971	0.07071	0.07171
37	VAC	0.03436	0.03536	0.03636
38	VAC	2.10132	2.12132	2.14132
39	VAC	0.34955	0.35355	0.35755
40	VAC	0.06971	0.07071	0.07171
41	VAC	0.03436	0.03536	0.03636
42	VAC	7.00107	7.07107	7.14107
43	VAC	3.49553	3.53553	3.57553
44	VAC	0.70111	0.70711	0.71311
45	VAC	0.34955	0.35355	0.35755
46	VAC	0.06971	0.07071	0.07171
47	VAC	0.03136	0.03536	0.03936
48	VAC	0.70111	0.70711	0.71311
49	VAC	0.34955	0.35355	0.35755
50	VAC	0.06971	0.07071	0.07171
51	VAC	0.03436	0.03536	0.03636
52	VAC	2.10132	2.12132	2.14132
53	VAC	0.34955	0.35355	0.35755
54	VAC	0.06971	0.07071	0.07171
55	VAC	0.03436	0.03536	0.03636

Note

After making calibration adjustments, it is essential that you lock the calibration factors as described below. This stores the calibration factors in flash memory so that the instrument will retain its calibration when power is turned off.

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Locking the Calibration Factors

After all items have been calibrated, lock the calibration factors as follows.

1. Click the mouse on the “Lock Cal Factors” button in the Calibration Panel (Figure 7-8).

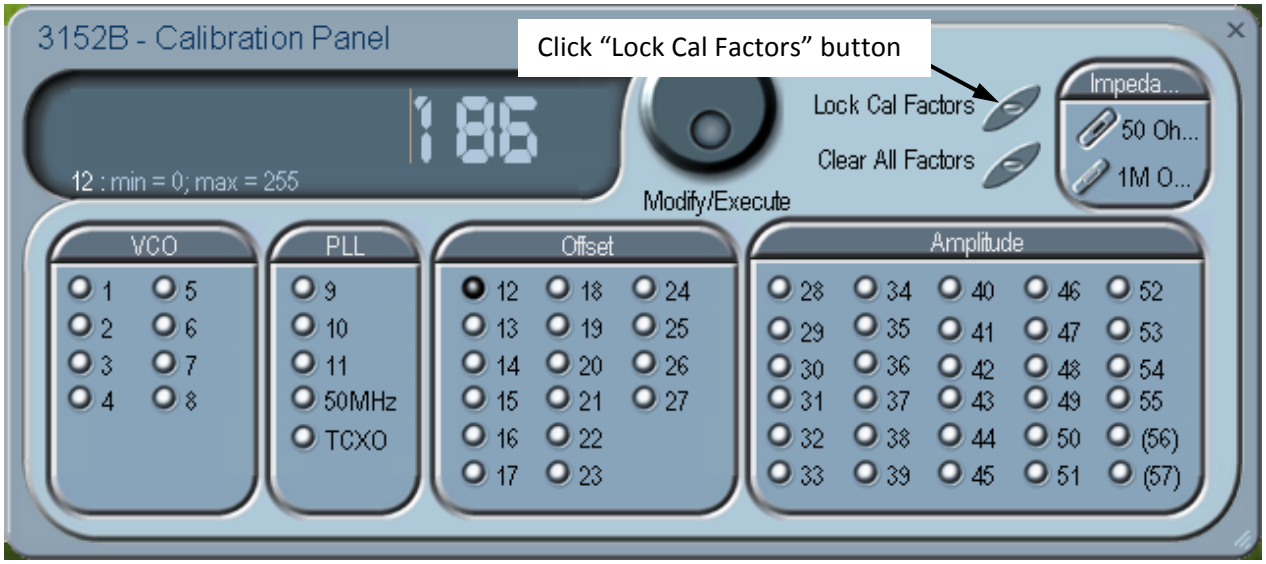


Figure 7-8, Locking the Calibration Factors

2. A pop-up window will appear (Figure 7-9).

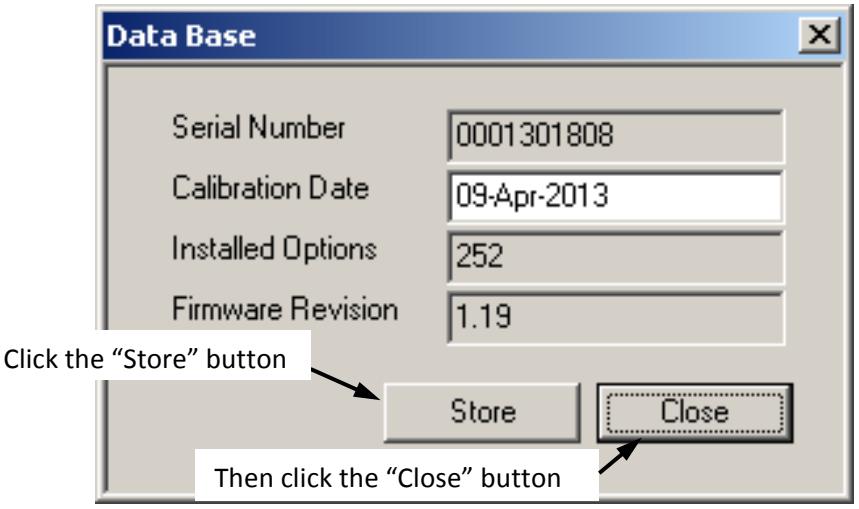


Figure 7-9, Confirmation for Locking Calibration Factors

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3. Click the “Store” button. Since the computer screen gives no visual response to the store operation, you may wish to get a visual indication by observing a brief flash of the front-panel “Access” indicator (Model 3152B) or “Link” indicator (Model 3100) as you click the “Store” button.
4. Click the “Close” button.
5. Exit the ArbConnection software by clicking the “X” in the upper right-hand corner of the main window. This completes the calibration procedure.

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Factory Calibration

Warm-up

Install the 3152B in a VXIbus chassis. Turn on chassis power and allow the 3152B to warm up and stabilize for at least 30 minutes before calibrating. If the instrument has been subjected to temperatures outside the range of 25°C ± 5°C , allow at least one additional hour for the instrument to stabilize before calibrating.

Procedure

Initialization

1. Invoke ArbConnection.
2. Click on the Calibration tab on the Panels bar. The Calibration Panel shown in Figure 7-10 will appear.



Figure 7-10, Calibration Panel

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NOTE

Parameters that are adjusted only during Factory Calibration are enclosed in parentheses. All other parameters are calibrated during Factory Calibration or Periodic Calibration.

In the panel, each parameter to be calibrated is labeled with a number from 1 to 57 except the 50MHz and TCXO adjustments in the PLL group. Adjustments should be carried out exactly in sequential order. The numbers that are associated with each adjustment are identified by a setup number in the title of each of the adjustments in the following procedure.

Adjustment values have a range of 0 through 255, with a center setting of 128. If you are not able to calibrate within the specified range, there is either a problem with the way you are measuring the parameter or a problem with the instrument. In either case, do not leave any adjustment in its extreme setting but center the adjustment and resolve the problem before proceeding with the calibration.

Note that in the following procedures, although configuration of the 3152B is done automatically, configuration details are shown for reference. There is no requirement to change the 3152B configuration during the adjustment procedure except where specifically noted.

Note
After making calibration adjustments, it is essential that you lock the calibration factors as described in the section “Locking the Calibration Factors” at the end of this procedure. This stores the calibration factors in flash memory so that the instrument will retain its calibration after power is turned off.

VCO Adjustments

The VCO controls the accuracy and linearity of the sample clock generator. Correct operation of the VCO circuit ensures the accuracy of the frequency path. Use this procedure if you suspect that there is a frequency linearity and/or accuracy issue.

(Setup 1)

160 MHz SCLK

Equipment: DMM

Preparation:

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1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Configure the 3152B as follows:
   SCLK: 160 MHz
3. Connect the DMM probes between R107 and ground

Adjustment:

1. Adjust CAL:SETUP 50 for a DMM reading of 0 V, ±100 mV

(Setup 2)

180 MHz SCLK

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Configure the 3152B as follows:
   SCLK: 180 MHz
3. Connect the DMM probes between R107 and ground

Adjustment:

1. Adjust CAL:SETUP 51 for a DMM reading of 0 V, ±100 mV

(Setup 3)

200 MHz SCLK

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Configure the 3152B as follows:
   SCLK: 200 MHz
3. Connect the DMM probes between R107 and ground

Adjustment:

1. Adjust CAL:SETUP 52 for a DMM reading of 0 V, ±100 mV

(Setup 4)

220 MHz SCLK

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Configure the 3152B as follows:

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SCLK: 220 MHz

3. Connect the DMM probes between R107 and ground

Adjustment:

1. Adjust CAL:SETUP 53 for a DMM reading of 0 V, ±100 mV

(Setup 5)

240 MHz SCLK

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Configure the 3152B as follows:
   SCLK: 240 MHz
3. Connect the DMM probes between R107 and ground

Adjustment:

1. Adjust CAL:SETUP 54 for a DMM reading of 0 V, ±100 mV

(Setup 6)

260 MHz SCLK

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Configure the 3152B as follows:
   SCLK: 260 MHz
3. Connect the DMM probes between R107 and ground

Adjustment:

1. Adjust CAL:SETUP 55 for a DMM reading of 0 V, ±100 mV

(Setup 7)

277 MHz SCLK

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Configure the 3152B as follows:
   SCLK: 277 MHz
3. Connect the DMM probes between R107 and ground

Adjustment:

1. Adjust CAL:SETUP 56 for a DMM reading of 0 V, ±100 mV

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(Setup 8)

290 MHz SCLK

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   - Function: DCV
   - Range: 1 V
2. Configure the 3152B as follows:
   - SCLK: 290 MHz
3. Connect the DMM probes between R107 and ground

Adjustment:

1. Adjust CAL:SETUP 57 for a DMM reading of 0 V, ±100 mV

PLL Adjustments

The PLL operation is basic to the sample clock generator. Correct operation of the PLL circuit ensures the accuracy of the frequency path as well as the accuracy of the PLL phase. Use this procedure if you suspect that there is a frequency and/or PLL accuracy issue.

(Setup 9)

PLL Preparation

Equipment: No equipment required for this step.

Preparation:

1. Configure the 3152B as follows:
   - Function Mode: Arbitrary
   - Wavelength: 1000 points
   - Waveform: Square
   - Run Mode: PLL
2. Set CAL:SETUP 61
3. Set CAL:VAL 120
4. Set CAL:SETUP 63

Adjustment: None required. This step is part of the preparation for Setup 10 below.

(Setup 10)

Phase “0”

Equipment: Digital Oscilloscope, Function Generator, BNC "T" Connector (one male to two females), BNC to BNC coaxial cable

Preparation:

1. Prepare the external function generator waveform as follows:
   - Amplitude: 5 Vp-p
   - Waveform: Square
   - Frequency: 10 kHz

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2. Set the oscilloscope channel impedance as follows:
   Channel 1: 1 MΩ
   Channel 2: 50 Ω
3. Connect a BNC "T" connector to oscilloscope channel 1.
4. Connect one end of the "T" connector to the function generator output.
5. Connect the other end of the "T" connector to the TRG/PLL input of the 3152B.
6. Connect the 3152B output to oscilloscope channel 2.
7. Configure the 3152B as follows:

Function Mode:	Arbitrary
Wavelength:	1000 points
Waveform:	Square
Run Mode:	PLL

Adjustment:

1. Adjust CAL:SETUP 62 for counter reading of -250 ns to 250 ns.

(Setup 11)

Phase Fine "0"

Equipment: Counter, Function Generator, "T" Connector, BNC to BNC cables

Preparation:

1. Prepare the external function generator waveform as follows:

Amplitude:	5 Vp-p
Waveform:	Square
Frequency:	10 kHz

2. Configure the counter as follows:
   Channel 1 input impedance: High
   Channel 2 input impedance: 50 Ω
   Function: TI A -> B
3. Connect a BNC "T" connector to counter channel A
4. Connect one end of the "T" connector to the function generator output.
5. Connect the other end of the "T" connector to the TRG/PLL input of the 3152B, using a 50 Ω terminator at the 3152B connector.
6. Connect the 3152B output to counter input B.
7. Configure the 3152B as follows:

Function Mode:	Arbitrary
Wavelength:	1000 points
Waveform:	Square
Run Mode:	PLL
Fine Phase Offset:	+30°

Adjustment:

1. Adjust CAL:SETUP 61 for a counter reading of 8.28 μs to 8.38 μs.
2. Repeat Setup 10 and Setup 11 until the errors have

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been minimized.

Oscillator Adjustments

Use this procedure to adjust the reference oscillator and gated oscillator. These oscillators determine the accuracy of the output frequency and timing functions so, if you suspect that there is an accuracy issue, proceed with the calibration of the oscillators. Note that (Setup 50 MHz) is marked as a factory adjustment and, therefore, it is not normally required during normal calibration cycles except when the gated oscillator accuracy does not meet the published specification limit or after a repair has been executed on this circuit.

(Setup 50MHz)

50 MHz Gated Oscillator Adjustment

Equipment: Counter, Function Generator, BNC to BNC cables
Preparation:

1. Configure the counter as follows:
   - Termination: 50 Ω DC
   - Function: TI A -> B
   - Slope B: Negative
2. Connect the 3152B output to the oscilloscope input
3. Connect an external function generator to the front panel TRG/PLL connector
4. Using ArbConnection, prepare and download the following waveform:
   - Wavelength: 100 points
   - Waveform: Pulse: Delay = 0.01 %, Rise/Fall Time = 0 %, High Time = 99.99 %
5. Configure the 3152B as follows:
   - Function Mode: Arbitrary
   - Run Mode: Triggered
   - Retrigger Mode: On
   - Retrigger Delay: 20 μs
6. Using an external function generator, manually trigger the 3152B

Adjustment:

1. Set CAL:SETUP 0
2. Adjust C10 for a period of 20 μs ±5%

(Setup TCXO)

10 MHz TCXO Frequency

Equipment: Counter, BNC to BNC cables
Preparation:

1. Configure the counter as follows:
   - Function: Freq A
   - Termination: 50 Ω
2. Connect the 3152B output to counter channel A.
3. Configure the 3152B as follows:
   - Frequency: 10 MHz
   - Ref Source: Internal
   - Output: On

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Amplitude 2 V
Wave: Square

Adjustment:

1. Adjust CAL:SETUP 1 for a counter reading of 10 MHz ± 2 Hz

Base Line Offset Adjustments

The base line offset adjustments assure that the AC signal is symmetrical around the 0V line. Use this procedure if you suspect that there is a base line accuracy issue.

Starting with 3152B firmware revision 1.18, a 1 Meg calibration table is available for calibration. This calibration omits the 50 Ω feedthrough termination and thus requires adjustment to twice the setup voltage as for the normal 50 Ω calibration. It is recommended that the 50 Ω calibration is done first. Next, select 1 Meg impedance mode by using the selection button in the upper right hand corner of the calibration panel (see Figure 7-11).

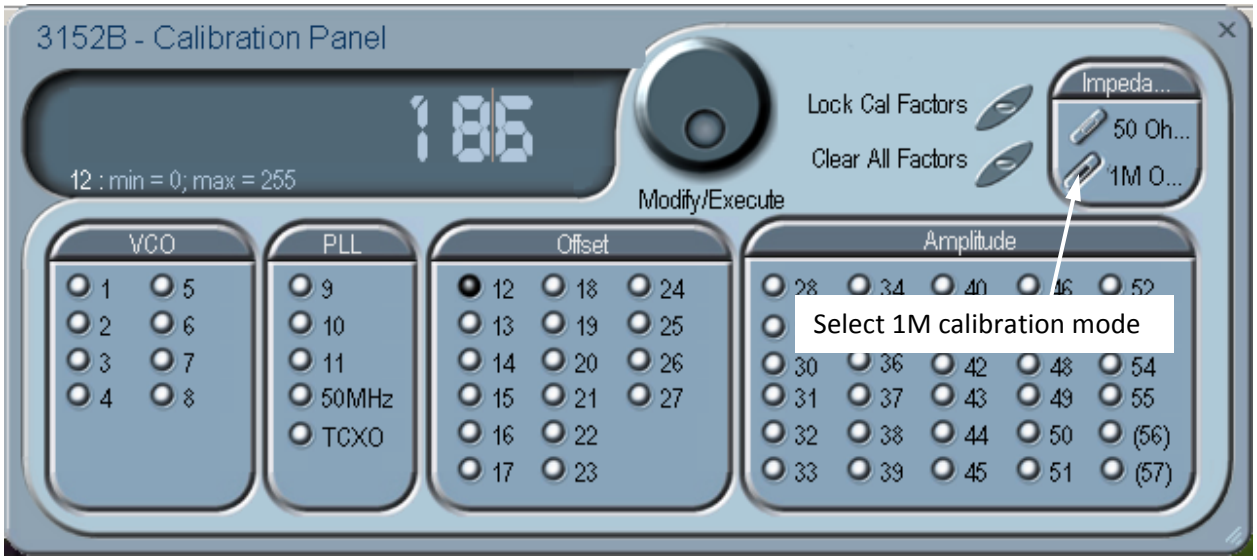


Figure 7-11, Selecting 1M Calibration Mode

Setup 12

Amplifier Offset, Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough

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termination (omit termination for 1 Meg calibration).

3. Configure the 3152B as follows:

Function	Standard
Waveform	Sine
Amplitude	0 V
Frequency	1 MHz

Adjustment:

50 Ω Mode**:** Adjust CAL:SETUP 2 for a DMM reading of 0 V ±20 mV

1 Meg Mode**:** Adjust CAL:SETUP 2 for a DMM reading of 0 V ±40 mV

Setup 13

Pre-Amplifier Offset, Amplifier Out

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:

Function:	DCV
Range:	100 mV

2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:

Function	Standard
Waveform	Sine
Amplitude	0 V
Frequency	1 MHz

Adjustment:

50 Ω Mode**:** Adjust CAL:SETUP 3 for a DMM reading of 0 V ± 5 mV
1 Meg Mode**:** Adjust CAL:SETUP 3 for a DMM reading of 0 V ± 10 mV

Setup 14

Base Line Offset, Amplifier In – Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:

Function:	DCV
Range:	100 mV

2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:

Mode:	Modulation
Output:	On
Amplitude:	6 V

Adjustment:

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50 Ω Mode**:** Adjust CAL:SETUP 4 for a DMM reading of 0 V ± 20 mV.
1 Meg Mode**:** Adjust CAL:SETUP 4 for a DMM reading of 0 V ± 40 mV.

Setup 15

Base Line Offset, Amplifier Out – Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Mode: Modulation
   Output: On
   Amplitude: 1 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 5 for a DMM reading of 0 V ± 5 mV
1 Meg Mode**:** Adjust CAL:SETUP 5 for a DMM reading of 0 V ± 10 mV

Setup 16

Base Line Offset, Amplifier In – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Output: On
   Amplitude: 6 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 6 for a DMM reading of 0 V ± 20 mV
1 Meg Mode**:** Adjust CAL:SETUP 6 for a DMM reading of 0 V ± 40 mV

Setup 17

Base Line Offset, Amplifier Out - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

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Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Output: On
   Amplitude: 1 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 7 for a DMM reading of 0 V ± 5 mV
1 Meg Mode**:** Adjust CAL:SETUP 7 for a DMM reading of 0 V ± 10 mV

Offset Adjustments

The offset adjustments ensure that the DC offsets are within the specified range. Use this procedure if you suspect that offset accuracy is an issue.

Starting with 3152B firmware revision 1.18, a 1 Meg calibration table is available for calibration. This calibration omits the 50 Ω feedthrough termination and thus requires adjustment to twice the setup voltage as for the normal 50 Ω calibration. It is recommended that the 50 Ω calibration is done first. Next, select 1 Meg calibration by using the selection button in the upper right hand corner of the calibration panel (see Figure 7-11).

Setup 18 + 1 V Offset Output, Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Amplitude: 20 mV
   Offset +1 V
   Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 46 for a DMM reading of +1 V ± 5 mV
1 Meg Mode**:** CAL:SETUP 46 for a DMM reading of +2 V ± 10 mV

Setup 19 +3 V Offset Output, Amplifier In

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Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Amplitude: 20 mV
   Offset +3 V
   Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 47 for a DMM reading of +3 V ± 15 mV
1 Meg Mode**:** CAL:SETUP 47 for a DMM reading of +6 V ± 30 mV

Setup 20

+5 V Offset Output, Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Amplitude: 20 mV
   Offset +5 V
   Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 48 for a DMM reading of +5 V ± 25 mV
1 Meg Mode**:** CAL:SETUP 48 for a DMM reading of +10 V ± 50 mV

Setup 21

+7 V Offset Output, Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:

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Amplitude: 20 mV
Offset +7 V
Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 49 for a DMM reading of +7 V ± 35 mV
1 Meg Mode**:** CAL:SETUP 49 for a DMM reading of +14 V ± 70 mV

Setup 22

-1 V Offset Output, Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Amplitude: 20 mV
   Offset -1 V
   Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 45 for a DMM reading of -1 V ± 5 mV
1 Meg Mode**:** CAL:SETUP 45 for a DMM reading of -2 V ± 10 mV

Setup 23

-3 V Offset Output, Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Amplitude: 20 mV
   Offset -3 V
   Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 44 for a DMM reading of -3 V ± 15 mV
1 Meg Mode**:** CAL:SETUP 44 for a DMM reading of -6 V ± 30 mV

Setup 24

-5 V Offset Output, Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination

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(for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Amplitude: 20 mV
   Offset -5 V
   Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 43 for a DMM reading of -5 V ± 25 mV
1 Meg Mode**:** CAL:SETUP 43 for a DMM reading of -10 V ± 50 mV

Setup 25

-7 V Offset Output, Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

4. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
5. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
6. Configure the 3152B as follows:
   Amplitude: 20 mV
   Offset -7 V
   Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 42 for a DMM reading of -7 V ± 35 mV
1 Meg Mode**:** CAL:SETUP 42 for a DMM reading of -14 V ± 70 mV

Setup 26

+1 V Offset, Output Amplifier Out

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Amplitude: 20 mV

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Offset +1 V
Output: On

Adjustment:
50 Ω Mode**:** CAL:SETUP 10 for a DMM reading of +1 V ±5 mV; Note and record the DMM reading.
1 Meg Mode**:** CAL:SETUP 10 for a DMM reading of +2 V ±10 mV; Note and record the DMM reading.

Setup 27

-1 V Offset, Output Amplifier Out

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Amplitude: 20 mV
   Offset -1 V
   Output: On

Adjustment:

1. 50 Ω Mode**:** CAL:SETUP 11 for a DMM reading of -1 V ±5 mV; note reading.
2. 1 Meg Mode**:** CAL:SETUP 11 for a DMM reading of -2 V ±10 mV; note reading.
3. Repeat Setup 26 and Setup 27 until errors are balanced between the steps.

Amplitude Adjustments

The amplitude adjustments ensure that the AC levels are within the specified range. Use this procedure if you suspect that amplitude accuracy is an issue.

Starting with 3152B firmware revision 1.18, a 1 Meg calibration table is available for calibration. This calibration omits the 50 Ω feedthrough termination and thus requires adjustment to twice the setup voltage as for the normal 50 Ω calibration. It is recommended that the 50 Ω calibration is done first. Next, select 1 Meg calibration by using the selection button in the upper right hand corner of the calibration panel (see Figure 7-11).

Setup 28

10 V Amplitude, Amplifier In - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual

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banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 10 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 12 for a DMM reading of 3.5355 V ±35 mV
1 Meg Mode**:** Adjust CAL:SETUP 12 for a DMM reading of 7.0711 V ±70 mV

Setup 29

5 V Amplitude, Amplifier In - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 5 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 13 for a DMM reading of 1.7678 V ±20 mV
1 Meg Mode**:** Adjust CAL:SETUP 13 for a DMM reading of 3.5355 V ±40 mV

Setup 30

1 V Amplitude, Amplifier In - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V

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2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 1 V
   Offset: 1 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 14 for a DMM reading of 353.55 mV ±3 mV
1 Meg Mode**:** Adjust CAL:SETUP 14 for a DMM reading of 707.11 mV ±6 mV

Setup 31

500 mV Amplitude, Amplifier In – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
1. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
2. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 500 mV
   Offset: 1 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 15 for a DMM reading of 176.78 mV ±2 mV
1 Meg Mode**:** Adjust CAL:SETUP 15 for a DMM reading of 353.55 mV ±4 mV

Setup 32

100 mV Amplitude, Amplifier In - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:

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Frequency: 1 kHz
Output: On
Amplitude: 100 mV
Offset: 1 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 16 for a DMM reading of 35.355 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 16 for a DMM reading of 70.711 mV ±1 mV

Setup 33

50 mV Amplitude, Amplifier In – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 50 mV
   Offset: 1 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 17 for a DMM reading of 17.678 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 17 for a DMM reading of 35.355 mV ±1 mV

Setup 34

1 V Amplitude, Amplifier Out - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 1 V

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Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 18 for a DMM reading of 353.55 mV ± 3 mV
1 Meg Mode**:** Adjust CAL:SETUP 18 for a DMM reading of 707.11 mV ± 6 mV

Setup 35

500 mV Amplitude, Amplifier Out – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 500 mV
   Offset: 250 mV

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 19 for a DMM reading of 176.78 mV ±2 mV
1 MegMode**:** Adjust CAL:SETUP 19 for a DMM reading of 353.55 mV ±4 mV

Setup 36

100 mV Amplitude, Amplifier Out - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 100 mV
   Offset: 250 mV

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 20 for a DMM reading of 35.355 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 20 for a DMM reading of 70.711 mV

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±1 mV

Setup 37

50 mV Amplitude, Amplifier Out – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 50 mV
   Offset: 250 mV

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 21 for a DMM reading of 17.678 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 21 for a DMM reading of 35.355 mV ±1 mV

Setup 38

3 V Amplitude, Post Attenuators - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 3 V

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 22 for a DMM reading of 1.0607 V ±10 mV
1 Meg Mode**:** Adjust CAL:SETUP 22 for a DMM reading of 2.1213 V ±20 mV

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Setup 39

500 mV Amplitude, Post Attenuators – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 500 mV

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 23 for a DMM reading of 176.78 mV ±2 mV
1 Meg Mode**:** Adjust CAL:SETUP 23 for a DMM reading of 353.55 mV ±4 mV

Setup 40

100 mV Amplitude, Post Attenuators - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 100 mV

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 24 for a DMM reading of 35.355 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 24 for a DMM reading of 70.711 mV ±1 mV

Setup 41

50 mV Amplitude, Post Attenuators – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

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Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 50 mV

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 25 for a DMM reading of 17.678 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 25 for a DMM reading of 35.355 mV ±1 mV

Amplitude Adjustments (Modulation)

The amplitude adjustments (modulation) ensure that AC levels are within the specified range. Use this procedure if you suspect that the amplitude accuracy is an issue for the CW modes.

Setup 42

10 V Amplitude, Amplifier In - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 10 V
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 26 for a DMM reading of 3.5355 V ±35 mV
1 Meg Mode**:** Adjust CAL:SETUP 26 for a DMM reading of 7.0711 V ±70 mV

Setup 43

5 V Amplitude, Amplifier In - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination

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(for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 5 V
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 27 for a DMM reading of 1.7678 V ±20 mV
1 Meg Mode**:** Adjust CAL:SETUP 27 for a DMM reading of 3.5355 V ±40 mV

Setup 44

1 V Amplitude, Amplifier In - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 1 V
   Offset: 1 V
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 28 for a DMM reading of 353.55 mV ±3 mV
1 Meg Mode**:** Adjust CAL:SETUP 28 for a DMM reading of 707.11 mV ±6 mV

Setup 45

500 mV Amplitude, Amplifier In - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

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1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 500 mV
   Offset: 1 V
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 29 for a DMM reading of 176.78 mV ±2 mV
1 Meg Mode**:** Adjust CAL:SETUP 29 for a DMM reading of 353.55 mV ±4 mV

Setup 46

100 mV Amplitude, Amplifier In - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 100 mV
   Offset: 1 V
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP30 for a DMM reading of 35.355 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP30 for a DMM reading of 70.711 mV ±1 mV

Setup 47

50 mV Amplitude, Amplifier In - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the

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3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).

3. Configure the 3152B as follows:
   - Frequency: 1 kHz
   - Output: On
   - Amplitude: 50 mV
   - Offset: 1 V
   - Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 31 for a DMM reading of 17.678 mV ±2 mV
1 Meg Mode**:** Adjust CAL:SETUP 31 for a DMM reading of 35.355 mV ±4 mV

Setup 48

1 V Amplitude, Amplifier Out - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   - Function: ACV
   - Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   - Frequency: 1 kHz
   - Output: On
   - Amplitude: 1 V
   - Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 32 for a DMM reading of 353.55 mV ±3 mV
1 Meg Mode**:** Adjust CAL:SETUP 32 for a DMM reading of 707.11 mV ±6 mV

Setup 49

500 mV Amplitude, Amplifier Out - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   - Function: ACV
   - Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   - Frequency: 1 kHz

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Output:	On
Amplitude:	500 mV
Offset:	250 mV
Mode:	Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 33 for a DMM reading of 176.78 mV ±2 mV
1 Meg Mode**:** Adjust CAL:SETUP 33 for a DMM reading of 353.55 mV ±4 mV

Setup 50

100 mV Amplitude, Amplifier Out - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:

Function:	ACV
Range:	100 mV

2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:

Frequency:	1 kHz
Output:	On
Amplitude:	100 mV
Offset:	250 mV
Mode:	Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 34 for a DMM reading of 35.355 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 34 for a DMM reading of 70.711 mV ±1 mV

Setup 51

50 mV Amplitude, Amplifier Out - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:

Function:	ACV
Range:	100 mV

2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:

Frequency:	1 kHz
Output:	On
Amplitude:	50 mV
Offset:	250 mV

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Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 35 for a DMM reading of 17.678 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 35 for a DMM reading of 35.355 mV ±1 mV

Setup 52

3 V Amplitude, Post Attenuators - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: ACV
   Range: 10 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 3 V
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 36 for a DMM reading of 1.06066 V ±10 mV
1 Meg Mode**:** Adjust CAL:SETUP 36 for a DMM reading of 2.12132 V ±20 mV

Setup 53

500 mV Amplitude, Post Attenuators - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 500 mV
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 37 for a DMM reading of 176.78 mV ±2 mV
1 Meg Mode**:** Adjust CAL:SETUP 37 for a DMM reading of 353.55 mV

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±4 mV

Setup 54

100 mV Amplitude, Post Attenuators - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 100 mV
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 38 for a DMM reading of 35.355 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 38 for a DMM reading of 70.711 mV ±1 mV

Setup 55

50 mV Amplitude, Post Attenuators - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω feedthrough termination (for the 50 Ω calibration; omit this during the 1 Meg portion), Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 100 mV
2. Connect the 3152B output to the DMM input. Terminate the 3152B output at the DMM input with the 50 Ω feedthrough termination (omit termination for 1 Meg calibration).
3. Configure the 3152B as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 50 mV
   Mode: Modulation

Adjustment:
50 Ω Mode**:** Adjust CAL:SETUP 39 for a DMM reading of 17.678 mV ±0.5 mV
1 Meg Mode**:** Adjust CAL:SETUP 39 for a DMM reading of 35.355 mV ±1 mV

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Pulse Response Adjustments

The pulse response adjustments ensure that rise and fall times as well as aberrations are within the specified range. Use this procedure if you suspect that the pulse response is an issue. Note that setups 56 and 57 are marked as a factory adjustment and therefore, they are normally not required during normal calibration cycles unless the pulse response of the output stage has drifted and does not meet the published specification limits or after a repair has been executed on this circuit.

(Setup 56)

Pulse Response, Amplifier Out

Equipment: Oscilloscope, BNC to BNC cable, 20 dB feedthrough attenuator

Preparation:

1. Configure the 3152B as follows:
   Function: Square
   Amplitude: 1 V
2. Connect the 3152B output to the oscilloscope input. Set oscilloscope input impedance to 50 Ω.
3. Set oscilloscope vertical sensitivity to 20 mV
4. Set CAL:SETUP40

Adjustment:

1. Adjust the vertical trace to 6 divisions
2. Adjust RV1 for best pulse response (4 ns typ., 5 % aberrations)

(Setup 57)

Pulse Response, Amplifier In

Equipment: Oscilloscope, BNC to BNC cable, 20 dB feedthrough attenuator

Preparation:

1. Configure the 3152B as follows:
   Function: Square
   Amplitude: 6 V
2. Connect the 3152B output to the oscilloscope input. Use 20 dB feedthrough attenuator at the oscilloscope input.
3. Set oscilloscope input impedance to 50 Ω
4. Set oscilloscope vertical sensitivity to 0.1 V
5. Set CAL:SETUP41

Adjustment:

1. Adjust vertical trace to 6 divisions
2. Adjust C25 for best pulse response (4 ns typ., 5 % aberrations)

Locking the Calibration Factors

After all items have been calibrated, lock the calibration factors as follows.

1. Click the mouse on the “Lock Cal Factors” button in the Calibration Panel (Figure 7-12).

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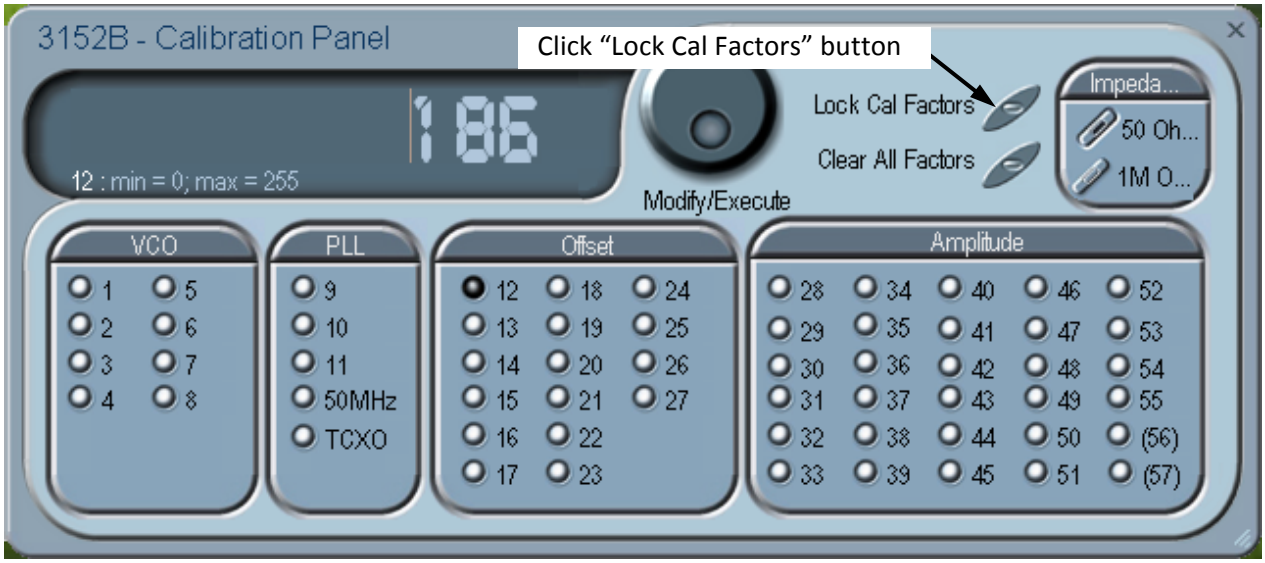


Figure 7-12, Locking the Calibration Factors

2. A pop-up window will appear (Figure 7-13).

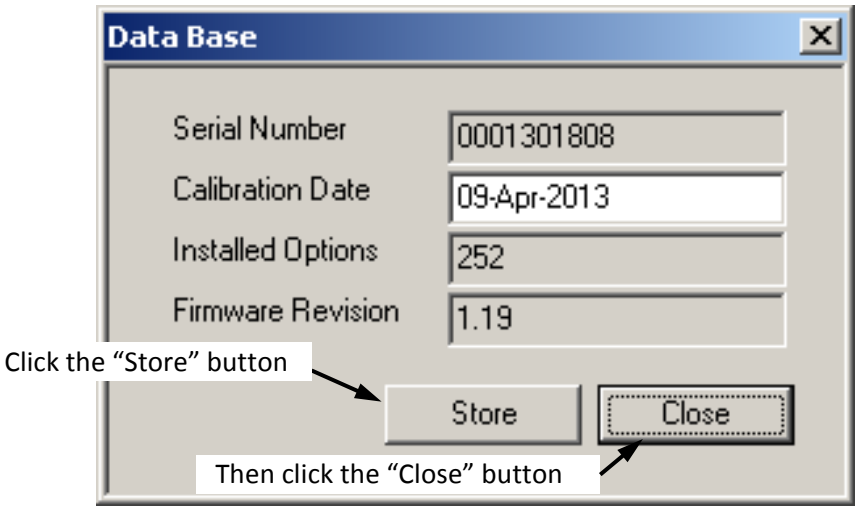


Figure 7-13, Confirmation for Locking Calibration Factors

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3. Click the “Store” button. Since the computer screen gives no visual response to the store operation, you may wish to get a visual indication by observing a brief flash of the front-panel “Access” indicator (Model 3152B) or “Link” indicator (Model 3100) as you click the “Store” button.
4. Click the “Close” button.
5. Exit the ArbConnection software by clicking the “X” in the upper right-hand corner of the main window. This completes the calibration procedure.

Calibrating the 3201A/3202A

Calibration of the 3201A/3202A consists of adjusting the flatness of the square waveform shape for the best combination of high frequency response and minimum overshoot/undershoot. These adjustments are required only during initial factory calibration or after repairs have been made to the related circuitry.

Channel 1 – Low-Frequency Response

Equipment: Oscilloscope, waveform generator, x10 attenuator

Preparation:

1. Configure the waveform generator as follows:
   Frequency: 1kHz
   Waveform: Square wave
   Amplitude: 1.6V
2. Connect the waveform generator channel 1 output to the 3202A, channel 1, input A.
3. Connect the 3202A channel 1 output through the x10 attenuator to the oscilloscope.
4. Set oscilloscope to DC coupling and 50Ω termination.

Adjustment:

1. Adjust RV2 for best combination of flatness and rise time of the square waveform shape.

Channel 2 – Low-Frequency Response (3202A Only)

Equipment: Oscilloscope, waveform generator, x10 attenuator

Preparation:

1. Configure the waveform generator as follows:
   Frequency: 1kHz
   Waveform: Square wave
   Amplitude: 1.6V
2. Connect the waveform generator channel 1 output to the 3202A, channel 2, input A.
3. Connect the 3202A channel 1 output through the x10 attenuator to the oscilloscope.
4. Set oscilloscope to DC coupling and 50Ω termination.

Adjustment:

1. Adjust RV5 for best combination of flatness and rise time of the square waveform shape.

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Channel 1 – High-Frequency Response

Equipment: Oscilloscope, waveform generator, x10 attenuator

Preparation:

1. Configure the waveform generator as follows:
   Frequency: 1MHz
   Waveform: Square wave
   Amplitude: 1.6V
2. Connect the waveform generator channel 1 output to the 3202A, channel 1, input A.
3. Connect the 3202A channel 1 output through the x10 attenuator to the oscilloscope.
4. Set oscilloscope to DC coupling and 50Ω termination.

Adjustment:

1. Adjust RV1, RV3 and C10 for transition time between 18ns and 22ns and lowest aberration.

Channel 2 – High-Frequency Response (3202A Only)

Equipment: Oscilloscope, waveform generator, x10 attenuator

Preparation:

1. Configure the waveform generator as follows:
   Frequency: 1MHz
   Waveform: Square wave
   Amplitude: 1.6V
2. Connect the waveform generator channel 1 output to the 3202A, channel 2, input A.
3. Connect the 3202A channel 1 output through the x10 attenuator to the oscilloscope.
4. Set oscilloscope to DC coupling and 50Ω termination.

Adjustment:

1. Adjust RV4, RV6 and C27 for transition time between 18ns and 22ns and lowest aberration.

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Updating the Firmware

WARNING

Only qualified persons may perform firmware updates. DO NOT attempt to perform this operation unless you are trained, as you may otherwise render the instrument inoperable. Always verify with customer service that you have the latest firmware file before starting an update.

As explained in Chapter 1, the waveform generator comes in three different versions: Model 3152B, model 3100M-3152B, and Model 3100R-3152B, where the first two versions are message-based and the last is registered-based. Upgrading the 3100R-3152B firmware is easier because a file is being replaced. On the other hand, the message-based products use flash memory to store the program and therefore, the upgrade is a bit more complicated. Information on how to detect the firmware version and how to upgrade firmware is given in the following.

Updating Registered-based Firmware

Before you update the firmware of your registered-based instrument (Model 3100R-3152B), first check the revision level of the programming file on your computer. Each firmware update was done for a reason and therefore, if you want to update the firmware for a problem in your system, check the readme file that is associated with the update to see if an update will solve your problem. There are a number of ways to check the revision level of your firmware:

1) Using Windows Explorer, open the C:\WINDOWS\SYSTEM32 folder in the Windows directory and locate the file RI3152B.dll. Right click with your mouse on the file name and select properties. Click on the Version tab and note the Product Version information as listed in this tab.

2) Using a SCPI command from an external utility, you can read the firmware version by sending the following query:

`SYST:INFO:FIRM:VERS?`

The response is a string showing the firmware version, e.g., 1.18.

3) Using ArbConnection, select the General/Filters panel from the System tab and click on the Firmware Version button. The General/Filters panel with the firmware revision indication is shown in Figure 7-13.

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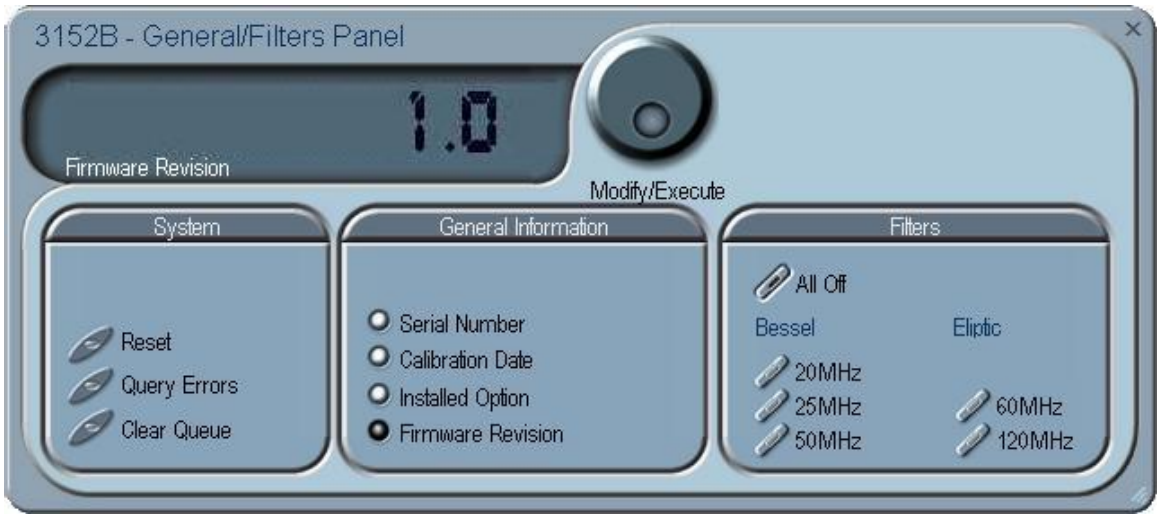


Figure 7-14, Firmware Revision Screen

Before updating the firmware, check with the factory to determine whether the new firmware supports the hardware revision you currently have.

To update the 3152B firmware, simply install the latest version of the VXI Plug&Play driver or the latest version of ArbConnection, or just replace the RI3152B.dll in the C:\WINDOWS\SYSTEM32 folder with a newer version.

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Updating Message-based Firmware

Before you attempt to update the firmware of your message-based instrument (Models 3152B and 3100M-3152B), first check the revision level of the product. Each firmware update was done for a reason and therefore, if you want to update the firmware to address a specific problem in your system, check the readme file that is associated with the update to see if an update will solve your problem. There are a number of ways to check the revision level of your firmware:

1. Use a SCPI command from an external utility. You can read the firmware version by sending the following query:

   `SYST:INFO:FIRM:VERS?`

   The response is a string showing the firmware version, e.g., 1.18.

2. Using ArbConnection, select the General/Filters panel from the System tab and click on the Firmware Version button. The General/Filters panel with the firmware revision indication is shown in Figure 7-3.

The computer that will be used for performing the update must have the 3152B Plug&Play driver installed. If it does not, then you may download the current version from the Astronics Test Systems web site (search for 3152B plug&play).

Use the following procedure to upgrade the firmware once you determine that a firmware upgrade will improve the performance of your instrument.

1. Install the 3152B in a VXIbus chassis and apply power to the chassis.

2. Run the VXI resource manager (Resman.exe).

3. Copy the new 3152B object file to a folder on the hard disk. The object file has a filename containing the model number and version number. For example, the file "ri3100-v1.27.bin" is for Model 3100 (covering Models 3100M, 3100R, 3152A, and 3152B) and is version 1.27.

4. Launch "updater.exe". To locate it, navigate to the installation path of the 3152B Plug&Play driver. The path is typically:

   C:\Program Files\IVI Foundation\VISA\WinNT\ri3152Bb

   In this folder is the "firmware updater" folder, containing the file "updater.exe". Double-click "updater.exe" to launch the updater.

5. The updater window will appear as shown in Figure 7-13. In the

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Resource Name pull-down menu, select the logical address of the module to be updated. In the example shown in Figure 7-14, the item "VXIO::2::INSTR" refers to logical address 2.

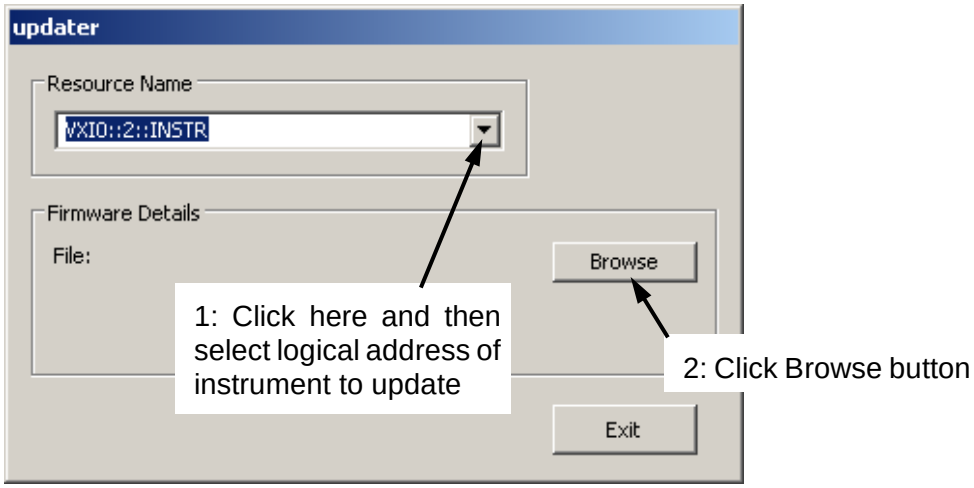


Figure 7-15, Updater Window

6. Click the Browse button. A file selection window will open.

7. Navigate to the folder where you placed the 3152B object file in step 3. Select the file (for example "ri3100 v1.27.bin") and then click Open.

8. The updater window will then include the Update button as shown in Figure 7-15.

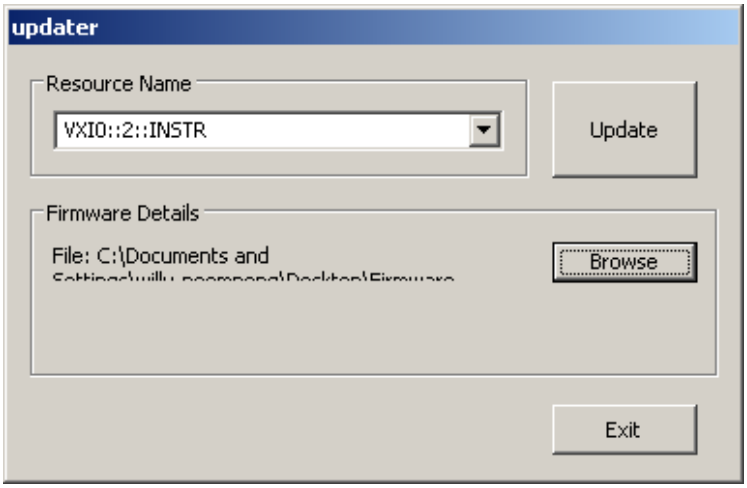


Figure 7-16, Updater Window with Update Button

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CAUTION
Before clicking on the Update button in the next step below, be ready to observe the Fail LED on the 3152B, and follow the instructions carefully.

9. Click the Update button and then immediately watch the Fail LED on the 3152B front panel. Wait for the LED to come on before proceeding. This will typically take between 5 and 20 seconds. If the Fail LED does not come on within two minutes, turn off power to the VXIbus chassis and contact the factory for further instructions.

10. After the Fail LED comes on, wait until it turns off or until at least one minute elapses.

11. By this time, a download success message will have appeared (Figure 7-16). Click the OK button. Then click the Exit button in the updater window.

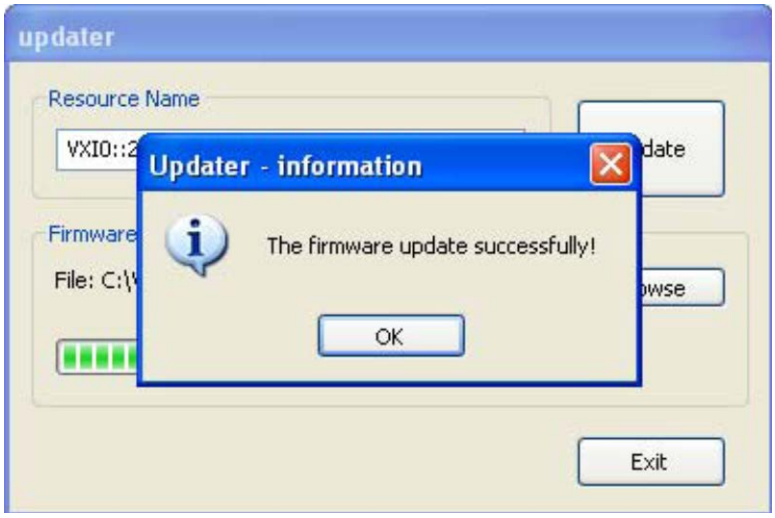


Figure 7-17, Successful Firmware Update

12. Turn off power to the VXI chassis. Wait at least two seconds, and then turn it back on.

13. Run the Resource Manager (Resman).

14. Send a *IDN? command to the 3152B. The response will be a text string stating the model number and firmware version, as in this example:

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```
Racal Instruments,3152B,0,1.27\r\n
```

In this example, the firmware version is 1.27.

15. Verify that the firmware version is the one you loaded.

The updated instrument is ready to use.

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Appendix A
3152B Specifications

Outputs

Main Output

Channels	1
Connector	Front panel BNC: 3151B & 3152B: OUTPUT 3100M/R: OUT
Impedance	50 Ω ±1%
Protection	Short Circuit to Case Ground, 10 s max
Standby	Output On or Off (Output Disconnected)
Amplitude	20 mV to 32 Vp-p, output open circuit 10 mV to 16 Vp-p, into 50 Ω
Resolution	4 digits
Accuracy (measured at 1kHz into 50Ω)	1.6 V to 16 Vp-p: ±(1% + 30 mV) 160 mV to 1.599 Vp-p: ±(1% + 2 mV) 10 mV to 159.9 mVp-p: ±(1% + 200 μV)
DC Offset Range	0 to ±7.995 V
Resolution	1 mV
Accuracy	±(1% ± 1% from Amplitude ±5 mV)

Square Wave, Pulse Performance

Rise/Fall Time (10%-90%)	5 ns, 10 mV to 12 V; 6 ns, 12 V to 16 V
Aberration	<6%, 10 mV to 12 V; 8%, 12 V to 16 V

Sync Output

Connector	Front panel BNC: 3151B & 3152B: SYNC OUT 3100M/R: SYNC TTLTRG0-7
Level	TTL
Sync Type	Pulse with Arbitrary and Standard Waves; LCOM in Sequence and Burst Modes (including Burst Modulation); Marker with Modulation Mode only, programmable position
Width	4 to n-8
Position	Point 0 to maximum segment size, programmable with 4-point resolution

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Filters

Description	Filters can be switched in and out freely except in standard waveform shape where the filters are automatically used by the instrument to reconstruct the sine shape.
Type	25 MHz Bessel 50 MHz Bessel 60 MHz Elliptic 120 MHz Elliptic

General Run Modes

Description	Define how waveforms start and stop. Run modes description applies to all waveform types and functions, except where noted otherwise.
Continuous	Continuously free-run output of a waveform. Waveform generation can be enabled and disabled from a remote interface only.
Triggered	Upon trigger, outputs one waveform cycle. Last cycle always completed. Trigger can be internal or external.
Burst	Upon trigger, outputs a single or multiple pre-programmed number of waveform cycles. (Does not apply to Sequence Mode). Burst is programmable from 1 through 1M cycles. Bust triggering can be internal or external.
Gated	Transition or level enables or disables generator output. Last cycle always completed

Trigger Characteristics

Sources

Internal	Asynchronous timer generates triggers repeatedly
Timer Range	1 μs to 20 s
External	External trigger input is enabled
Input	Front panel BNC: 3151B & 3152B: TRIG/PLL IN 3100M/R: TRG/PLL
Impedance	20 kΩ, nominal
Range	±10 V
Resolution	10 mV
Sensitivity	100 mVrms
Damage Level	30 Vrms
Frequency Range	DC to 5 MHz
Slope	Positive/Negative transitions, selectable
Minimum Pulse Width	≥10 ns
BUS	Trigger commands from a remote controller only
VXI Backplane	TTLTRG0-7 inputs or outputs, programmable
System Delay (Trigger input to waveform output)	6 sample clock cycles+150 ns
Trigger Delay (Trigger input to waveform output)	[(0; 100 ns to 20 s) + system delay]

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Resolution	20 ns
Error	6 sample clock cycles + 150 ns
Re-trigger Delay (Waveform end to waveform restart)	100 ns to 20 s
Resolution	20 ns
Error	3 sample clock cycles + 20 ns
Trigger Jitter	±1 sample clock period

Frequency/Time Accuracy

10 MHz Reference Source	Internal, External, VXI backplane CLK10
Internal	≥0.0001% (1 ppm TCXO) initial tolerance from 19°C to 29°C; 1ppm/°C below 19°C and above 29°C; 1 ppm/year aging rate
External	
Connector	Front panel BNC: 3151B: REF IN 3152B: PM IN 3100M/R: EXT 10MHz
Impedance and Level	10 kΩ ±5%, TTL, 50% ±2% duty cycle, or 50 Ω ±5%, 0 dBm, manually selectable using internal jumpers
External Sample Clock Source	External, ECLTRG0
Connector	Front panel BNC: 3151B & 3152B: CLOCK IN 3199M/R: EXT SCLK
Frequency	External: DC to 250 MHz ECLTRG0: DC to 66MHz
Impedance and Level	50 Ω ±5%, PECL or NECL

PLL Characteristics

Description	Automatically locks 3152B output to external signal applied to trigger port
PLL Input Characteristics	Same as trigger input
External Lock Frequency Range	Standard Waveforms: 500 Hz to 10 MHz Arbitrary Waveforms: 500 Hz to 100 M/(points per cycle)
Phase Control	Coarse: ± 180º Fine: ± 36º with 0.01 º resolution
Phase Control Accuracy	± 2% ±1 sample clock period

PM Characteristics

Description	External signal offsets phase. Available in PLL mode when unit is locked to an external signal.
PM Input Bandwidth	100 Hz-10 kHz
External Lock Frequency Range	Standard Waveforms: 500 Hz to 10 MHz Arbitrary Waveforms: 500 Hz to 100 M/(points per cycle)
PM Input	
Impedance	100 kΩ ±5%
Sensitivity	20º / V

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Range	± 130 º
PM Accuracy	± 10%

Function Generator Characteristics

Description	One may select from a list of a built-in library of standard waveforms. The waveforms are computed every time a waveform is selected. The integrity of the waveform and its upper frequency limit depend on the programmed frequency value and the number of waveform points that are used for computing one cycle interval.
Standard Functions	Sine Triangle Square Pulse Ramp Sinc pulse Gaussian pulse Exponential decay/rise pulse DC
Frequency Range	
Sine, Square	100 μHz to 100 MHz
All other waveforms	100 μHz to 16 MHz
Frequency Resolution	11 digits
Accuracy & Stability	Same as frequency reference

Sine

Start Phase Range	0-360°
Start Phase Resolution	0.05°
Power Range (Sine Raised to a power)	1-9

Sine Wave Performance

THD (load >100 kΩ)	0.1% to 100 kHz, STD and CW
Harmonics and Spurious at less than 5 Vp-p	<100 MHz: -28 dBc <30 MHz: -35 dBc <10 MHz: -40 dBc
Harmonics & Spurious at less than 10 Vp-p	<100 MHz: -30 dBc <10 MHz: -35 dBc <1 MHz: -40 dBc
Flatness at less than 5 Vp-p	<100 MHz: 10% <10 MHz: 5% <1 MHz: 2%
Flatness at less than 10Vp-p	<100 MHz: 15% <10 MHz: 5%

Triangle

Start Phase Range	0-360°
Start Phase Resolution	0.05°
Power Range (Triangle Raised to a power)	1-10

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Square

Duty Cycle Range	0% to 99.9%

Pulse

Delay, Rise/Fall Time, High Time Ranges	0%-99.99% of period (each independently)

Ramp

Delay, Rise/Fall Time, High Time Ranges	0%-99.9% of period (each independently)

Gaussian Pulse

Time Constant Range	1-200

Sync Pulse

“Zero Crossings” Range	4-100

Exponential Pulse

Time Constant Range	-200 to 200

DC Output Function

Setting options	Percent of maximum amplitude; DC levels
Range	0% to ±100% of maximum amplitude; -16 V to +16 V

Arbitrary Waveform Generator Characteristics

Description	Arbitrary Waveforms are created on a remote computer and downloaded to the instrument through one of the available remote interfaces. The frequency of the waveform is calculated from its programmed sample clock value and the number of waveform points that were used for creating the waveform
Sample Clock Range	
Continuous Run Mode	100 mS/s to 250 MS/s (300 MS/s, typically at 25°C)
All Other Run Modes	100 mS/s to 225 MS/s (240 MS/s, typically at 25°C)
Resolution	11 digits
Accuracy and Stability	Same as reference
Native Vertical Resolution	16 bits (65,536 amplitude increments)
Emulation Vertical Resolution	12 bits (automatically shifts legacy data to 16 bit format)
Waveform Segmentation	Permits division of the waveform memory into smaller segments.
Number of Memory Segments	1 to 16k
Waveform Segments, size and resolution	2 point size increments from 10 to 1M points (2/4M optional)
Custom Waveform Creation Software	ArbConnection software allows instrument control and creation of custom waveforms

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Sequenced Waveforms Generator Characteristics

Description	Segments may be linked and repeated in a user-selectable order. Segments are advanced using either a command or a trigger
Sample Clock Range	
Continuous Run Mode	100 mS/s to 250 MS/s (300 MS/s, typically at 25°C)
All Other Run Modes	100 mS/s to 225 MS/s (240 MS/s, typically at 25°C)
Resolution	11 digits
Accuracy and Stability	Same as reference
Advance Modes	
Automatic Sequence Advance	No trigger required to step from one segment to the next. Sequence is repeated continuously per a pre-programmed sequence table.
Stepped Sequence Advance	Current segment is sampled continuously until a trigger advances the sequence to the next programmed segment and sample clock rate.
Single Sequence Advance	Current segment is sampled the specified number of repetitions and then idles at the end of the segment. Next trigger samples the next segment the specified repeat count, and so on.
Mixed Sequence Advance	Each step of a sequence can be programmed to advance either a) automatically (Automatic Sequence Advance), or b) with a trigger (Stepped Sequence Advance)
Sequencer Steps	1 to 16 k
Segment Loops	1 to 1 Meg
Minimum Segment Duration	500 ns
Minimum Segment Size in a Sequence	10 points
Custom Sequence Creation Software	ArbConnection software allows instrument control and creation of custom sequences. Sequences are built as tables and downloaded to the instrument
Download Modes	Normal, using SCPI commands; Fast, using binary data (<250 ms / 100 steps)

Modulated Waveform Generator Characteristics

General

Description	Using this mode of operation, one may select from a list of built-in modulation schemes.
Carrier Waveform (CW)	Sinewave
Modulation Source	Internal
Run Modes	Off (outputs CW), Continuous, Triggered, Delayed Trigger, Re-trigger, Burst and Gated
Interrupted Modulation Carrier Idle Mode	On or Off, programmable
Run Mode Advance Source	Front panel TRIG IN, TTLTRG(0-7), Internal trigger, Software commands
Trigger Delay (Trigger input to modulation output)	[(0; <100 ns to 20 s) + system delay]
Resolution	20 ns
Error	6 sample clock cycles + 150 ns

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Re-trigger Delay (Modulation end to modulation restart)	<100 ns to 20 s
Resolution	20 ns
Error	3 sample clock cycles + 20 ns
Trigger Parameters	All trigger parameters such as level, slope, jitter, etc. apply

Marker Output

Description	Marks the crossing of a specific frequency and step setting. The marker pulse is generated through the SYNC connector. Marker placement is available for all modulation modes except AM
Output	SYNC connector, TTLTRG(0-7)
Level	TTL
Marker Type	Single pulse at the specified frequency
Position	Programmable for a specific frequency setting

Sweep

Swept Waveform	Sine, square or triangle
Sweep Step	Linear or log
Sweep Direction	Up or Down
Sweep Range	10 Hz to 100 MHz
Sweep Time	1.4 μs to 40 s

FM

Modulated Waveform	Sine wave
Modulating Waveforms	Sine, square, triangle, Ramp
Carrier Frequency Range	10 Hz to 100 MHz
Modulating Frequency Range	10 mHz to 350 kHz
Peak Deviation	Up to 50 MHz

Arbitrary FM

Description	Operated from an external utility only such as ArbConnection. The modulating waveform can be designed as an arbitrary waveform
Modulated Waveform	Sine wave
Carrier Frequency Range	10 Hz to 100 MHz
Modulating Waveform	Arbitrary waveform
Modulating Waveform Sampling Clock	1 S/s to 2.5 MS/s
Number of frequencies	2 to 10,000

AM

Modulated Waveform	Sine wave
Carrier Frequency Range	10 Hz to 100 MHz
Envelop Waveform	Sine, square, triangle, Ramp
Envelop Frequency	10 mHz to 100 kHz
Modulation Depth	0% to 200% (software above 100%)

Frequency Hopping

Hopped Waveform	Sine wave
Hop Frequency Range	10 Hz to 100 MHz

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Resolution	11 digits
Hop Table Size	2 to 1000
Dwell Time Mode	Fixed or Programmable for each step
Dwell Time	100 ns to 20 s
Dwell Time Resolution	20 ns

Amplitude Hopping

Hopped Waveform	Sine wave
Frequency Range	10 Hz to 100 MHz
Resolution	11 digits
Hop Amplitude Range	0 to 16 Vp-p
Resolution	Maximum amplitude/4096
Hop Table Size	2 to 5000
Dwell Time Mode	Fixed or Programmable for each step
Dwell Time	100 ns to 20 s
Dwell Time Resolution	20 ns

FSK

Shifted Waveform	Sine wave
Carrier/Shifted Frequency Range	10 Hz to 100 MHz
Baud Range	1 bit/sec to 10 Mbits/sec
FSK Data Bits Length	2 to 4000

PSK

Shifted Waveform	Sine wave
Carrier Frequency Range	10 Hz to 100 MHz
Phase Shift Range	0° to 360°
Baud Range	1 bits/sec to 10 Mbits/sec
PSK Data Bits Length	2 to 4000

ASK

Shifted Waveform	Sine wave
Carrier Frequency Range	10 Hz to 100 MHz
Amplitude Shift Range	0 V to 16 Vp-p
Resolution	Maximum amplitude/4096
Baud Range	1bits/sec to 2.5 Mbits/sec
ASK Data Bits Length	2 to 4000

3D

Operation	Operated from an external utility only such as ArbConnection, the carrier waveform can be programmed to freely sweep in three dimensions: amplitude, frequency and phase.
Modulated Waveform	Sine
Carrier Frequency Range	10 Hz to 100 MHz
Modulating Sampling Clock	1 S/s to 2.5 MS/s
Number of profile indexes	2 to 30000

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Pulse Generator Waveform Characteristics

Operation	The 3152B has a special mode where the instrument type is transformed to operate as a digital pulse generator. When this mode is selected, the operation of the arbitrary waveform and its outputs are disabled and possibly, arbitrary waveforms are overwritten
Programmability	1. All pulse parameters, except rise and fall times, may be freely programmed within the selected pulse period provided that the ratio between the period and the smallest incremental unit does not exceed the ratio of 1,000,000 to 1 (4,000,000 to 1 with the memory option), thus the specifications below do not show the maximum limit as each must be computed from the above relationship.
2. Rise and fall times may be freely programmed provided that the ratio between the rise/fall time and the smallest incremental unit does not exceed the ratio of 100,000 to 1.	
3. The sum of all pulse parameters must not exceed the pulse period setting	
Pulse State	On or Off. On generates pulse output; Off generates 0 Vdc
Pulse Mode	Single or double, programmable
Polarity	Normal, inverted, or complemented
Period	80 ns minimum, programmed with 4 ns increments
Delay	0 ns min; 1e6 s max (2e6 s max with option 1)
Pulse Width	4 ns minimum; 1e3 s max
Double Pulse Delay	0 ns minimum; 1e3 s max
Rise/Fall Times	0 ns minimum; 1e3 s max (actual min = <5 ns)
High Time	0 ns minimum
Amplitude Window	10 mVp-p to 16 Vp-p
Low Level	-8 V to +7.992 V
High Level	-7.992 V to +8 V

Half-Cycle Waveform Generator Characteristics

Description	Half Cycle waveforms are the same as the standard functions except waveforms are generated as a sequence of half cycles. The delay between the half cycles is programmable
Function Shape	Sine, Triangle, Square
Frequency Range	0.01 Hz to 1 MHz
Phase Start Range	0° to 360.0° (Sine and triangle only)
Start Phase Resolution	0.1°
Duty Cycle Range	0% to 99.99% (Square only)
Duty Cycle Resolution	0.1%
Run Modes	Continuous, Triggered
Delay Between Half Cycles	200 ns to 20 s (Applies to continuous run mode only)
Resolution	20 ns

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Counter/Timer Characteristics

Operation	The 3152B has a special mode where the instrument type is transformed to operate as a counter/timer. When this mode is selected, the operation of the arbitrary waveform and its outputs are disabled
Measurement Functions	Frequency, Period, Period Averaged, Pulse Width and Totalize

Frequency, Period Averaged

Frequency Range	20 Hz to 100 MHz (typically >120 MHz)
Period Averaged Range	10 ns to 50 ms
Resolution	7 digits in one second of gate time, reduced proportionally with lower gate times

Period, Pulse Width

Range	500 ns to 50 ms
Resolution	100 ns

Totalize

Frequency Range	20 Hz to 100 MHz
Accumulation Range	10^{12}-1

General

Input	Front panel TRIG IN, BNC connector
Trigger Level Range	±10 V
Sensitivity	500 mVp-p
Damage Level	±12 V
Minimum Pulse Width	≥10 ns
Slope	Positive/Negative transitions, selectable
Gate Time	100 µs to 1 s
Reading Modes	
Repetitive	Continuous measurements are executed when signal is present at the input
Hold	Single measurement is executed upon command
Gated	Active in Gated Totalize mode only
Time Base	
Type	TCXO
Temperature Stability	1 ppm, 0°C - 40°C
Long Term Stability	1 ppm, 1 year

Backplane Multiple Instrument Synchronization

Description	Multiple instruments can be daisy-chained and synchronized to provide multi-channel systems. Phase (leading edge) offset between master and slave units is programmable.
Initial Skew	<± 75 ns + 4 sample clock cycle
Synchronized Waveforms	Standard, Arbitrary and Sequenced using the automatic sequence advance mode only
Synchronized Run Modes	Continuous, Triggered, Gated and Counted Burst

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Trigger Delay	100 ns to 20 s, separately programmable for each synchronized instrument
Trigger Delay Resolution	20 ns
Synchronization Frequency Range	
Standard Waveforms	1.5 kHz to 100 MHz
Arbitrary and Sequenced Waveforms	2.5 MS/s to 150 MS/s, limited by a specific VXI backplane ability to transmit high frequency signals.

Leading Edge Offset

Description	Leading edge offset is programmable for master and slave units. Operates in conjunction with the continuous run mode only
Offset Range	<100 ns to 20 s
Resolution and Accuracy	20 ns

Options

4M Arbitrary Memory	Expands the arbitrary memory from the standard 1 M to 4 M. Available on the 3100M-3152B and 3100R-3152B models.

VXIbus General Information

Module Form	Single slot, C-size module
Protocol	A16/A24/A32/D16 Slave, Message-Based
VXIbus Revision	3.0
SCPI Revision	1993.0
SCPI Emulation	3152A, 3152, 3151, VX4750, Specials
Logical Address Settings	1 - 255, configured via DIP switches
Shared Memory (Write only)	D16/A24/A32
Front Panel LEDs	Fail (Red), Access (Amber), PLL On (Amber), Output On (Green)
Front Panel Connectors (5 BNC)	Main Output, Sync Output, Trigger Input, SCLK Input (or PM Input, internally selectable), 10 MHz Reference input

General

Power Requirements	25W maximum
EMC Certification	CE marked
Operating temperature	0 °C to 55 °C
Storage Temperature	-40°C to 70 °C
Safety	Designed to meet IEC 1010-1, UL 3111-1, CSA 22.2 #1010
Workmanship Standards	Conform to IPC-A-610D

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Appendix B

3100M/3100R/3151B/3152B Module Specifications

Input Characteristics

Number of Channels	Single channel (3201A) or dual channel (3202A)
Inputs	2 for each channel
Connectors	Channel 1: BNC and SMB Channel 2: SMB and SMB
Impedance	50 Ω, 75 Ω, or 1 MΩ (configured at factory)
Coupling	DC
Damage Level	12 Vp-p (-6 V to +6 V peaks)
Frequency Range	DC to 15 MHz (full power bandwidth) when loaded with matching output impedance

Output Characteristics

General

Connector	Channel 1: BNC Channel 2; SMB
Impedance	50 Ω, 75 Ω, or 600 Ω (configured at factory)
Coupling	DC
Protection	Short-circuit, 10 seconds
Gain	x10, fixed (can be special-ordered with different gain setting)
Polarity	Non-inverting
Amplitude	0 to 20 Vp-p into matching impedance 0 to 40 Vp-p into high impedance

Square Wave Characteristics

Transition Time	<22 ns
Aberrations	<7%

Sine Wave Characteristics

Bandwidth	15 MHz, at 20 Vp-p (-3dB)
Accuracy	±(3% of full-scale amplitude range + 25 mV), square wave at 1 kHz

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Flatness (10Vp-p)	±5% of amplitude to 1 MHz;
	±10% of amplitude to 7.5 MHz;
	±25% of amplitude to 15 MHz
THD (load >100 kΩ)	0.1%, 10 Hz to 100 kHz
Harmonics	<-47 dBc, 100 kHz to 1 MHz (10 Vp-p)
	<-38 dBc, 1 MHz to 10 MHz (10 Vp-p)
	<-30 dBc, 10 MHz to 15 MHz (10 Vp-p)

General

Physical Size	1/2 high, "C" module
Power Requirements	+24 VDC - 350 mA
	-24 VDC - 350 mA
	+12 VDC - 55 mA
	-12 VDC - 55 mA
	<19 W at full power
Signal Ground	Grounded to case ground
EMC Certification	CE marked
Safety	Designed to meet IEC EN61010-1, UL 3111-1
Workmanship Std.	Conform to IPC-A-610D

Environmental

Operating Temperature	0 °C to 50 °C, RH 80% (non-condensing)
Storage Temperature	-30 °C to 80 °C

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Appendix C
3152A/3152B Specification Compatibility

Amplitude Characteristics

Specification	3152A	3152B
Accuracy		
Amplitude Range/Accy (1 kHz)	1.6 V to 16 Vp-p: ±(1% + 20 mV)	1.6 V to 16 Vp-p: ±(1% + 30 mV)
	160 mV to 1.599 Vp-p: ±(1% + 2 mV)	160 mV to 1.599 Vp-p: ±(1% + 2 mV)
	10 mV to 159.9 mVp-p: ±(1% + 200 µV)	10 mV to 159.9 mVp-p: ±(1% + 200 µV)
DC offset Range: Accy	±8 V: ±(1% +1% of amplitude +20 mV)	0 to ±7.995 V: ±(1% ± 1% from Amplitude ± 5 mV)
	±800 mV: ±(1% +1% of amplitude +2 mV)	**Note**: 3152B has only one offset amplitude window.
	±80mV: ±(1% +1% of amplitude +200 µV)	
	Note: 3152A has three offset amplitude windows.	

Standard Waveforms

Specification	3152A	3152B
Sine		
Frequency Range	100 µHz to 50 MHz	100 µHz to 100 MHz
Frequency Resolution	7 digits	11 digits
Distortion (load >100 kΩ)	< 0.1%, below 100 kHz (2000 pts min)	0.1% to 100 kHz, STD and CW
Harmonics (& Spurious included for 3152B)	<10 MHz, ≤10 Vp-p, -40 dBc	<10 MHz, <5 V, -40dBc
	<10 MHz, ≤16 Vp-p, -35 dBc	<10 MHz, <10 V, -35dBc
	<50 MHz, ≤10 Vp-p, -28 dBc	<100 MHz, <5 V, -28dBc
	<50 MHz, ≤16 Vp-p, -20 dBc	<100 MHz, <10 V, -30dBc
Flatness	1%, to 1 MHz	1% to 1 MHz (< 5Vpp)
	5% to 10 MHz	5% to 10 MHz (< 10Vpp)
	15%, to 50 MHz	10% to 100 MHz (< 5Vpp); 15% to 100 MHz (< 10Vpp)
Filters	20 MHz 7-pole Gaussian	25 MHz, Bessel
	25 MHz 7-pole elliptic	50 MHz Bessel
	50 MHz 7-pole elliptic	60 MHz Elliptic
		120 MHz Elliptic

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Specification	3152A	3152B
Square Wave		
Frequency Range	100 µHz to 50 MHz	100 µHz to 100 MHz
Rise/Fall Time	7 ns Typical	10 mV to 12 V: 5 ns
		12 V to 16 V: 6 ns
Aberration	<5%	10 mV to 12 V: <6%
		12 V to 16 V: 8%
Other Waveforms	100 µHz to 1 MHz	100 µHz to 16 MHz

Arbitrary Waveforms

Specification	3152A	3152B
Memory Size	64 k or 512 k	1 M (512 k for legacy compliance)
Number of Segments	1 to 4 k	1 to 16 k
Minimum Segment Size	10	10 (FORM:INST LEG); 16 (FORM:INST MOD)
Vertical Resolution	12-bits	12-bits (FORM:INST LEG); 16-bits (FORM:INST MOD)
Waveform Size Increment	2 points	2 points (FORM:INST LEG); 4 points (FORM:INST MOD)
Sample Clock Range	100 mS/s to 100 MS/s	100 mS/s to 250 MS/s (300 MS/s typical)
Waveform Creation Software	WaveCAD	WaveCAD or ArbConnection

Sequenced Waveforms

Specification	3152A	3152B
	Automatic Advance	Automatic Advance
		Stepped Sequence Advance
		Single Sequence Advance
		Mixed Sequence Advance
Sample Clock Range	100 mS/s to 100 MS/s	100 mS/s to 250 MS/s (300 MS/s typical)
Sequencer Steps	1 to 4096	1 to 16 k
Segment Loops	1 to 1 Meg	1 to 1 Meg
Minimum Segment Duration	100 ns	500 ns

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Swept Waveforms

Specification	3152A	3152B
Types	SEQ: Sequencer sweep; requires calculation	DDS: Native DDS provides fast, continuous sweep
Parameters		
Waveforms	Sine, square or triangle (SEQ)	Sine (DDS or SEQ), square (SEQ), or triangle (SEQ)
Sweep Spacing	Linear or log	Linear or log
Sweep Direction	Up or down	Up or down
Sweep Duration	.01 to 1000 s	1.4 μs to 40 s
Sweep Frequency Range	1 mHz to 10 MHz	10 Hz to 100 MHz

Sampling Clock

Specification	3152A	3152B
Parameters		
Range	100 mHz to 100 MHz	100 mHz to 250 MHz
Resolution	7 digits	11 digits
Reference	Internal ref (optional), CLK10	Internal ref, external ref, CLK10
Source	Internal, external	Internal, external

Phase Locked Loop

Specification	3152A	3152B
Standard Waveforms		
Frequency Range (lock)	500 Hz to 10 MHz	500 Hz to 10 MHz
Arbitrary Waveforms		
Frequency Range (lock)	500 Hz to 100 M/(points per cycle)	500 Hz to 100 M/(points per cycle)
External Lock Threshold	±10 V with 10 mV resolution, programmable	±10 V with 10 mV resolution, programmable
External Lock (max)	30 Vrms	
Phase Control		
Coarse	± 180º (0.72º resolution or higher)	±180º
Fine	± 36º with 0.01º resolution	±36º with 0.01º resolution
Accuracy	Coarse: 5.4 x frequency (MHz) + res / 2 ± 5º	±2% ±1 sample clock period
	Fine: 10%, typical	

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Phase Modulation

Specification	3152A	3152B
Parameters		
Type	External	External
PM Bandwidth	100 Hz to 10 kHz	100 Hz to 10 kHz
Sensitivity	20°/ V, nominal	20°/ V, nominal
Phase Range	±180º	±180º
Accuracy	±30%	±10%

Triggering Characteristics

Specification	3152A	3152B
Trigger Input		
Impedance	66 kΩ, ±5%	20 kΩ, nominal, (S-2900 version: 66 kΩ)
Level	±10 V	±10 V
Resolution	10 mV	10 mV
Sensitivity	100 mVrms	100 mVrms
Maximum Input Voltage	30 Vrms	30 Vrms
Minimum Pulse Width	20 ns	10 ns
Slope	Positive or negative edge	Positive or negative edge
Sources		
Internal Timer	15 μs to 1000 s	1 μs to 20 s
External	±10 V, 10 mV resolution; 30 Vrms max	±10 V, 10 mV resolution; 30 Vrms max
Software	*trg	*trg
Parameters		
System Delay	150ns + (2 ± 1) sample clock periods	150 ns + 6 clock periods
Sync Output		
Sync Type	BIT, LCOMP, HCLK, Pulse	BIT, LCOMP, HCLK, Pulse, Zero Crossing
Width Range	2 to 500 points	2 to n-4 points
Position	0 to segment size	0 to segment size
Resolution	2 points	2 points (FORM:INST LEG); 4 points (FORM:INST MOD)

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Multi-module Synchronization

Specification	3152A	3152B
Parameters		
Lock Type	Backplane using ECLTrg0 and TTLTrg0	Backplane using ECLTrg0 and TTLTrg0
		VXI LBUS
Standard Waveform Range	up to 33 MHz	1.5 kHz to 100 MHz
Arbitrary Waveform Range	up to 67 Ms/s	2.5 MS/s to 150 MS/s
Phase Resolution	12.5 ns maximum (depends on SCLK)	20 ns

Counter

Specification	3152A	3152B
Parameters		
Modes	In PLL mode only	Any mode, waveform generation is disabled
Function(s)	Frequency	Frequency, period, period averaged, pulse width and totalize
Range	500 Hz to 10 MHz	20 Hz to 100 MHz (> 200 MHz typical)
Resolution	4 digits/s	7 digits/s

Additional Functions

Specification	3152A	3152B
Modes	Internal Modulation:AM (up to 200%)	Internal Modulation: FM, Arbitrary FM, AM, Frequency Hopping, Amplitude Hopping, ASK, FSK, 3D Modulation, mPSK
	Waveforms: Arbitrary (from memory)	Waveforms: Arbitrary or DDS (CW or modulated)
		Pulse Generator (analog pulse generator interface)
		Half-cycle waveforms, programmable re-triggering

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