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# 3152A

# PRECISION PLL

# SYNTHESIZER

**PUBLICATION NO. 980867**

EADS North America Defense Test and Services, Inc.
4 Goodyear, Irvine, CA 92618
Tel: (800) 722-2528, (949) 859-8999; Fax: (949) 859-7139

info@eads-nadefense.com
sales@eads-nadefense.com
helpdesk@eads-nadefense.com
http://www.eads-nadefense.com




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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.



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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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# Racal Instruments

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We

Racal Instruments Inc.
4 Goodyear Street
Irvine, CA 92718

declare under sole responsibility that the

**3152A Arbitrary Waveform Generator**
**P/N 407808-003,-013,-103,-113**

conforms to the following Product Specifications:

**Safety:** EN 61010-1

**EMC:** Immunity: EN61326, Class A, Table 1
Emissions: EN61326, Class A, Table 3

**Supplementary Information:**

The above specifications are met when the product is installed in a Racal Instruments certified enclosure, with faceplates installed over all unused slots, as applicable.

The product herewith complies with the requirements of EN61010-1 and EN61326.

Irvine, CA, January 14, 2002

Quality Manager

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# Chapter 1
# GETTING STARTED

## What's In This Chapter

This chapter contains a general description of the VXIbus 3152A Waveform Synthesizer and an overall functional description of the instrument. It lists and describes various options available for this model. It also describes the 3152A front panel connectors and indicators.

***NOTE:***

**This manual provides a complete description of all features and options available with the 3152A; however, some items described in the following paragraphs may not be installed in your instrument.**

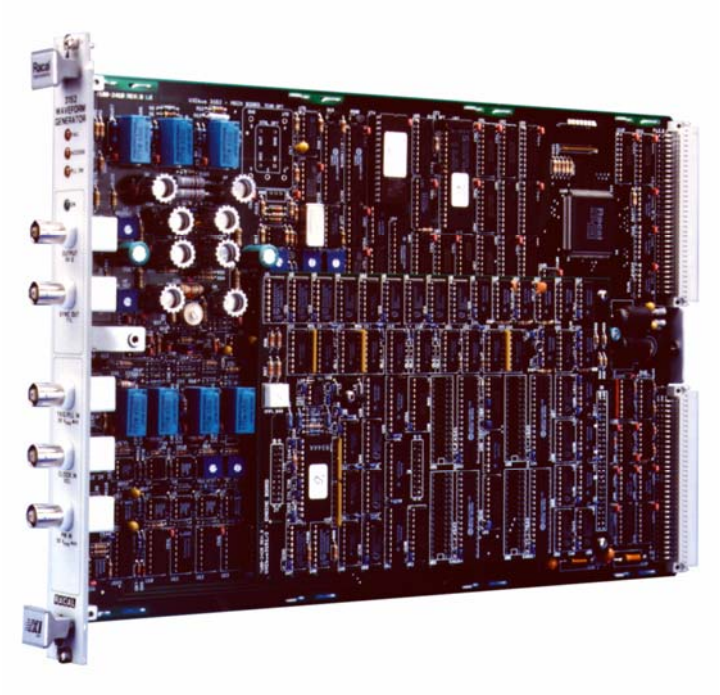


**Figure 1-1, 3152A**



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# Introduction

The 3152A is a VXIbus, single slot C-size Synthesized Waveform Generator. It is a high performance waveform synthesizer that combines two powerful instruments in one small package; a function generator and an arbitrary waveform generator. The instrument provides a variety of standard waveforms to be used as test stimuli for different electronic devices. The 3152A is also capable of generating arbitrary waveforms with sampling rates to 100 MHz at 12 bits of vertical resolution.

Despite its small size, the 3152A offer many features and functions such as *VXIplug&play* compatibility, backplane phase synchronization, front-panel PLL, sweep, counted burst, internal trigger-generator, and more. The instrument generates high quality, high accuracy waveforms throughout the specified frequency range, amplitude span, and operating temperature. The 3152A generates sine waveforms with a spectral purity that can only be matched by much more expensive bench type synthesizers.

The 3152A generates standard waveforms at frequencies ranging from 100 µHz to 50 MHz. Frequency may be set with 7 digit resolution. Accuracy and stability of the output frequency depend on the reference clock. As a default, CLK10 is used as the reference clock. The typical accuracy and stability of CLK10 is 100 ppm. An optional internal TCXO circuit provides 1 ppm accuracy and stability. When the optional TCXO is installed, the output frequency can be programmed with a full seven digits of resolution.

Arbitrary waveforms are generated with clock rates ranging from 100 mHz to 100 MHz. Output amplitude may be programmed within the range of 20 mV to 32 Vp-p into an open circuit, and 10 mV to 16V into 50Ω. Amplitude and offsets are programmed with 4 digit resolution.

Besides normal continuous mode, the 3152A offers a variety of interrupted modes. The output waveform may be gated, triggered, or may generate a counted burst of waveforms. A built-in trigger generator with a programmable period can replace an external trigger.

The 3152A generates arbitrary waveforms with 12 bits of resolution. There are nine standard waveforms that are memory-resident. Other waveforms may be generated, either manually or downloaded from the controller to the instrument using shared memory or standard data bus transfer. Waveforms may also be generated using the WaveCAD program.



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The 3152A waveform synthesizer is a digital instrument. Besides standard waveforms, any waveform generated must first be loaded into the arbitrary waveform memory. The arbitrary waveform memory is a bank of 8-bit words. Each word represents a point on the waveform. Each word has a horizontal address that can range from 0 to 523288) and a vertical address that can range from -2048 to +2047 (12 bits). Using a high speed clocking circuit, the digital contents of the arbitrary waveform memory are extracted and routed to the D/A converter. The D/A converts the digital data to an analog signal, and the output amplifier completes the task by amplifying or attenuating the signal at the output connector.

The 3152A is fully programmable using SCPI commands and syntax. There are two ways to program the 3152A, the first being low level programming of each individual parameter. The second alternative is to use the *VXIplug&play* soft front panel for high level programming. The *VXIplug&play* soft front panel simulates a mechanical front panel with the necessary push buttons, displays and dials to operate the 3152A as a bench-top instrument. The 3152A will not operate without being programmed. Therefore, it is recommended that the user become familiar with its basic features, functions and programming concepts as described in this and the following chapters.

## Options

A number of options are offered with the 3152A. Compare the option number with the number that is printed on the instrument to verify which of the options is installed in your instrument. Note that all 3152A options are installed in the factory. Contact your nearest EADS North America Defense Test and Services, Inc. representative if the number printed on the case does not reflect the correct version ordered. The list of available 3152A options is given below:

407808-001 - 3152A - 100MS/s Waveform Synthesizer, w/64K RAM

407808-003 - 3152A - 100MS/s Waveform Synthesizer, w/512K RAM

407508-011 - 3152A - 100MS/s Waveform Synthesizer, w/64K RAM, 1ppm

407508-013 - 3152A - 100MS/s Waveform Synthesizer, w/512K RAM, 1ppm

407808-203 - 3152A - 100MS/s Waveform Synthesizer, w/512K RAM, Tektronix VX4750 Emulation

407508-213 - 3152A - 100MS/s Waveform Synthesizer, w/512K RAM, 1ppm, Tektronix VX4750 Emulation



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The 512K RAM option designates the memory size supplied with the 3152A. The standard memory size is 512K (524288 words). With the standard memory size, 523288 point waveforms can be programmed because 1000 words are allocated for standard waveforms.

The 64K RAM option designates instruments supplied with 64K of memory expansion. With the 64K option, 64536 point waveforms can be programmed.

1ppm denotes improved accuracy and stability over the internal 10 MHz reference clock. Normally, VXIbus modules receive their clock reference from VXIbus CLK10. There are applications that require complete separation from VXIbus clocks. The TCXO (1ppm) option, when installed, provides the required separation.

## Safety Considerations

The 3152A has been manufactured according to international safety standards.

***WARNING:***

**Do not remove instrument covers when operating or when the chassis power cord is connected to the mains.**

Any adjustment, maintenance and repair of an opened, powered-on instrument should be avoided as much as possible, but when necessary, should be carried out only by a skilled person who is aware of the hazard involved.

## Supplied Accessories

The 3152A is supplied with an Instruction Manual. The manual includes disks with VXI*plug&play* soft front panel and drivers along with WaveCAD for Windows.

## Specifications

Instrument specifications are listed in **Appendix A**. These specifications are the performance standards or limits against which the instrument is tested. Specifications apply under the following conditions: output terminated into 50Ω after 30 minutes of warm up time, and within a temperature range of 20°C to 30°C. Specifications outside this range are degraded by 0.1% per °C.



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## Functional Description

A detailed functional description is given in the following paragraphs. The description is divided into logical groups: input and output connectors, operating modes, output type, output state, synchronization, filters and front panel indicators.

## Input and Output Connectors

The 3152A has 5 BNC connectors on its front panel: main output, SYNC output, phase modulation input, external clock input and the trigger/PLL input. The 3152A Front Panel is shown in **Figure 1-2**.

## Main Output

The main output connector outputs standard, user, and sequenced waveforms. Output impedance of this output is 50Ω, that is, the cable which is connected to this input should be terminated with a 50Ω resistance. Output amplitude accuracy is calibrated when connected to a 50Ω load. If the output is connected to a different load resistance, determine the actual amplitude from the resistance ratio of the internal 50Ω to the load impedance. The output amplitude is doubled when the output impedance is above 1MΩ.

## SYNC Output

The SYNC Output generates a single TTL pulse for synchronizing other instruments (i.e., an oscilloscope) to the output waveform. The SYNC signal always appears at a fixed point relative to the waveform. The SYNC output generates a single point pulse for standard and arbitrary waveforms. The location of the SYNC signal along the waveform is programmable from point 2 to the last point on the waveform.

## External Clock Input

The External Clock Input is available for those applications required to run the complete system off the same clock. Normally, this input is disabled. When enabled under program control the clock at this input replaces the internal clock generator and the output waveform will begin generating waveforms with clock rates that are present at the external clock input. Do not confuse the clock frequency with the frequency of the waveform. The actual frequency of the output waveform depends on the number of points that are allocated for the waveform. For example, if the external clock is 10 MHz and the number of points that were assigned to the active segment is 1000, the output frequency will be 10 KHz (10 MHz divided by the number of points). The external clock input accepts fixed level ECL signals within the range of DC to 100 MHz.



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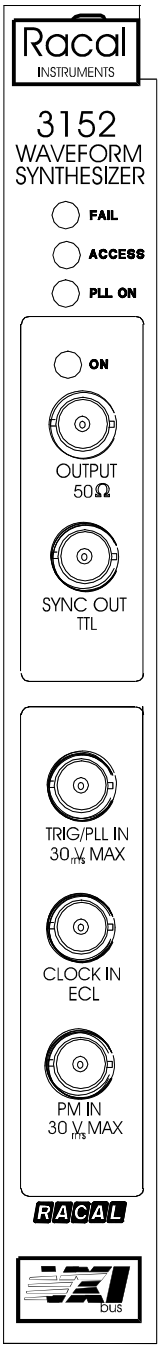



**Figure 1-2, 3152A Front Panel**



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## PM Input

The PM Input accepts signals that phase modulate the main output frequency. The phase modulation function operates in conjunction with the PLL function. The PM input is active at all times. Therefore, unless you intend to use this function, do not connect any cables to this input during normal operation of the 3152A.

## Trigger Input

The Trigger Input accepts signals that stimulate the 3152A to output waveforms. The trigger input is inactive when the instrument is in continuous operating mode. When placed in trigger, gated or burst mode, the trigger input is made active and waits for the right condition to trigger the instrument. In trigger and burst modes, the trigger input is edge sensitive, i.e., it senses transitions from high to low or from low to high to trigger the 3152A. The direction of the transition is programmable. In PLL mode, the trigger input is used as phase reference input.

In gated mode, the trigger input is level sensitive, i.e., the 3152A output is enabled when the level is high and idle when the level is low. Level sensitivity may be programmed for the trigger input.

## Operating Modes

There are a number of operating modes that the 3152A can be programmed to operate in: continuous mode, triggered mode, gated mode and burst mode. These operating modes are described below.

### Continuous Mode

In continuous mode, the selected waveform is output continuously at the selected frequency, amplitude and offset.

### Triggered Mode

In triggered mode, the 3152A circuits are armed to generate one output waveform. The trigger circuit is sensitive to transitions at the trigger input. Select between positive or negative transitions to trigger the instrument. You may also program the trigger level to the desired threshold level on the external signal. When triggered, the synthesizer outputs the waveform and remains idle at the last point of the waveform. The 3152A can be armed to receive a trigger signal from the front panel BNC connector, a VXIbus backplane TTLTRG<n> or from an internal, programmable trigger generator.



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The trigger signal, whether it comes from the front panel or from the VXIbus, has to pass through circuitry. These circuits cause a small delay known as system delay. System delay cannot be eliminated completely. It is, however, minimized in the 3152A to approximately 200ns maximum. System delay is a factor that must be considered when applying a trigger signal. It defines how long it will take from a valid trigger edge to the moment that the output reacts.

While system delay cannot be controlled, the 3152A offers a controllable trigger delay parameter. When utilized, delay from a trigger signal to output waveform may be programmed from 0 clocks to one million clocks. This delay is additional to the system delay.

### Burst Mode

The burst mode is an extension of the triggered mode where the 3152A can be armed to output a counted number of waveforms following a triggered signal. Like trigger mode, burst can be triggered from a front panel BNC connector, a VXIbus backplane TTLTRG<n> or from an internal, programmable trigger generator.

### Gated Mode

In gated mode, the 3152A circuits are armed to generate output waveforms as long as a gating signal is true. Unlike the triggered mode, the gated mode is level sensitive. When the gating signal goes false, the waveform at the output connector is first completed and the output goes to an idle state. The stop amplitude level, after a gating signal, is the last point on the waveform.

## Output Type

The 3152A can output three types of waveforms: standard waveforms, arbitrary waveforms and sequenced waveforms. The three types of waveforms are described in the following.



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## Standard Waveforms

The 3152A generates waveforms from a memory that has to be loaded before the waveforms can be can generated. There are 512K points of memory standard. A smaller memory, 64K version is also available as an option. 1000 points from this memory are allocated for standard waveforms. Waveforms are loaded into this part of the memory each time a standard function is selected.

The 3152A can be programmed to output nine different standard waveforms: sine wave, triangular wave, square wave, pulse, ramp, sinc (sine(x)/x), gaussian pulse, exponential pulse and DC. There are certain parameters that are associated with each standard function. These parameters can be programmed to generate modified standard waveforms.

## Arbitrary Waveforms

The arbitrary waveform memory is capable of storing one or more user waveforms. There are 523288 points (64536 optional) that can be allocated to one waveform that has this length. If there is no need to use the complete memory, it can be divided into smaller segments, variable in size. Load each segment with a different waveform and program the 3152A to output the required waveform for a specific test. Loading data to arbitrary waveform memory can be a time-consuming task, especially if the complete 512K is loaded in one shot. The 3152A utilizes the VXIbus shared memory concept that speeds data transfer from and to the host computer. In this mode, the memory bank is disconnected from the CPU circuit and its bus is accessible from the VXIbus for direct memory access by the host computer.

## Sequenced Waveforms

The 3152A employs a sophisticated circuit that allows dividing the memory into smaller segments, linking of the segments in user-defined order, and repeating of each linked segment up to one million times. The sequence circuit is useful for generating long waveforms with repeated sections. The repeated waveform has to be programmed once and the repeater will loop on this segment as many times as selected. When in sequenced mode, there is no loss of time between linked or looped segments. **Figure 1-6** shows an example of a sequenced waveform. Assume the waveforms in **Figures 1-3** through **1-5** were placed in segments 1 through 3.



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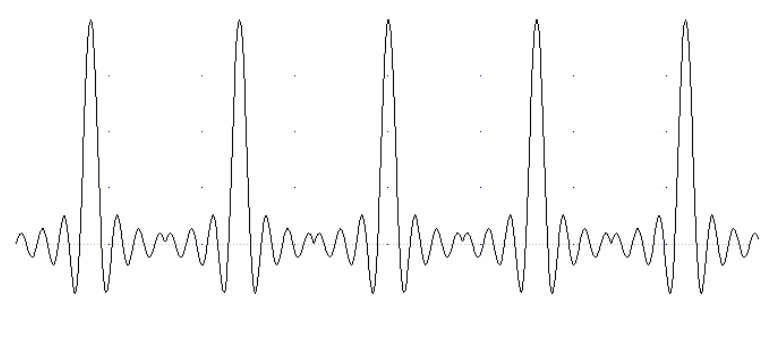


**Figure 1-3, Segment 1 - Sin(x)/x Waveform**

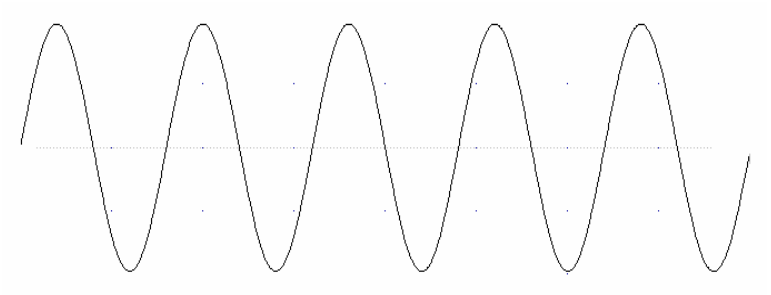


**Figure 1-4, Segment 2 - Sine Waveform**

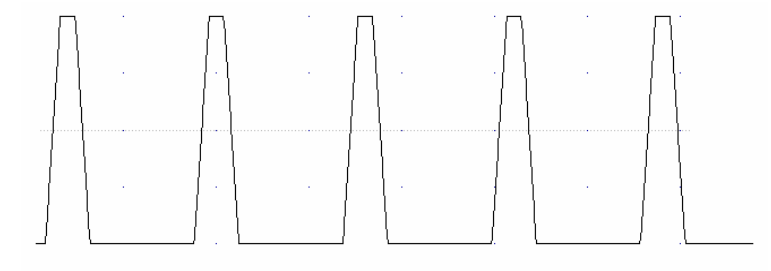


**Figure 1-5, Segment 3 - Pulse Waveform**

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



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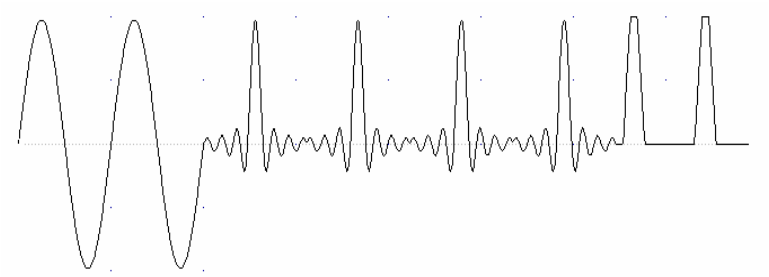


**Figure 1-6, Sequenced Waveforms**

## Sweep Waveforms

The 3152A's Sweep Mode is a special case of Sequenced Mode which utilizes the sequencer and the 3152A's 512k of waveform memory to store a sequence of sine, square or triangle waveforms. The sweep is user-programmable to have up to 2000 steps and as few as 10. Sweep steps are individual waveforms stored in segments. Sweep advance spacing is specified as either linear or logarithmic and either up or down in frequency. Sweep may be either continuous or triggered.

## Output State

The main output can be turned on or off. The internal circuit is disconnected from the output BNC connector by a mechanical switch under program control (relay). This feature is useful for connecting the 3152A main output, along with other instruments, to an analog bus. For safety reasons, after power on, the main output is always off.

## Backplane Synchronization

Multiple 3152As may be synchronized and operated together inside one VXIbus chassis. With one instrument configured as master and the rest of the instruments configured as slaves, the instruments are phase-locked to the start phase on the master module. The slave modules may be configured to have phase offsets within the range of 0 to 360. There is no need to install multiple 3152A modules in adjacent slots to be able to phase synchronize modules.



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## Front-Panel PLL

The 3152A may be phase locked to an external reference and phase shifted from the start phase of the external reference from -180 to +180. The reference signal is applied to a front-panel input BNC. In this way, the same reference can be applied to multiple modules to generate multi-phase signal patterns. The reference signal for the PLL function is applied to the TRIG IN. It shares the same characteristics as the trigger input, programmable trigger level and programmable slope. When placed in this mode, the 3152A scans the TRIG IN connector for a valid signal. Once sensed, the 3152A measures its frequency and centers its lock-in range around this frequency. The 3152A then locks automatically on the frequency of the external signal. There is no need for manual initiation or operator intervention for locking the 3152A to an external reference. The PLL range is 500 Hz to 10 MHz.

## Frequency Counter

The 3152A uses an autoranging counter circuit to measure frequencies of reference signals at the trigger input. This built-in counter is made available for you in PLL mode. Thus, you can use the 3152A as a frequency counter provided that the signal at the trigger input is valid and the PLL ON LED illuminates. Frequencies are measured from 500 Hz to 10 MHz. External frequency query returns four digits with a decimal point and suffix multiplier.

## Phase Modulation

When the 3152A is placed in PLL mode, there are two ways to control the phase offset. The first option is to modify the phase offset setting using SCPI commands. This method is extremely accurate while permitting phase offset adjustments with 0.01 increments. The PM IN provides another option for changing phase offsets. Applying voltage to this input changes the start phase of the synthesizer continuously, depending on the voltage level at the phase modulation input. The applied voltage range is DC to 10 kHz, depending on the lock frequency and the number of waveform samples.

## Filter

Three filters are built into the 3152A, each having a different cutoff frequency and rise time properties. These filters are available for use in various applications, depending on the specific requirement. The 20 MHz Gaussian filter has a gaussian response which smooths fast transitions and eliminates ringing and aberrations. The 25 MHz and the 50 MHz filters are elliptical with a very sharp cutoff frequency. They are useful for removing the staircase effect from waveforms that are generated with high frequency clock rates.


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## Front Panel Indicators

There are three LEDs on the front panel. The FAIL LED (Red) illuminates at power-up until the 3152A has passed its self-test. If the 3152A self-test fails, the FAIL LED remains illuminated.

The FAIL LED may be illuminated during normal operation if the 3152A stops communication.

The ACCESS LED (Amber) illuminates each time a command has been received by the 3152A. This light remains on during shared memory data transfer.

The PLL ON LED is off during normal operation. In PLL mode, the PLL ON illuminates when a valid signal is available at the trigger input and lock frequency is available at the main output connector.

When the output state is on, the OUTPUT LED (Green) light illuminates. It goes off when the output state is changed to off.

## Programming The 3152A

The 3152A has no controls on the front panel. Instrument functions, parameters, and modes can only be accessed through VXIbus commands. There are a number of ways to "talk" to the instrument. They all require that an appropriate software driver be installed in the Resource Manager (slot 0). The rest is a matter of practice and knowledge of the language in use. There are other system considerations like address selection that have to be settled before programming the instrument. These topics are discussed in later chapters.

Low level programming of the 3152A is done using SCPI (Standard Commands for Programmable Instruments) language or using binary commands for high speed. Programming aspects are covered in **Chapters 3 and 4**.

High level drivers like VXI*plug&play* and WaveCAD are beyond the scope of this manual. Please check the Racal Instruments web site: www.racalinstruments.com to download the latest versions of the 3152A VXIplug&play install disk, LabVIEW driver and WaveCAD.



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# Chapter 2

# CONFIGURING THE INSTRUMENT

## Installation Overview

This chapter contains information and instructions necessary to prepare the 3152A for operation. Details are provided for initial inspection, grounding safety requirements, repacking instructions for storage or shipment, logical address selection and installation information.

## Unpacking and Initial Inspection

1. Remove the 3152A module and inspect it for damage. If any damage is apparent, inform the carrier immediately. Retain shipping carton and packing material for the carrier's inspection.

2. Verify that the pieces in the package you received contain the correct 3152A module option and the 3152A Users Manual. Notify EADS North America Defense Test and Services, Inc. if the module appears damaged in any way. Do not attempt to install a damaged module into a VXI chassis.

3. The 3152A module is shipped in an anti-static bag to prevent electrostatic damage to the module. Do not remove the module from the anti-static bag unless it is in a static-controlled area.

## Safety Precautions

The following safety precautions should be observed before using this product and associated computer. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cables, connector jacks, or test fixtures. The American National Standard Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak or 60 VDC are present.



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***WARNING:***

**For maximum safety, do not touch the product, test cables, or any other instrument parts while power is applied to the circuit under test. ALWAYS remove power from the entire test system before connecting cables or jumpers, installing or removing cards from the computer, or making internal changes such as changing the module address.**

***WARNING:***

**Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always keep your hands dry while handling the instrument.**

When using test fixtures, keep the lid closed while power is applied to the device under test. Safe operation requires that the computer lid be closed at all times during operation. Carefully read the “Safety Precautions” instructions that are supplied with your computer. Before performing any maintenance, disconnect the line cord and all test cables.

Maintenance should be performed by qualified service personnel.

## Performance Checks

The instrument has been inspected for mechanical and electrical performance before shipment from the factory. It is free of physical defects and in perfect electrical order. Check the instrument for damage in transit and perform the electrical procedures outlined in the section entitled **Unpacking and Initial Inspection**.

## Grounding Requirements

To insure the safety of operating personnel, the U.S. O.S.H.A. (Occupational Safety and Health) requirement and good engineering practice mandate that the instrument panel and enclosure be "earth" grounded. Although BNC housings are isolated from the front panel, the metal part is connected to earth ground.


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***WARNING:***

**Do not make an attempt to float the output from ground as it may damage the 3152A and your equipment.**

## Long Term Storage or Repackaging For Shipment

If the instrument is to be stored for a long period of time or shipped immediately, proceed as directed below. If you have any questions, contact your local EADS North America Defense Test and Services, Inc. Customer Service Department.

Repack the instrument using the wrappings, packing material and accessories originally shipped with the unit. If the original container is not available, purchase replacement materials.

Be sure the carton is well-sealed with strong tape or metal straps.

Mark the carton with the model and serial number. If it is to be shipped, show sending and return address on two sides of the box.

***NOTE:***

**If the instrument is to be shipped to EADS North America Defense Test and Services for calibration or repair, attach a tag to the instrument identifying the owner. Note the problem, symptoms, and service or repair desired. Record the model and serial number of the instrument. Show the work authorization order as well as the date and method of shipment. ALWAYS OBTAIN A RETURN AUTHORIZATION NUMBER FROM THE FACTORY BEFORE SHIPPING THE INSTRUMENT TO EADS NORTH AMERICA DEFENSE TEST AND SERVICES, INC.**

## Preparation For Use

Preparation for use includes removing the 3152A from the container box, selecting the required logical address and installing the module in a VXIbus chassis.



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## Logical Address Selection

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

To change the 3152A's logical address, use the 8-position DIP switch accessible from the top side of the module near the rear end of the case (switch S1). **Figure 2-1** shows the location of the logical address switch. The switches are marked with numbers 1 to 8. The 3152A uses binary values ($2^0$ to $2^7$) to set the logical address using the active low address switch. A switch is active when its arm is placed in the ON position.

EADS North America Defense Test and Services, Inc. ships the 3152A with logical address 2.

## Emulation Mode Selection

The 3152A Synthesizer has numerous enhancements over the older 3152 and 3152-S-1619. For those customers wishing to use the 3152A as a direct replacement for the 3152 or 3152-S-1619, the 3152A has an emulation mode capability. In this mode of operation, the 3152A will identify itself as a 3152 or 3152-S-1619 and act exactly like the selected model.

***NOTE:***

**When using the 3152A in 3152 emulation mode, the 3152 Software Driver must be used. This driver is available on the Racal Instruments web site http://www.racalinstruments.com software Drivers download area.**

The module is shipped from the factory in 3152A Mode. To put the module in 3152 or 3152-S-1619 emulation mode, simply flip the appropriate position of the Instrument ID switch. This switch is accessed through the left side panel of the module. Setting the switch to the ON position entails moving the switch towards the front panel. This is shown in **Figure 2-2**.

## Address Space Selection

The 3152A Synthesizer may operate in either A24 or A32 Address Space modes. The module is shipped from the factory in A24 mode. To set the module to A32 mode set the switch to the ON position by moving the switch towards the front panel. This is shown in **Figure 2-2**.


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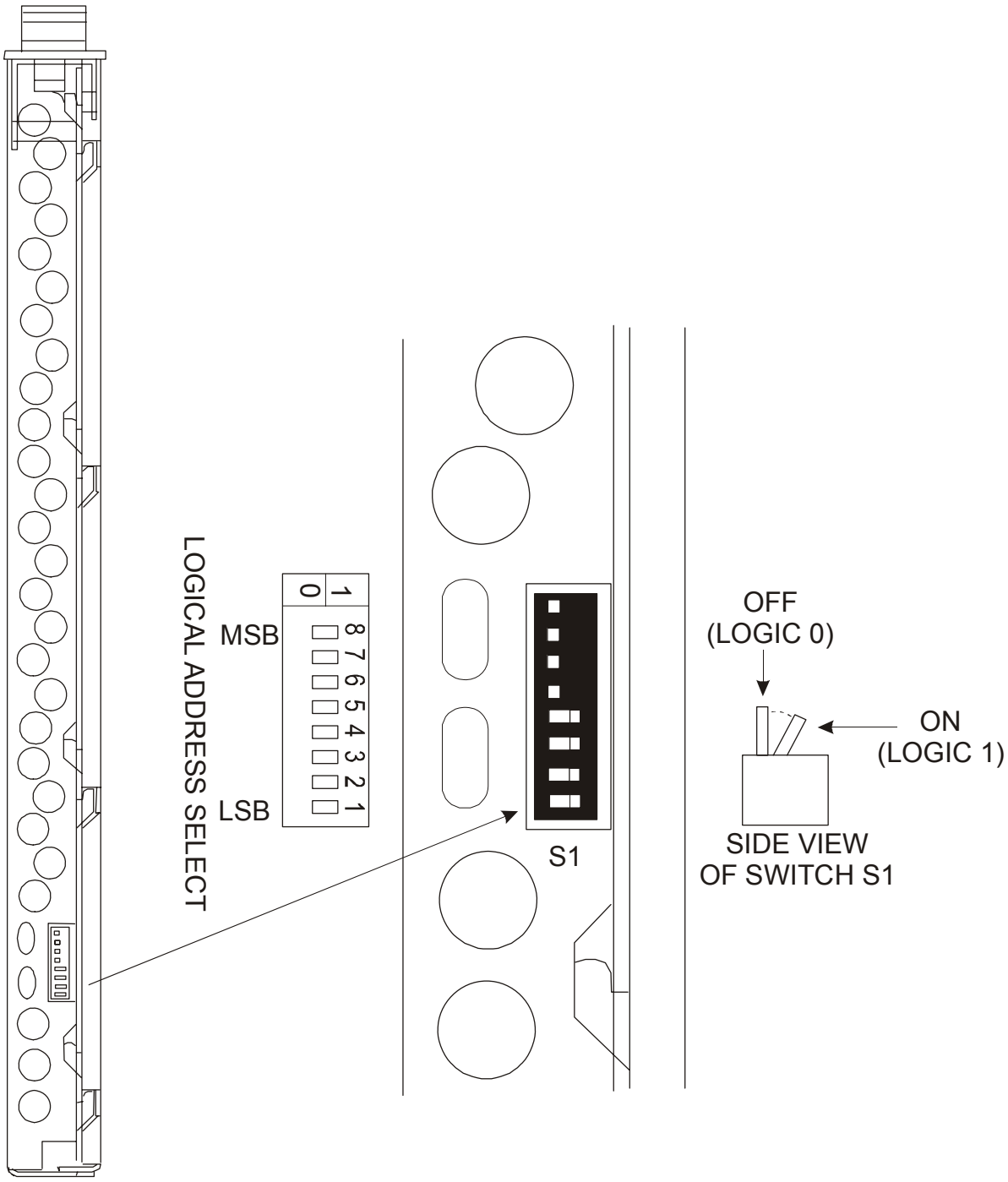



**Figure 2-1, Set The Logical Address**



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## Installation

The instrument can be installed in any slot except slot 0 in a VXIbus mainframe. When inserting the instrument into the mainframe, it should be gently rocked 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 two captive screws above and below the ejectors to secure the instrument into the chassis.

After installation, perform an initial checkout and operational verification.

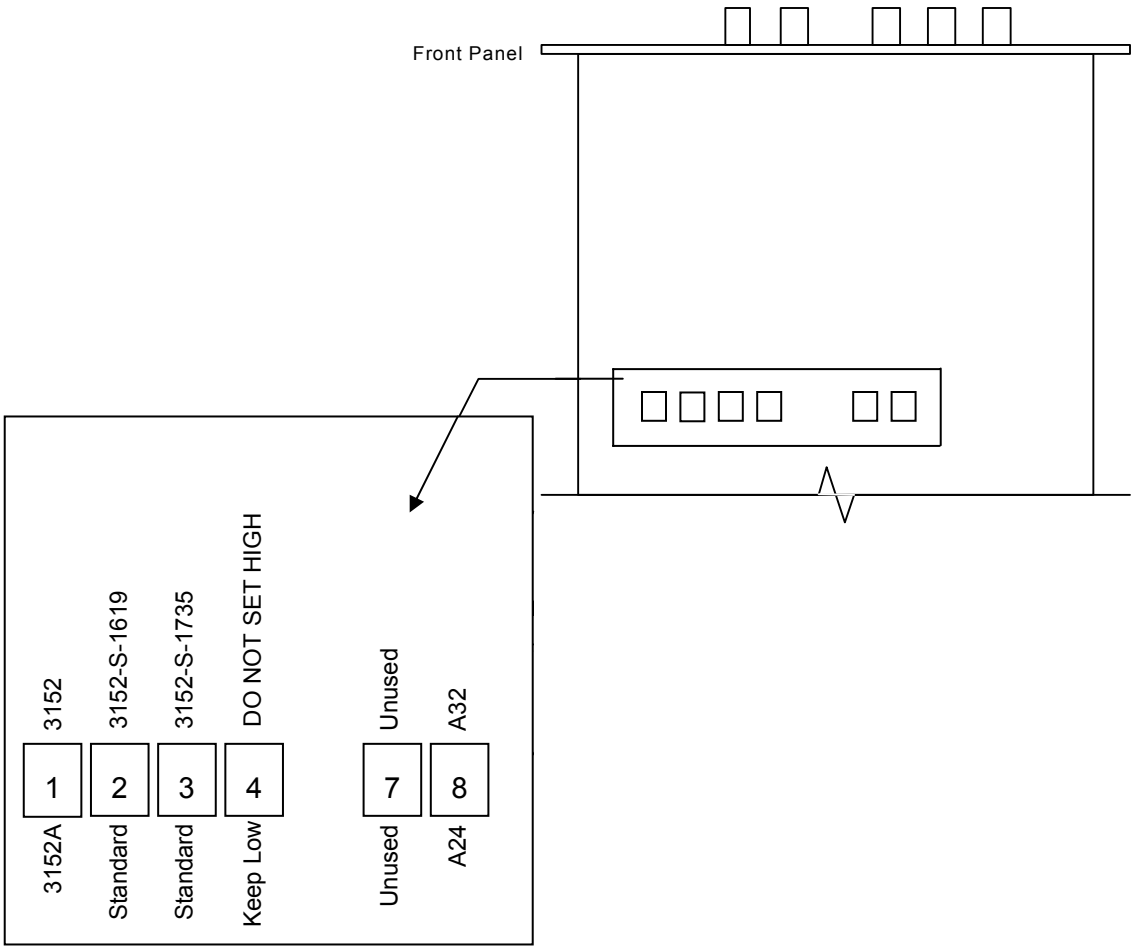



**Figure 2-2, 3152 Emulation Mode and Address Space Switch**


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# Chapter 3
# USING THE INSTRUMENT

## Overview

This chapter contains information about how to operate the 3152A. Unlike bench-type instruments, the 3152A must be programmed to turn on functions, change parameters and configure various operating modes. The instrument can be programmed using a set of SCPI commands. A list of SCPI commands (and the alternate HS command set) that control the 3152A is given in **Table 4-1**. The following paragraphs describe the various modes of operation and give examples on how to program the 3152A.

## Output Termination

During use, output connectors must be properly terminated to minimize signal reflection or power loss due to an impedance mismatch. Proper termination is also required for an accurate amplitude level at the main output connector. Use 50Ω cables and terminate the main and SYNC cables with terminating resistors. Always place the 50Ω termination at the far end of the cables.

## Input/Output Protection

The 3152A provides protection for internal circuitry connected to input and output connectors. Refer to the specifications in **Appendix A** to determine the level of protection associated with each input or output connector.

## Power On/Reset Defaults

At Power On or as a result of a software reset, the 3152A defaults to the conditions shown in **Table 3-1**. A complete list of all parameters and their default values is given in **Chapter 4**.

Use the following command to place the instrument in its default state:

```
RESet;
```

Using the IEEE-STD-488.2 common command *RST will have the same result.



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**Table 3-1, Default Conditions After Power On, RESet or *RST**

| | | | |
|---|---|---|---|
| Output State: | Off | Operating Mode: | Continuous |
| Filter State: | Off | Filter Type: | 20MHz |
| ECLTRG0-1: | Off | TTLTRG0-7: | Off |
| Output Trigger Source: | BIT | SYNC State: | Off |
| Std. Wave Frequency: | 1 MHz | Arb. Wave Sample Clock: | 1 MHz |
| Amplitude: | 5V | Offset: | 0V |
| Output Mode: | FIXed (Std.) | Standard Waveform: | Sine |
| Inter-module Phase | | Advance Mode: | Auto |
| Synchronization State: | Off | SYNC Out Position: | Point n-6 |
| | | SYNC Slate: | Off |
| Trigger Slope: | Positive | Internal Trigger Period: | 100s |
| Shared Memory State: | Off | Shared Memory Mode: | Read |

## What To Do Now

When writing low level code to operate the 3152A, follow the instructions in this chapter to understand the meaning and response that each command generates. Examples contained in the following paragraphs show basic techniques on how to program output waveforms.

Example 1

The following example programs the 3152A to turn on the main output, generate a square waveform, program the frequency to 2 MHz, program the amplitude to 5 V and offset to 2.5 V.

/* Reset the Model 3152A to its default condition as listed in **Table 3-1**.*/

```
:RESet;
```

/* Change the output waveform to square. Note that there is no need to use the FUNC:MODE command as the default value after RESet is FIXed.*/

```
:FUNCtion:SHAPe SQUare;
```

/* Change the frequency to 2 MHz.*/

```
:FREQuency 2e6;
```

/*Change the amplitude to 5 V and the offset to 2.5 V.*/

```
:VOLTage 5;
```

```
:VOLTage: OFFSet 2.5;
```



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There are three offset windows (±8 V, ±800 mV, ±80 mV); the window selected is a function of the amplitude setting. **Table 3-2** shows the maximum offset available within each window.

**Table 3-2, Peak to Peak Amplitude and Offset Ranges**

| Attenuator Range | Amplitude Range | Window | Maximum Offset |
|---|---|---|---|
| 1 | A > 1.6 V | ±8 V | 0 to ±7.19 V |
| 2 | 160 mV < A ≤ 1.6 V | ±800 mV | 0 to 719 mV |
| 3 | 10 mV ≤ A ≤ 160 mV | ±80 mV | 0 to 75 mV |

To calculate the maximum offset available for a particular amplitude setting, use the following inequality:

$$\frac{V_{amplitude}}{2} + |V_{offset}| \leq 8V|800mV|80mV$$

In FIXed (Std.) Waveform mode, amplitude and offset limitations may be exceeded at a cost of dynamic range of the output AC signal.

For example, a FIXed mode sine wave with a 800mV peak to peak amplitude will force the 3152A into attenuator range 2 as long as the offset voltage setting does not exceed the maximum calculated by the equation above (400mV). But, if a 2V offset is needed, the 3152A will be forced into attenuator range 1 because 1.6V will be exceeded. Since the smallest full-scale signal cannot be less than 1.6V peak to peak in this range, the 3152A's main DAC must generate the waveform at 50% of full scale. This reduces the resolution to 11 bits, reducing the 3152A's dynamic range by 6dB.

/* Turn the main output on.*/

:OUTPut ON;

/*Turn the SYNC output on, if required.*/

:OUTPut:SYNC ON;

If the above commands are executed correctly, a square waveform will be seen on your oscilloscope.



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## Using the APPLy Command

The APPLy command provides a high level method of programming the synthesizer. 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 using APPLy:

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 synthesizer was programmed using the above APPLy:SQU command, query the square wave parameters using the following query:

APPL:SQU?



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The synthesizer returns a string that contains all the parameters associated with the square function similar to the following string:

“1.000000e+6,2.000,0.000,50"

The command:

APPLy: SINusoid {<frequency>,<amplitude>,<offset>, <phase>,<power>}

programs the synthesizer to output a sine waveform with frequency, amplitude, offset, start phase and power parameters. Parameters are not optional if the above APPLy command is used. Include all other parameters in the command. The default settings for these functions are: 1 MHz, 5 Vp-p, 0 V, 0 and 1.

APPLy: TRIangle {<frequency>,<amplitude>,<offset>, <phase>,<power>}

programs the synthesizer to output a triangle waveform with frequency, amplitude, offset, start phase, and power parameters. The default settings for these functions are: 1 MHz, 5 Vp-p, 0 V, 0 and 1.

The command:

APPLy: SQUare {<frequency>,<amplitude>,<offset>, <duty_cycle>}

programs the synthesizer to output a square waveform with frequency, amplitude, offset and duty cycle parameters. The default settings for these functions are: 1 MHz, 5 Vp-p, 0 V, and 50%.

The command:

APPLy: PULSe{<frequency>,<amplitude>,<offset>, <delay>,<high_time>,<rise_time>,<fall_time>}

programs the synthesizer to output a pulse waveform with frequency, amplitude, offset, delay, rise time, high time and fall time parameters. The default settings for these functions are: 1 MHz, 5 Vp-p, 0 V, 0%, 10%, 10% and 10%.



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The command:

APPLy: RAMP {<frequency>,<amplitude>,<offset>, <delay>, <rise_time>,<fall_time>}

programs the synthesizer to output a ramp waveform with frequency, amplitude, offset, delay, rise time, and fall time parameters. The default settings for these functions are: 1 MHz, 5 Vp-p, 0 V, 0%, 10% and 10%.

The command:

APPLy: SINC {<frequency>,<amplitude>,<offset>, <number_cycles>}

programs the synthesizer to output a sine(x)/x waveform with frequency, amplitude, offset, and number of cycles parameters. The default settings for these functions are: 1 MHz, 5 Vp-p, 0 V and 10.

The command:

APPLy: EXPonential <frequency>,<amplitude>,<offset>, <exponent>}

programs the synthesizer to output an exponential waveform with frequency, amplitude, offset, and exponent parameters. The default settings for these functions are: 1 MHz, 5 Vp-p, 0 V and -10.

The command:

APPLy: GAUSsian {<frequency>,<amplitude>,<offset>, <exponent>}

programs the synthesizer to output a gaussian waveform with frequency, amplitude, offset, and exponent parameters. The default settings for these functions are: 1 MHz, 5 Vp-p, 0 V and 10.

The command:

APPLy: DC {<percent_amplitude>}

programs the synthesizer to output a DC level. The DC level is set as a percent of programmed amplitude. The default setting for this function is 100%.


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The command:

APPLy: USER {<segment_number>,<sampling_clock>, <amplitude>,<offset>}

programs the synthesizer to output an arbitrary waveform. The specified segment number must be loaded with an arbitrary waveform before the synthesizer can execute this command successfully. This command lets you specify segment number, sampling clock rate, amplitude and offset. The default settings for these functions are: 1, 1 MHz, 5 Vp-p and 0 V.

The query:

APPLy:<function_shape>?

queries parameters associated with the specified function shape. Returns a string of values depending on the parameters that are available for the selected function shape.

The query:

APPLy?

queries parameters associated with the currently selected function shape and returns a string of values depending on the parameters available for the selected function shape. For example, if the synthesizer is programmed to output a ramp waveform, the APPL? command returns: "1e+6, 5, 0 , 0, 10, 10, 10".

**Example 2**

The following example programs the 3152A using the APPLy command. This example turns on the main output, generates a square waveform, programs frequency to 2 MHz, programs amplitude to 5 V and offset to 2.5 V. It also changes the square wave duty cycle parameter to 25%.

/* Reset the Model 3152A to its default condition as listed in **Table 3-1**.*/

:RESet;



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/* Change the output waveform to square, frequency to 2 MHz, amplitude to 5 V, offset to 2.5 V and duty cycle to 25%. Note that there is no need to use the FUNC:MODE command because the default value after RESet is FIXed.*/

:APPLy:SQUare 2e6,5,2.5,25

/* Turn the main output on. */

:OUTPut ON

/*Turn the SYNC output on, if required. */

:OUTPut:SYNC ON

If the above commands are executed correctly, a square waveform will be seen on your oscilloscope.

## Output Configuration Commands

The output configuration commands control the output function, shape, frequency, amplitude, filter and state. Optional modes are omitted from these commands.

## Selecting an Output Function Type

Use the following command to select the output function type:

FUNCtion:MODE {FIXed | USER | SEQuence | SWEep}

When "FIXed" is selected, the synthesizer outputs the standard waveform currently selected by the FUNC:SHAP command. When "USER" is selected, the synthesizer outputs the arbitrary waveform currently selected by the TRAC:SEL command. When "SEQuence" is selected, the synthesizer outputs the sequence that is programmed using the SEQ:DEF command. When “SWEep” is selected, a sweep waveform is calculated according to the sweep settings and downloaded into the instrument. See **Using Sweep Mode** for more information.

***CAUTION:***

**Placing the 3152A in Sweep Mode overwrites any waveforms, segments or sequences that are currently stored in 3152A memory. Be sure to back up any critical data stored in the 3152A before entering Sweep Mode.**



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The query:

FUNCtion:MODE?

queries the output function type and returns either FIX, USER, SEQ or SWE.

## Selecting a Standard Function Shape

Use the following command to select a standard output function:

FUNCtion: SHAPe {SINusoid | TRIangle | SQUare |

PULSe | RAMP | SINC | EXPonential | GAUSsian | DC}

The selected waveform is output using the previously selected frequency, amplitude, offset, and other relevant settings. The standard waveform will be output only after the FUNC:MODE:FIX command is selected.

The query:

FUNCtion:SHAPe?

queries the standard function shape and returns either SIN, TRI, SQU, PULS, RAMP, SINC, EXP, GAUS or DC.

## Changing the Frequency and Sample Clock

Use the following command to change the frequency for standard waveforms and sample clock for arbitrary waveforms:

FREQuency {<frequency> | MINimum | MAXimum}

MIN selects the lowest frequency allowed for the currently active function. MAX selects the highest frequency allowed for the currently active function. The default frequency setting is 1 MHz for all functions.

The query:

FREQuency?

queries the frequency setting for the standard function currently active and returns a value in Hertz.



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The command:

FREQuency: RASTer {<frequency> | MINimum |

MAXimum}

sets the sample clock frequency for the user and sequenced functions. MIN selects the lowest frequency allowed for the currently active segment or sequence. MAX selects the highest frequency allowed for the currently active segment or sequence. The default sample clock frequency setting is 1 MHz for all functions.

Note that the output frequency depends on the number of points specified in the waveform. The output frequency can be computed using the following formula: Output Frequency = Sample Clock / Number of points in the active segment.

The query:

FREQuency:RASTer?

queries the sample clock frequency setting for the arbitrary segment or sequence currently active and returns a value in Hertz.

## Selecting the Sample Clock Source

Use the following command to select the source for the sample clock for the user and sequenced functions:

FREQuency:RASTer:SOURce {EXT | INT | ECLTrg0}

EXT selects an external clock source. The external source is applied to the front panel CLOCK IN connector. INT selects the internally synthesized clock synthesizer. ECLTrg0 selects a sample clock that is available on the backplane. Note that ECLTrg0 is always the active sample clock source when the 3152A is set to operate as a slave in phase synchronization mode.

The query:

FREQuency:RASTer:SOURce?

queries the sample clock source setting and returns EXT, INT or ECLT0.



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## Programming the Output Amplitude and Offset

Use the following command to program the peak-to-peak amplitude for the generated waveform.

VOLTage {<amplitude>|MINimum|MAXimum}

MIN selects the smallest amplitude. MAX selects the largest amplitude. The default amplitude is 5.00 V (into 50Ω).

The query:

VOLTage?

queries the output amplitude for the currently selected function and returns a value in volts.

The command:

VOLTage:OFFSet <offset>

sets the offset for the currently active function. The default offset is 0 V.

The query:

VOLTage:OFFSet?

queries the output offset for the currently selected function and returns a value in volts.

## Selecting the Filter Type

Before selecting the filter type, use the following command to activate the filter:

OUTPut: FILTer { OFF | ON}

ON enables the filter that has been selected with the OUTP:FILT:FREQ command. The default filter state setting is OFF.

The query:

OUTPut:FILTer?

queries the output filter state and returns "0" (OFF) or "1" (ON).

The command:

OUTPut:FILTer:FREQuency {<20MHz | 25MHz | 50MHz>}



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sets the filter frequency for the currently active function. 20 MHz has a Gaussian response, and the 25 MHz and the 50 MHz filters have an Elliptical response. Note that the filters cannot be changed if the synthesizer is set to output sine waveform from its standard waveform library. The filters will be activated only after the OUTP:FILT ON command. The default filter setting is 20 MHz. Note also that 20 MHz, 25 MHz and 50 MHz designate filter types. These parameters should be programmed as switches, not as values. The filter type **cannot** be programmed using OUTP:FILT:FREQ 25e6 or OUTP:FILT:FREQ 50e6 Hz.

The query:

OUTPut:FILTer:FREQuency?

queries the currently selected filter setting and returns 20 MHz, 25 MHz or 50 MHz.

## Activating the Backplane ECLTRG and TTLTRG Lines

The 3152A can transmit and receive signals on the VXIbus ECLTRG and TTLTRG lines.

Use the following command to activate one of two backplane ECLTRG lines:

OUTPut: ECLTrg<n> { OFF | ON}

<n> designates the activated trigger line; 0 and 1 are available. ON enables the selected trigger line. The trigger source for this line can be selected with the TRIG:SOUR command. The default ECLTrg<n> state is OFF.

The query:

OUTPut:ECLTrg<n>?

queries the ECLTrg<n> state and returns "<n>,0" (OFF) or "<n>,1" (ON).

Turning on ECLTRG0 causes the module sample clock signal to be routed onto the VXI backplane. Other 3152As may be set up to receive this sample clock using the command FREQ:RAST:SOURCE ECLTRG0 (See **Selecting the Sample Clock Source**). ECLTRG1 should not be enabled onto the backplane. Note that ECLTRG0 and ECLTRG1 are both used for Inter-Module Synchronization.

The TTLTRG lines can be used to transmit and receive trigger signals between the 3152A and other VXIbus modules.


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Use the following command to activate one of eight backplane TTLTRG lines:

OUTPut: TTLTrg<n> { OFF | ON}

<n> designates the activated trigger line and 0 through 7 are available. ON enables the selected trigger line. The trigger source for this line can be selected with the TRIG:SOUR command. The default TTLTrg<n> state setting is OFF.

The query:

OUTPut:TTLTrg<n>?

queries the TTLTRG<n> state and returns "<n>,0" (OFF) or "<n>,1" (ON).

## Assigning the Validating Source For TTLTRG

The TTLTRG signals, when enabled and placed on the backplane, can be asserted with signals coming from a number of sources. Use the following command to assign the signal source for the active TTLTRG line:

OUTPut:TRIGger:SOURce {BIT | LCOMplete | INTernal | EXTernal}

**BIT** Generates a trigger signal at any point in the waveform. The trigger position within the waveform can be programmed using the OUTPUT:SYNC:POS:POIN command. This command is used to set both the TRIGger point and the SYNC point.

**LCOMplete** Generates a trigger signal in SEQuence mode only once when the selected segment appears for the first time.

**INTernal** Generates a trigger signal at intervals set by the internal trigger generator.

**EXTernal** Generates a trigger signal every time a trigger is applied to the front panel TRIG IN connector.

The query:

OUTPut:TRIGger:SOURce?

queries the validating signal source for the backplane TTLTRG<n> lines and returns BIT, LCOM, INT or EXT.



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## Enabling the Main Output

For safety reasons, the main output default setting is OFF. Disable or enable the main output using the following command:

OUTPut {OFF | ON}

When the main output state is programmed to ON, the output connector is connected to the output amplifier through a 50Ω resistor. In the OFF position, the output connector is disconnected from the output amplifier by means of a mechanical relay. Ensure that voltage is **not** applied to the main output connector when the 3152A output state is programmed to ON.

The query:

OUTPut?

queries the state of the main output and returns "0" (OFF) or "1" (ON).

## Enabling the SYNC Output

For safety reasons, the SYNC output default setting is OFF. Disable or enable the SYNC output using the following command:

OUTPut: SYNC {OFF | ON}

When the SYNC output state is programmed to ON, the SYNC output connector generates signals which are triggered by signals selected using the SYNC:SOUR command. In the OFF position, the SYNC connector has no output. It is connected electrically to the internal circuitry at all times. Ensure that voltage is **not** applied to the SYNC at any time. The default SYNC position is the 6th point from the end of the waveform. The position of the SYNC signal can be programmed using the OUTPUT:SYNC:POS:POIN command.

The query:

OUTPut:SYNC?

queries the state of the SYNC OUTPUT and returns "0" (OFF) or "1" (ON).


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## Assigning the Source For The SYNC Output

The SYNC output, when enabled, can be triggered by signals coming from a number of sources. Use the following command to select the source for validating the SYNC output:

OUTPut:SYNC:SOURce {BIT | LCOMplete | SSYNc | HCLock | PULSe}

**BIT** 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 countinuous mode.

**LCOMplete** 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 Sequence mode.

**SSYNc** 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.

**HCLock** Generates a trigger signal at intervals equal to half of the period of the sample clock. This option is useful for synchronizing two-point waveforms on an oscilloscope (sine and square waveforms above 10 MHz).

**PULSe** 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 3152A to emulate the sync pulse of another instrument that it is replacing in a test system.

The query:

OUTPut:SYNC:SOURce?

queries the signal source for the SYNC output and returns BIT, LCOM, SSYN, HCL or PULS.



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## Selecting the SYNC Position

The SYNC output can be programmed to output the SYNC signal at any point along the output waveform. Use the following command to select the SYNC output position:

OUTPut:SYNC:POSition[:POINt] <value>

The SYNC position can be selected from point 0 to the last point of the active waveform. SYNC position has to be programmed for each segment. The default SYNC position is 6 points from the end of the segment.

The query:

OUTPut:SYNC:POSition:POINt?

Queries the output SYNC position and returns an integer value.

## Setting the Sync Pulse Width

The sync output can be programmed to output a pulse with a programmable pulse width. Use the following command to set the sync pulse width:

OUTPut:SYNC:WIDTh <value>

The sync pulse width can be set to any number between 2 and 500 points. Sync width can be calculated by multiplying the Sampling Clock Period x OUTP:SYNC:WIDTh.

The query:

OUTPut:SYNC:WIDTh?

Queries the output sync width and returns an integer value.


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## Using the Built-In Standard Waveforms

The Standard Waveform commands control the various parameters of the active Standard Waveform. Standard waveform commands operate in a similar fashion for each of the Standard Waveforms. To simplify the description of this set of commands, only the standard waveform commands for the PULSe function are described. Use the same procedure to program parameters for the SINe, TRIangle, RAMP, SQUare, SINC, GAUSsian, EXPonential and DC waveforms.

The number of points used to define each Standard Waveform varies. For SINe and SQUare:

Freq $\leq$ 200kHz  Points = 500

Freq < 200kHz  $\text{Points} = \frac{100MHz}{Freq}$

Freq > 10MHz  Points = 10

For RAMP, PULSE, GAUSSian and EXPonential:

Freq $\leq$ 100kHz  Points = 1000

Freq > 100kHz  $\text{Points} = \frac{100MHz}{Freq}$

For TRIangle and SINC:

Freq $\leq$ 200kHz  Points = 500

Freq > 200kHz  $\text{Points} = \frac{100MHz}{Freq}$

The equations used for generating EXPonential, GAUSian and SINC functions are as follows:



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For the Positive EXPonential:

$$F(m) = -\frac{A}{2} + \frac{A}{2}\left[ e^{\frac{m}{7.7t}} - 1 \right]$$

Where

A = Amplitude

m = Current point (I..N)

N = Total number of points

t = Time constant set by user

For the Negative EXPonential:

$$F(m) = Ae^{-\mathrm{m}^2/\mathrm{t}^2} - \frac{A}{2}$$

For GAUSsian:

$$F(m) = Ae^{-\mathrm{m}^2/\mathrm{t}^2} - \frac{A}{2}$$

For SINC:

$$F(m) = \frac{Sine(2\pi \frac{m}{R}) \bullet A}{2\pi \frac{m}{R}}$$

Where $\mathrm{R} = \frac{N}{cyc}$ (number of points per cycle)

cyc = Number of cycles of SINC



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The selected standard waveform will be available at the output connector only after the FUNC:MODE FIX command has been executed.

With the FUNC:SHAP PULS selection, parameters for the PULSe function will effect the output waveform when modified. Note that changes made to parameters for a specific function do not have any effect on other functions. Also, changes made to other function parameters while the pulse shape is selected will not have any effect until that pulse shape is selected.

The command:

PULSe: DELay <value>

Sets the pulse delay in percent of the pulse period. For example, if the pulse period is 100 ms, 10% will delay the first transition of the pulse by 10 ms. Delay is measured from trigger to the first turning point.

The query:

PULSe:DELay?

queries the pulse delay setting and returns a value in percent.

The command:

PULSe: TRANsition <value>

sets the pulse rise time in percent of the pulse period. For example, if the pulse period is 100 ms, 5% rise time equals 5 ms. Pulse rise time is measured between the two turning points of the first transition.

The query:

PULSe:TRANsition?

queries the pulse rise time setting and returns a value in percent.

The command:

PULSe: WIDTh <value>

sets the pulse width in percent of the pulse period. For example, if the pulse period is 100 ms, 20% pulse width equals 20 ms. Pulse width is measured between the two turning points on the top of the pulse. The query:

PULSe:WIDTh?

queries the pulse width setting and returns a value in percent.



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The command:

PULSe:TRANsition: TRAiling <value>

sets the pulse fall time in percent of the pulse period. For example, if the pulse period is 100 ms, 15% fall time equals 15 ms. Pulse fall time is measured between the two turning points of the second transition.

The query:

PULSe:TRANsition:TRAiling?

queries the pulse fall time setting and returns a value in percent.

## Selecting an Operating Mode

The 3152A offers four operating modes: Continuous, Triggered, Gated and Burst. The selected waveform is repeated continuously when the instrument is set to operate in Continuous mode. In this mode, the 3152A does not require a trigger source to stimulate its output cycles. The default operating mode of the instrument is continuous.

Triggered, Gated, and Burst modes require an external signal to initiate output cycles. Information on how to trigger, gate and output a burst of waveforms is given in the following paragraphs.

## Triggered Mode

In Triggered mode, the output remains at a certain DC level as long as the TRIG IN signal from the front panel remains inactive. A TTL signal is used to stimulate the TRIG input. The synthesizer is sensitive to either the rising edge or the falling edge. Each time a transition at the trigger input occurs, the 3152A generates one complete output waveform. At the end of the output cycle, the output resumes position at a DC level equal to the last point of the waveform.

The Triggered mode operates on standard waveforms and arbitrary waveforms. Observe the limitations of the trigger signal as listed in the specification section of this manual. Note that for Standard Waveforms, other than square wave, the 3152A is limited to signal frequencies of 10 MHz or less. To place the 3152A in Triggered mode, use the following command:

INITitiate:CONTinuous {OFF | ON}


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OFF places the instrument in Triggered mode. ON restores continuous operation.

The query:

INITitiate: CONTinuous?

queries the instrument operating mode parameter and returns "0" (OFF) or "1" (ON).

## Gated Mode

The 3152A can be set to operate in Gated mode only after the INIT:CONT OFF command has been received. The output remains at a certain DC level as long as the TRIG IN signal from the front panel remains inactive. A TTL level signal is used to stimulate the TRIG input. The gating signal can be programmed to be either active high or active low. Each time the proper level is present at the trigger input connector, the 3152A generates output waveforms as long as the gate signal is present. When the gate signal is de-asserted, the output completes the last cycle and resumes position at a DC level equal to the last point of the waveform.

Gated mode operates on standard waveforms, arbitrary waveforms, and on sequences of waveforms. Observe the limitations of the gating signal as listed in the specification section of this manual. To place the 3152A in Gated mode, use the following commands:

INIT:CONT OFF

TRIGger: GATE {OFF | ON}

The default state for the Gated mode is OFF. Turning Gated mode ON automatically turns Burst mode off.

The query:

TRIGger:GATE?

queries the gate state and returns "0" (OFF) or "1" (ON).



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## Burst Mode

Burst mode is very similar to Triggered mode with the exception that only one trigger signal is needed to generate a counted number of output waveforms. In Burst mode, the output remains at a certain DC level as long as the TRIG IN signal from the front panel remains inactive. A TTL signal is used to stimulate the TRIG input. The generator is sensitive to either the rising edge or the falling edge. Each time a transition at the trigger input occurs, the 3152A generates a number of output cycles that have been programmed in the burst count parameter. At the end of the burst, the output resumes position at a DC level equal to the last point of the waveform. The burst count is programmable from 1 to $10^6$. The default burst value is 1.

The Burst mode operates on standard waveforms and arbitrary waveforms. Note that the 3152A cannot operate in Sequence and Burst modes simultanously. Observe the limitations of the trigger signal as listed in the specification section of this manual. To place the 3152A in Burst mode, use the following commands:

INITitiate:CONTinuous OFF

TRIGger: BURSt ON

TRIGger: COUNt <counts>

INIT:CONT OFF places the 3152A in a non-continuous mode. TRIG:BURS ON turns the burst function on. The TRIG:COUN specifies the number of waveforms output after a qualified trigger signal. To ensure proper operation, enable Burst mode after setting up the burst parameters. When Burst mode is enabled, previously programmed Trigger or Gate modes turn off automatically.

The query:

TRIGger:BURSt?

queries the state off Burst mode and returns "0" (OFF) or "1" (ON).

The query:

TRIGger:COUNt?

queries the burst count and returns an integer.


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## Selecting the Trigger Source

When an external source is not available, the operator has the option to use either the built-in trigger generator or a TTLTRG<n> signal to stimulate its output. Use the following command to select the trigger source for the instrument:

TRIGger:SOURce: ADVance {EXTernal | INTernal | TTLTrg<n>}

EXT is the default trigger source for the 3152A. Select the TTLT<n> option with <n> ranging from 0 to 7 to use one of the TTLTRG lines available on the backplane. Select INT to use the internal trigger generator. Remember to program the period of this generator (as shown later).

The query:

TRIGger:SOURce:ADVance?

queries the trigger source and returns EXT, INT or TTLT<n>.

## Using the Internal Trigger Generator

The internal trigger generator is a free-running generator which is asynchronous with the main output generator. When the internal trigger source is selected, the front panel TRIG IN signal is inactive. The internal trigger generator is also available in Burst mode, but has no effect in Gated mode. To use the internal trigger generator, place the instrument in Triggered mode, but select the internal trigger generator as the trigger source. Then use the following command to program an internal trigger period:

TRIGger: TIMer <value>

The period of the internal trigger generator can be programmed from 15 µs to 1000 s. The default period is 100 µs. The internal trigger generator is ignored when either an external or TTLT source is enabled.

The query:

TRIGger:TIMer?

queries the period of the internal trigger generator and returns a value in seconds.



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## Selecting the Trigger Slope

The trigger slope command selects the sensitive edge of the trigger signal that is applied to the TRIG IN connector. The 3152A can be made sensitive to either positive or negative transitions. Use the following command to select the edge sensitivity for the trigger signal:

TRIGger: SLOPe {POSitive | NEGative}

Positive going transitions will trigger the 3152A when the POS option is selected. Negative transitions will trigger the 3152A when the NEG option is selected. POS is the default slope.

The query:

TRIGger:SLOPe?

queries the trigger slope and returns POS or NEG.

## Using the Trigger Delay

The trigger delay command delays the output of a triggered or burst waveform by a specified number of sample clock cycles by a value of 10 to 2 million cycles. Actual delay is calculated by $T_{delays} = D_{cycles} / f_{SCLK}$ where $D_{cycles}$ is the programmed delay and $f_{SCLK}$ is the sample clock frequency setting. Enable or disable this feature by setting the STATe:

TRIGger:DELay:STATe {OFF | ON}

TRIGger:DELay: <value>

The queries:

TRIGger:DELay:STATe?

TRIGger:DELay?

query the state of the trigger delay feature and the delay value.



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## Selecting the Trigger Level

The trigger level command sets the threshold level at the trigger input connector. Trigger levels are adjustable from -10 V to +10 V with up to 4 digits. Trigger level resolution is always 10 mV. Use the following command to set the trigger level for the trigger signal:

TRIGger:LEVel <value>

This sets the trigger level for the signal which is applied to the TRIG IN. The default value is 1.6 V so there is no need to modify this value if you apply a TTL level signal to the trigger input.

TRIGger:LEVel?

queries the trigger level and returns a value in Volts.

## Using the Soft Trigger

There are a number of commands that are available to trigger the 3152A. The soft trigger command is one of them. To use the soft trigger command, place the instrument in the TRIG:SOUR EXT mode. Soft trigger is ignored in the internal or TTLTrg<n> modes. Use the following SCPI commands to trigger the instrument:

TRIGger

The IEEE-STD-488.2 common command *TRG will have the same effect. Use either software command to trigger the 3152A in Trigger, Burst and Triggered Sequence Advance modes.

## Generating Arbitrary Waveforms

The 3152A cannot generate arbitrary waveforms without first loading them into memory. A description of the arbitrary waveform function and an explanation on how to load waveforms into memory is given in the following paragraphs.



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## What Are Arbitrary Waveforms?

Arbitrary waveforms are generated from digital data points that are stored in memory. Each data point has vertical resolution of 12 bits (4096 points), i.e., each sample is placed on the vertical axis with a precision of 1/4096.

Arbitrary waveform memory has the capacity to store up to 512K of horizontal data points. Each horizontal point has a unique address - the first being 00000 and the last being 523,287. In cases where smaller wavelengths are required, the 3152A's waveform memory can be divided into smaller segments. Then it is possible to select which segment is sampled, how many times and in what sequence.

When the instrument is programmed to output arbitrary waveforms, a 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. The 3152A provides programmable sample clock rates from 100mHz to 100MHz.

Unlike the built-in standard waveforms, arbitrary waveforms must first 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 arbitrary waveform memory is given in the following paragraphs.

## Arbitrary Memory Management

The 3152A's arbitrary memory consists of a fixed length of 524,288 words. 1000 words are always reserved for the built-in standard waveforms. The maximum size arbitrary waveform that can be loaded into memory is 523,288 points long. It is not necessary to use the complete length of this memory. The memory can be partitioned into smaller segments and different waveforms can be loaded into each segment. The memory can be partitioned into 4096 segments, each having a unique length and identity. Minimum segment length is 10 points. Information on how to partition the memory is given in the following paragraphs.


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## Memory Management Commands

Arbitrary memory can be divided into smaller segments; up to 4096 different arbitrary waveforms can be generated with the 3152A. The length of each segment is left totally to the user's discretion. To partition the arbitrary waveform memory, use the following command:

TRACe: DEFine <segment_number>,<length>

Note that numbers, not names, are assigned to segments that are defined. Numbers can range from 1 through 4096. The order of assignment is not important as long as the size of the segments, having already been defined, is not changed. You cannot query the TRAC:DEF command so you must keep good track if you intend to partition the memory into many segments.

If a mistake is made and removal of one or more segments from the active directory is needed, use the following command:

TRACe: DELete <n>

where <n> is the number of the segment to be removed from memory. Note that if a segment is deleted, the memory portion that belonged to this segment is no longer accessible. The next segment that is defined will be placed after the last defined memory segment. However, if the last segment is deleted, the next downloaded segment will be written on top of the deleted one. There is danger that by using the TRAC:DEL command often large portions of memory will remain unused. It is, therefore, recommended to periodically clear the entire memory and only reload waveforms that will be used.

To partition the memory from the beginning, use the following command:

TRACe:DELete: ALL

***CAUTION:***

**This command will destroy waveforms that were previously loaded into memory. After using this command, waveform segments will line-up from address 0 upwards.**



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## Loading Arbitrary Waveforms

There are two ways to load waveforms into the 3152A; using a graphical user interface, i.e., WaveCAD, or low-level programming. When using WaveCAD, disregard most of this chapter as WaveCAD does the work for you. When writing your own code, use the following commands to load data into a specific memory segment.

First, define the work area. Define the segment number and its associated length. Segment length must be an even number. For example, to use segment number 8 and give it a length of 1000 points, use this command:

TRACe:DEFine 8,1000

***NOTE:***

**When large numbers of traces need to be defined it may be beneficial to use the SEGM:DATA command in place of repeated calls to TRAC:DEF when throughput needs to be optimized (see the next section for details).**

Next, make segment 8 the active segment. The active segment must be selected because as waveforms are loaded, the 3152A must be notified as to where to place the data it receives. Select the active segment using the following command:

TRACe: SELect 8

The next step is to transfer data to the active segment. Data is loaded into the 3152A using high-speed binary transfer. A special command is defined by IEEE-STD-488.2 for this purpose. High speed binary transfer allows any 8-bit bytes (including extended ASCII code) to be transmitted in a message. This command is particularly useful for sending large quantities of data. The 3152A uses this command to receive waveforms from the controller:

TRACe #42000<binary_block>

This command causes the transfer of 2000 bytes of data (1000) points into the active memory segment. The ASCII "#" ($23) is the start of the binary data block. "4" designates the number of digits that follow. "2000" is the even number of bytes to follow. The generator represents binary data as 12-bit integers that are sent as two bytes. Therefore, the total number of bytes is always twice the number of data points in the waveform. For example, 2000 bytes are required to download a waveform with 1000 points. Bytes are sent in byte-high, byte-low order. The FORM:SWAP command can be used to reverse this order.


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When sending binary blocks to the 3152A, the final byte must be transmitted with the EOI bit set. Carriage Return and Line Feed will not be detected as terminators. This permits the values $OD_{HEX}$ and $OA_{HEX}$ to be used as data points.

The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data Format is demonstrated in **Figure 3-1**.

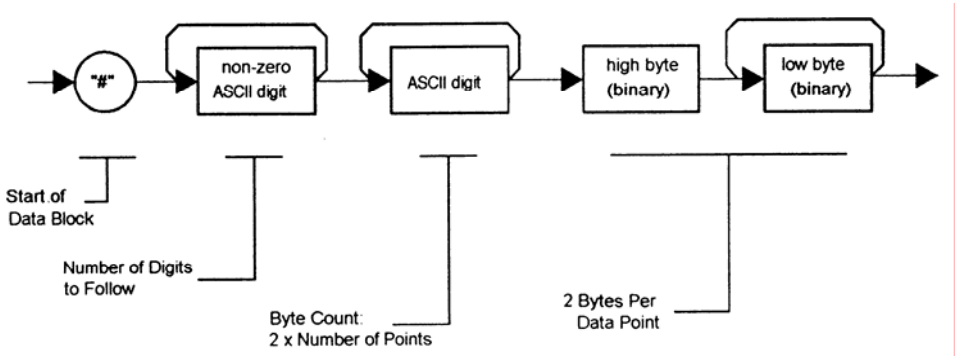



**Figure 3-1, Definite Length Arbitrary Block Data Format**

16-bits of data are sent to the 3152A although only 12 bits are required to generate the waveform. The order of bytes and bits and their values are shown in **Figure 3-2**.

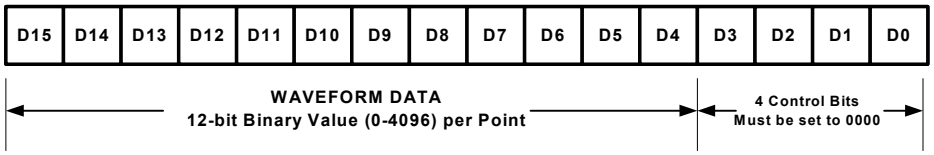



**Figure 3-2, 12-Bit Waveform Data Format**

In USER Waveform download mode, 16-bits of data are sent to the 3152A and all 16-bits are used to generate the waveform and the control and sync bits. The order of bytes and bits and their values are shown in **Figure 3-3**.



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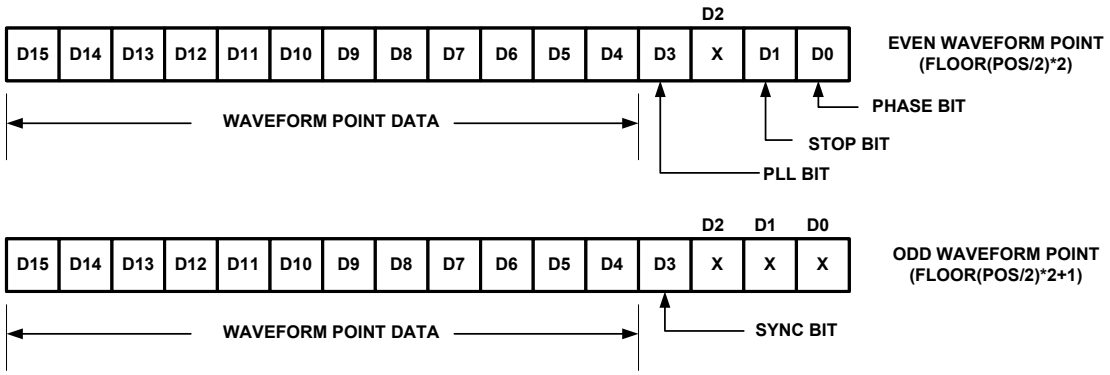



**Figure 3-3, 16-Bit Waveform Data Format**

***NOTE:***

**The 3152A operates in interlaced mode where two memory cells generate one byte of data. Segment size can be programmed in even-numbers only and the generator can accept binary blocks of data that are in multiples of 4 only. For example, 2000 bytes is an acceptable binary block. 2002 is not a multiple of 4, therefore, the generator automatically adjusts the size to 1002 points (2004 bytes) and generates an error message.**



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## High Speed Segment Downloads

In cases where large numbers of segments must be defined in 3152A memory (e.g., >50), for higher overall throughput (e.g., 5x-10x improvement) it is recommended that SEGM:DATA be used instead of a series of TRAC:DEF commands (described in the above section). The SEGM:DATA command takes the place of a series of SEQ:DEF commands by packing all relevent data into a IEEE-STD-488.2 Definite Length Arbitrary Block Data Format packet.

The format of the command is:

SEGMent:DATA#<header><binary data>

and the header structure is:

Nnnnn

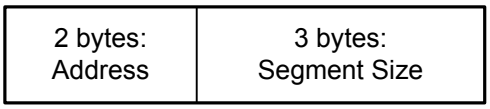
where N = how many digits follow within the header and nnnn is a decimal number (base 10) defining how many bytes of binary data will follow. The header is formatted in ASCII numbers. The number of bytes must be a multiple of 5. Each 5 bytes define one segment and its associated size.

Header examples:

41000 (1000 bytes in binary format to follow)

510000 (10000 bytes in binary format to follow)

The byte structure of one 5-byte segment definition (there can be up to 4096 segments) of the Binary Data section is:






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The Address field of the 5-byte segment table structure is calculated as follows:

1. The start address for segment 1 is 0x1F4.

2. Compute the start address for segment n (where n > 1) using the following equation:

ADDRESS(n) = ADDRESS(n-1) + (SIZE(n-1)/2)

For example, say you have 2 segments, the first is 10,000 points. The start address for segment number 2 is as follows:

ADDRES(2) = ADDRESS(1) + (SIZE(1)/2)

= 500 + 10000/2 = 500 + 5000; and in hex

= 0x1F4 + 0x1388 = 0x157C

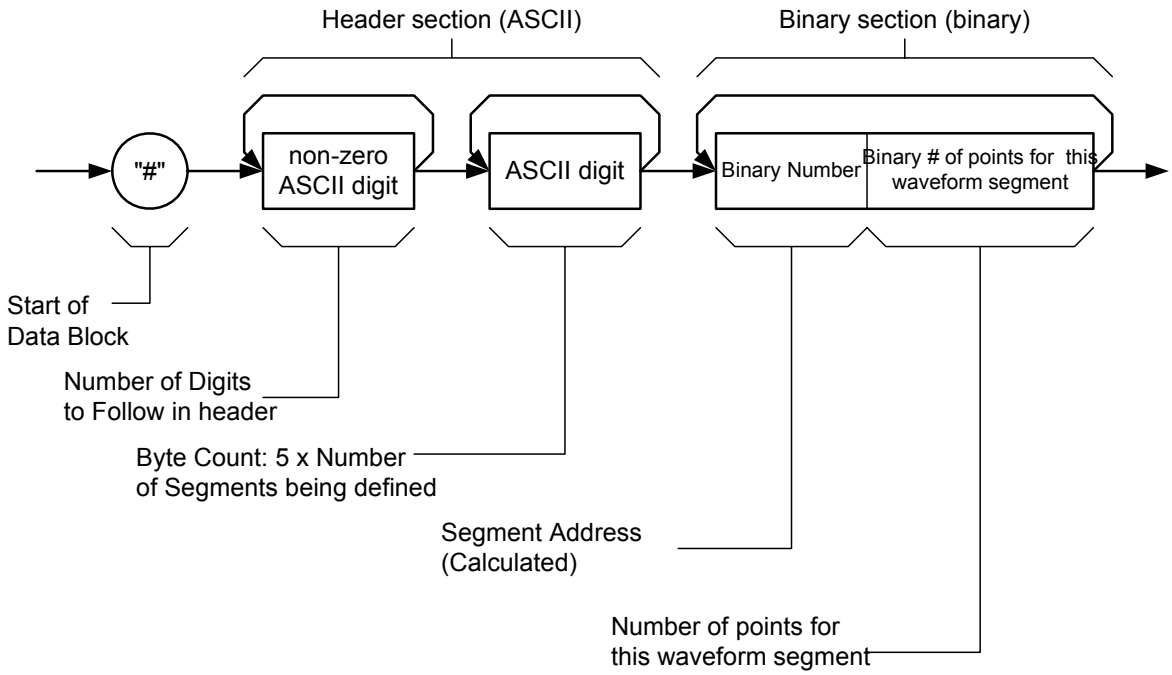



**Figure 3-4, High Speed Segment Downloads**



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The number of points section of the structure is just the 3-byte binary number representing the size of the waveform.

The SEGM:DATA is useful for speeding up test times when many waveform segments are required. It is best used as follows:

Use TRAC:DEF to define segment 1 to be the size of the sum of the waveform sizes for all waveforms to be downloaded into segments.

Load shared memory with a binary file representing the data from **all segments to be loaded** concatenated together.

Use the SEGM:DATA command to slice the data stored in segment 1 into n properly sized segments, where n is the original number of waveforms to be loaded.

This approach will provide the same result as obtained by loading the individual segments one by one. The difference is that the data will be loaded much more quickly and efficiently

## Reversing Byte Order

Binary data is sent to the 3152A in byte-high byte-low order. This order can be reversed using the following command:

BORDer {NORMal | SWAPped}

The default is NORM. This command is useful only for binary block transfers.

The query:

FORMat:BORDer?

queries the byte order configuration and returns "NORM" or "SWAP".



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## Selecting Binary Download Forma

Binary data is sent to the Model in either 12-bit or 16-bit binary format. When NORMal 12-bit downloads are used, the 3152A calculates the start, stop and sync bits stored in memory in the same data word as the 12-bit waveform points. When USER 16-bit downloads are used, the 3152A allows the user to download waveform data AND start, stop and sync bit information. This mode should be used with caution since an incorrect download can cause unexpected operation of the 3152A. It also can allow the user to create custom sync pulse patterns. See **Loading Arbitrary Waveforms** for more information on waveform formats.

The download mode is selected using the following command:

WAVEform {NORMal | USER}

The default is NORM. This command is applicable only for binary block transfers

The query:

FORMat:WAVEform?

queries the waveform download format and returns either "NORM" or "USER."

## Using Shared Memory

Shared memory transfer is the fastest way to get waveforms into the 3152A. In shared memory mode, the 3152A'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 shown in **Figures 3-1** and **3-2**. After the data is loaded into the 3152A, control is returned to the instrument.

In shared memory mode, the 3152A's memory acts similar to Direct Memory Access (DMA). The instrument has to be told when to receive data, send data, surrender control or gain control. The 3152A has an auto-increment address counter. The Slot 0 Controller need only select the base address for both write and read cycles. Shared Memory commands are explained below.

To write to or read from a segment, the user must first define the segment using the command TRACe:DEFine. The trace must then be selected using the command TRACe:SELect. Refer to Loading Arbitrary Waveforms for more information.


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The command:

SMEMory:MODE {READ | WRITe}

sets the instrument to receive data from (WRITE) or send data (READ) to the VXIbus.

The query:

SMEMory:MODE?

queries the shared memory mode and returns READ or WRITE.

The command:

SMEMory:STATe {OFF | ON}

places the 3152A in the shared memory state when ON is selected. After this, the instrument cannot accept normal commands. Data must be sent to the synthesizer using shared memory access. Normal command mode is resumed when the SMEMory:STATe is changed to OFF.

The query:

SMEMory:STATe?

queries the shared memory state and returns "0" (OFF) or "1" (ON).

The following sequence should be used for shared memory transfers.

1. Slot 0 sends commands:

   TRAC:DEF (n),(m) (Shared Memory write only)

   TRAC:SEL <n>

   SMEM:MODE {READ WRITE}

   SMEM:STATE ON

2. Slot 0 repeatedly sends:

   *OPC?

When response is 1, shared memory transfers may start.

3. Slot 0 sends command:

   SMEM:STATE OFF

   once data transfer is complete.



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The *OPC? Response is set to 1 when the 3152A has transferred memory access from the internal CPU to shared memory. This typically takes a few milliseconds but depends on the size of the memory transfer.

## 16-Bit Shared Memory Download

When you download waveform data using the standard shared memory routine, the 3152A accepts waveform data only and the internal CPU places the various bits that control segment length, SYNC position, etc. Look at **Figure 3-3** and observe that you must download 16 bits, of which only 12 determine point value while the other 4 bits are not used.

The process of downloading waveforms, using the standard shared memory mode requires a few steps: 1) Select segment, 2) Define segment length, 3) Define SYNC position, 4) Select the active segment. These four operations are multiplied by the number of segments to be programmed to get the total.

The 16-bit shared memory download mode lets you bypass all of these steps and program the entire memory, including SYNC, trigger start point, PLL phase point and stop bit in one download process, thus saving valuable time.

There is a basic difference between the two download modes. The standard shared memory download mode lets you download waveforms alone. After the waveform has downloaded the CPU takes control and performs the basic tasks such as placing the data at the appropriate start address and initializing the SYNC, PLL, phase and stop bits. The information to set these bits is calculated by the CPU and therefore, the CPU is in control.

In contrast, when 6-bit shared memory downloads are used, control is passed from the instrument to the user. In this case, the CPU does not perform control bit settings and it is entirely up to the user to initialize control bits properly, otherwise the 3152A will not generate waveforms as expected.

Use the commands below to download waveform data using 16-bit shared memory download mode:

Change the download mode to 16-bit using the following command:

FORMat:WAVE {NORMal | USER}

NORM is the default setting. USER places the 3152A into 16-bit memory download mode.


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***WARNING:***

**Changing modes from NORM to USER and vice-versa is destructive to the waveform memory. This command has an affect on the segment table and SYNC and break point bits location. Other parameters, such as amplitude, offset and sample clock frequency are not affected by this command.**

The query:

FORMat:WAVE?

queries the waveform download mode and returns NORM or USER.

The command:

SMEMory: {OFF | ON}

toggles the shared memory state. OFF is the default position. After this command, the instrument cannot accept normal commands. Data must be sent to the generator using shared memory access. Normal command mode is resumed when the SMEMory:STATe is changed to OFF.

The query:

SMEMory?

queries the shared memory state and returns "0" (OFF) or "1" (ON).

Following the SMEM ON command, you can start downloading waveform data. **Figure 3-3** shows an example of waveform data points. Explanation of the various words and control bits are given below.

Things to consider when you lay out your data:

1. Waveform data points are made of 16-bit words.
2. Minimum number of words to download is 10.
3. Words are downloaded in groups of 2. Therefore, the minimum number of groups is 5.
4. In each word, D2 is ignored while D1 and D0 are also ignored in odd words only. D3 is used for the PLL bit in even words and the SYNC bit in odd words. D1 in even words is the stop bit and D0 in even words is the phase bit. D4 through D15 are used for point data. D15 is the MSB



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### The Control Bits

There are four control bits that must be loaded within a group of two words, they are the PLL, trigger phase offset, SYNC and stop bits.

The control bits are located as shown in the figure. Note that the odd-even order of these bits is critical.

The bits are described below:

**PLL Bit –** This bit is a don't care unless the 3152A will be used in PLL mode to lock to an external analog (or digital) signal. This bit represents the phase shift of the waveform with respect to the input trigger point. Exactly one PLL bit may be set per waveform segment for proper operation of the PLL mode of the 3152A.

**Trigger Phase Offset Bit –** The trigger phase offset bit determines the offset point in the waveform where the waveform starts after receiving a trigger signal. Like the PLL bit, Trigger phase offset bits can be placed in one location only.

**SYNC Bit –** The SYNC bit determines the offset point on the waveform where the 3152A outputs a SYNC signal. The SYNC signal width is always 2 sample clock cycles wide per SYNC bit set. Multiple SYNC bits can be placed at any location along the length of the programmed waveform segment to create complex sync signals.

**Stop Bit –** The Stop bit determines the end point of the waveform. Stop bits can be placed in one location only for typical. If you place multiple stop bits, the waveform will stop at the first stop bit encountered. The waveform will actually stop at the waveform point after the one with the stop bit set.

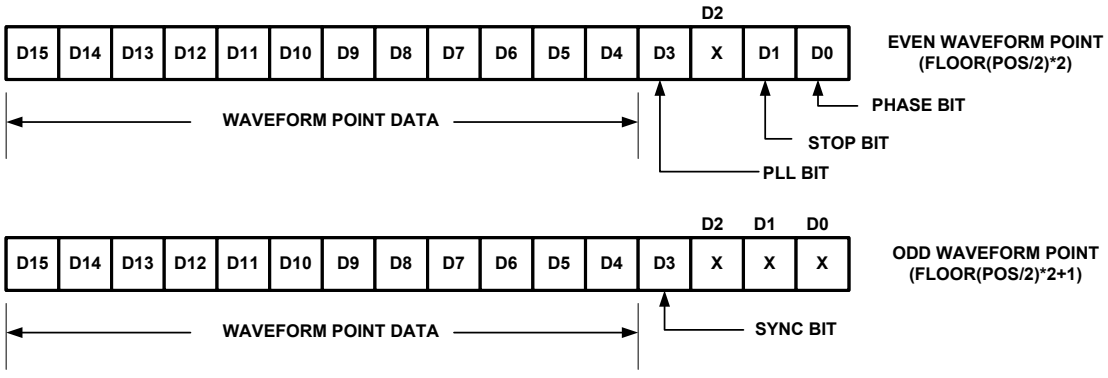



**Figure 3-3** (Repeated)**, 16-Bit Waveform Data Format**


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## Sequences

Sequenced waveforms are a means of adding more capability to the synthesizer. The 3152A can link 4096 segments and loop on each segment up to $10^6$ times.

## Generating Sequenced Waveforms

### What Are Sequenced Waveforms?

Sequenced waveforms are made of a number of arbitrary waveforms that can be linked and repeated in various manners. Sequenced waveforms are generated from waveforms stored in a library of memory segments. Before using a sequence of waveforms, load arbitrary memory with the required waveforms. Use TRAC# or shared memory methods to load waveforms into memory.

Information on how to partition the memory and load waveforms is given in the section entitled **Generating Arbitrary Waveforms**.

An example of how sequenced waveforms work is demonstrated in the following figures. **Figure 3-5** shows a sine(x)/x waveform that was loaded into segment 1. **Figure 3-6** shows a sine waveform that was loaded into segment 2. **Figure 3-7** shows a pulse waveform that was loaded into segment 3.

The sequence generator lets you link segments in user-defined order and repeat each segment as many times as needed.

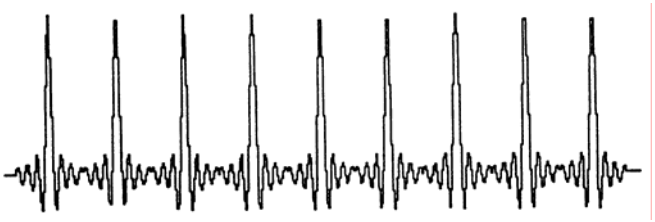


**Figure 3-5, Sin(x)/x Waveform Loaded Into Segment 1**



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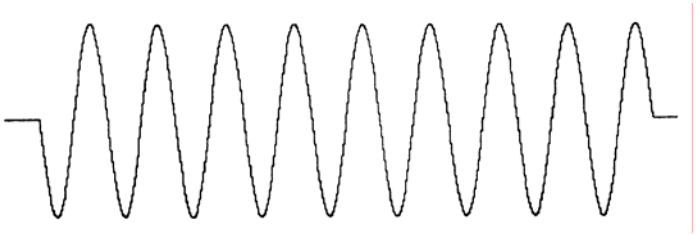


**Figure 3-6, Sine Waveform Loaded Into Segment 2**

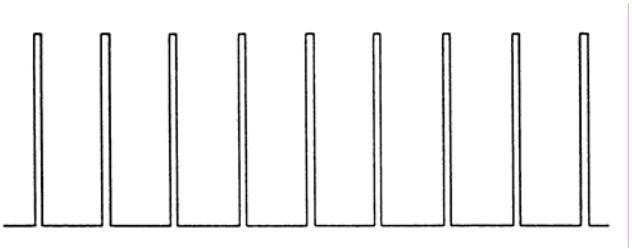


**Figure 3-7, Pulse Waveform Loaded Into Segment 3**

**Figure 3-8** shows a sequence of waveforms that were stored in three different memory segments. Note that segment number 2 is generated first and repeated twice, segment 3 follows once and then segment 1 is repeated four times.

## Sequence Commands

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

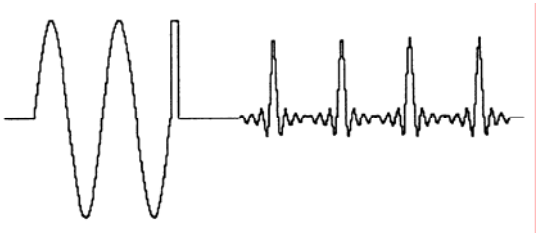


**Figure 3-8, Sequenced Waveforms - Continuous Advance Mode**



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

Aside from step numbers, each step has two other parameters: segment number and repeat counter. The segment number specifies which segment will be linked, and the repeat counter specifies how many times the segment will repeat. Use the following command to generate a sequence:

SEQuence:DEFine {<step_number>,
<segment_number>,<repeat>}

Use this command up to 4095 times, each time for a different step and for a different segment number and repeat combination. Note that the same segment number can be used for different sequence steps. The SEQ:DEF command does not change the FUNC:MODE setting. Unless the FUNC:MODE SEQ command is used, the SEQ:DEF command will have no immediate effect on the output waveform or function.

***NOTE:***

**The SEQ:DATA command be used in place of a series of SEQ:DEF commands if higher throughput is needed (see the next section).**

The sequence generator goes through the steps in descending order. In the continuous operating mode, the sequence is repeated automatically after the last step has been completed. When the generator is set to operate in Triggered mode, the output stops at the last point of the last waveform in the sequence. In Gated mode, the sequence is always completed after the gate stop signal.

If removal of a step from the sequence is required, use the following command:

SEQuence:DELete <n>

where <n> is the step number to be removed from the sequence.

To delete all sequences, use the following command:

SEQuence:DELete:ALL



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***CAUTION:***

**The above command will destroy sequences previously loaded into memory.**

## High Speed Sequence Downloads

In cases where large numbers of sequence steps must be downloaded to the 3152A (e.g., >50), for higher overall throughput (e.g., 5x-10x improvement) it is recommended that SEQ:DATA be used instead of a series of SEQ:DEF commands (described in the above section). The SEQ:DATA command takes the place of a series of SEQ:DEF commands by packing all relevent data into a IEEE-STD-488.2 Definite Length Arbitrary Block Data Format packet.

The format of the command is:

SEQuence:DATA#<header><binary data>

and the header structure is:

Nnnnn

where N = how many digits follow within the header and nnnn is a decimal number (base 10) defining how many bytes of binary data will follow. The header is formatted in ASCII numbers. The number of bytes must be a multiple of 5. Each 5 bytes define one step and its associated looping.

Header examples:

41000 (1000 bytes in binary format to follow)

510000 (10000 bytes in binary format to follow)

The byte structure of one 5-byte step (there can be up to 4096 steps) of the Binary Data section is:

| 2 bytes: Segment # | 3 bytes: Number of Repeats |
|---|---|



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The byte ordering of the Segment Number section is: High byte, low byte. There is an offset between the Segment Number above and the actual segment number.

The above structure ranges from 0 to 4095. The corresponding segments are selected as ranging from 1 through 4096 with the TRAC:SEL command.

The Repeat Number binary structure requires restructuring of the byte order. The MSB of the 3 bytes is shifted around to the beginning and the mid-byte and LSB (Least Significant Byte) are shifted left by one byte.

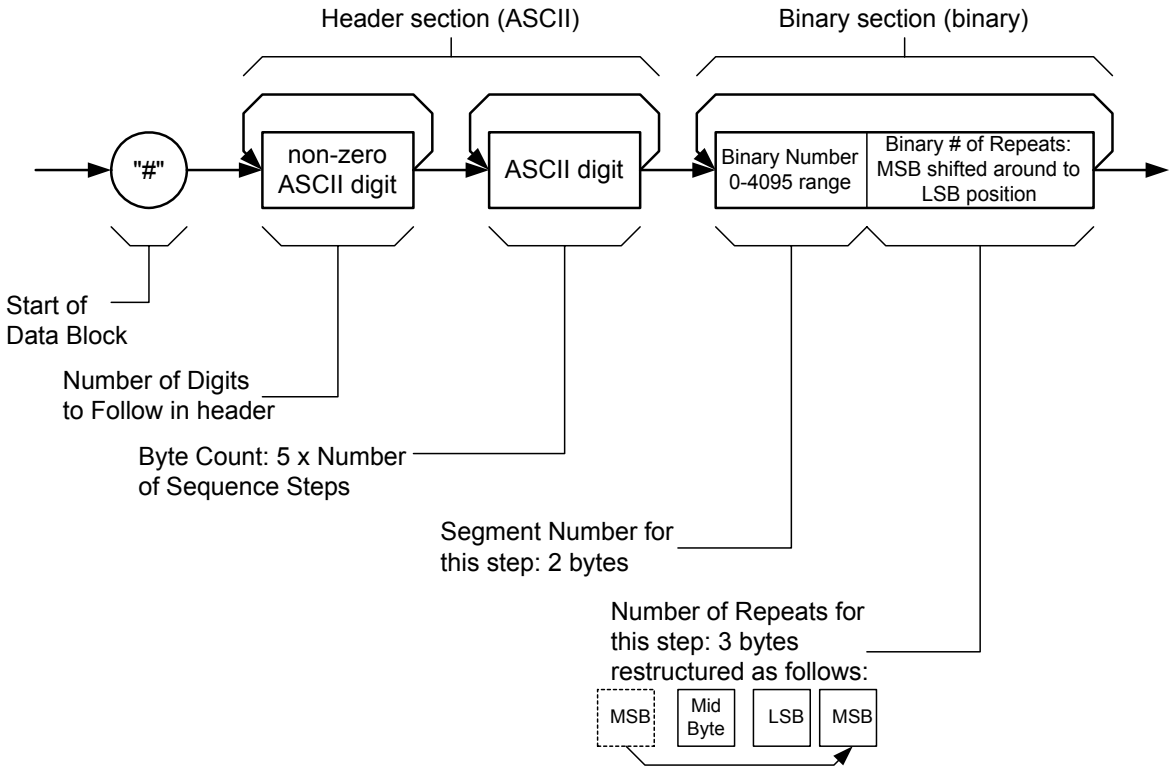



**Figure 3-9, Sequenced Downloads**



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A simple example using the sequence command is to generate a 1 step sequence with segment 1 repeated 74565 times:

SEQ:DATA#15<0000234501h>

where the 15 means:

1 specifies that one more byte will follow

5 specifies that 5 binary bytes will follow

and the <0000230145h>:

74565 is 00012345h rearranged to be 234501

Four zeros (0000) for segment 1 (segment 0)

Putting these together gives 0000234501

## Triggered Sequence Advance

Triggered Sequence Advance is a special case sequenced mode. In Triggered Sequence Advance mode, the 3152A idles between steps until a valid trigger signal is sensed. The trigger source can be selected from a number of options:

- An external trigger signal applied to the front panel TRIG IN connector
- An internal trigger generator whose period is programmable
- VXIbus TTLTRG<n> triggers
- soft triggers.

A sequence operating in Continuous mode was seen in **Figure 3-8**. **Figure 3-10** shows an example of the same sequence in Triggered Sequence Advance mode.


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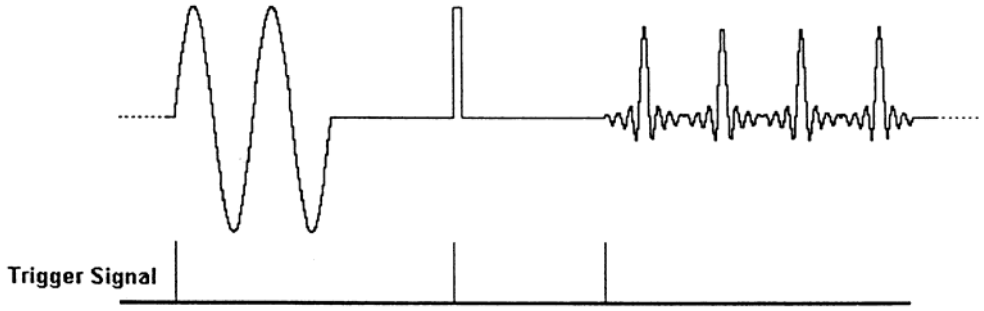



**Figure 3-10, Sequenced Waveforms - Triggered Advance Mode**

## Triggered Sequence Advance Commands

Placing the 3152A in Triggered Sequence Advance mode is done in Triggered mode only. First, prepare the sequence of waveforms using the commands that were explained before. Second, place the instrument in Triggered mode using the INIT:CONT OFF command. To place the 3152A in Triggered Sequence Advance mode, use the following command:

SEQuence:ADVance {AUTO | TRIGger}

AUTO specifies the normal continuous advance and TRIGger places the instrument in Triggered Sequence Advance mode.

The query:

SEQuence:ADVance?

queries Triggered Sequence Advance mode and returns AUTO or TRIG.

## Backplane Inter-Module Synchronization

Although multiple 3152As within one chassis run off a common clock (CLK10), their outputs are not synchronized to each other. If the same waveform length and clock rates for two modules are selected and both are displayed on an oscilloscope, the outputs may look as though they are synchronized even though they are not. The waveforms may not start at the same point along the waveform. If another waveform is selected or if the same waveforms are reprogrammed, you may notice that the phase relationship between the two modules has changed again.



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***CAUTION:***

**Phase synchronization requires the use of the VXI ECLTRG0 and ECLTRG1 signals. Other VXI instruments must not drive ECLTRG0/1 while phase synchronization is enabled.**

There are phase synchronization commands that can tightly control phase offsets between two or more 3152As. These commands are described below. To use the following commands, two 3152As are required. When synchronizing modules, the waveforms in each module must have exactly the same number of points.

First, load the waveforms in all the modules in preparation for phase synchronization. Then select one 3152A as master and program it using the following commands:

PHASe:LOCK ON

PHASe:SOURce MAST

The above 3152A is now programmed as master. Next, program the other 3152A modules as slaves (SLAVe) and program their phase offset in relation to the master. As an example, program the second and third 3152A with 120 and 240 degree offsets, respectively.

Use the following commands on the second 3152A:

PHASe:SOURce SLAVe

PHASe:LOCK ON

PHASe:ADJust 120

Use the following commands on the third 3152A:

PHASe: SLAVe

PHASe:LOCK ON

PHASe:ADJust 240

The three 3152A modules are now synchronized.

The sample clock rate has no effect on phase offset accuracy. However, when trying to synchronize modules that are programmed to output waveforms with few memory points, a ±1 count error between modules may be seen. To remove this error, use the following command:

PHASe:LOCK:NULL



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***CAUTION:***

**The PHASe:NULL command toggles between removing one count and adding one count. Therefore, if there was no error, sending this command may add a 1 count error.**

The query:

PHASe:LOCK?

queries the Phase Lock mode and returns "0" (OFF) or "1" (ON).

The query:

PHASe:ADJust?

queries the phase offset and returns a value in degrees.

In query:

PHASe:SOUR?

queries the phase lock source and returns MAST or SLAV.

## Front-Panel Phase Synchronization

The 3152A can phase lock to an external reference which is applied to the trigger input. The locking process is done automatically by the generator. There is no need for the user to initiate or set the generator's lock-in range for this mode. A front-panel LED illuminates when the reference signal is valid and the 3152A locks on the external signal. After lock has been achieved, you may shift the phase between the reference and the generator from -180° to +180°.

***NOTE:***

**Phase offset resolution depends on the number of waveform samples. For instance, if you have 1000 waveform samples, there is no problem with adjusting the phase offset in 1° increments (360° / 1000 < 1). As another example, if you have only 10 waveform samples, the best phase offset increments are only 36° (360° / 10 = 36°).**

There is a special fine adjustment for phase offset with a 36° range. This adjustment is useful in places where a 36° gap is too wide. The fine phase adjustment improves phase offset settings to 0.01° and can be used in conjunction with the coarse phase offset adjustment at any phase offset setting point.



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## PLL Commands

In PLL mode, the 3152A can be used as a slave only. Use the following commands to program the 3152A to lock to an external reference.

PLL:LOCK ON

This command places the 3152A in PLL mode. If no valid reference signal is applied to the trigger input, the PLL ON LED remains off. If you feel that the 3152A should lock and it does not, check the following:

Make sure that trigger level is adjusted correctly

Make sure that the 3152A frequency setting permits lock in the required range. Two graphs, one for fixed mode and the other for user mode are given in Appendix A, showing the lock range relationship between the reference and the internal frequency settings。

PLL:ADJust <value>

applies a phase offset between the reference signal and the main output. The default value is $0^{o}$. Phase offsets can be adjusted between $-180^{o}$ and $+180^{o}$. Best resolution for this parameter is $1^{o}$, degrading to $36^{o}$ at $10^{o}$ point waveform samples.

PLL:FINE <value>

applies a fine adjustment to the absolute setting of the PLL:ADJ command. The default value is $0^{o}$. Fine phase adjustment is usable between $-36^{o}$ and $+36^{o}$.

As an example of the use of this command, we'll take a 100 sample waveform. The best phase offset resolution for this waveform is $3.6^{o}$ ($360^{o}$ / 100 points). If you need to set an offset of $50^{o}$, the 3152A will accept this value, but will not be able to set this offset correctly. Since the resolution is $3.6^{o}$, the output will offset by $50.4^{o}$. You can now correct the phase to exactly $50^{o}$ by using the PLL:FINE -0.4 command.

PLL:LOCK?

queries the PLL's state. It returns a "0" (OFF) or "1" (ON).

PLL:ADJust?

queries the PLL offset. It returns a value in degrees.

PLL:FINE?

queries the PLL's fine offset. It returns a value in degrees.



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## Using the Frequency Counter

In PLL mode, the 3152A uses an autoranging counter circuit to measure frequencies of reference signals at the trigger input. This built-in counter is made available to you as long as the signal at the trigger input is valid and the PLL ON LED illuminates. Frequencies are measured from 500Hz to 10MHz with 4 digit resolution.

To measure external frequencies you must first place the 3152A in PLL mode. Use the following command:

PLL:LOCK ON

If no valid reference signal is applied to the trigger input, the PLL ON LED remains off. If you feel that the 3152A should lock and it does not, do the following:

Check that trigger level is adjusted correctly. You may change trigger level settings using the TRIG:LEV command. The default trigger level setting is 1.6 V.

Check that the 3152A frequency setting permits lock in the required range. Two graphs, one for fixed mode and the other for user mode are given in Appendix A, showing the lock range relationship between the reference and the internal frequency settings.

FREQuency:EXTernal?

queries the external frequency in Hz. 0.000e0 reading indicates that no valid signal is available at the trigger input.

## Using the Phase Modulation Input

The phase modulation function operates in conjunction with the front-panel PLL function. The PM Input accepts signals that phase modulate the main output frequency after it has locked to an external reference. Note that this input is active at all times and unless you intend to use this function, do not connect any cables to this input during normal operation of the 3152A.

When the 3152A is placed in PLL mode, the phase of the main output signal may be shifted from the reference phase using the phase modulation input. Although not very accurate, the phase modulation input provides a way of phase offsetting the main output above and below $360^{o}$.

The PM IN is sensitive to voltage levels. Applying 1 V to this input generates a phase offset of $20^{o}$. Likewise, applying -1 V to this input generates a phase offset of $-20^{o}$. You may apply 20V to this input and generate a phase offset of $400^{o}$. The applied frequency range is dc to 10KHz, depending on the lock frequency and the number of waveform samples.



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## Amplitude Modulation Commands

Arbitrary waveforms stored in memory segments are used as modulating envelopes in Amplitude Modulation mode. The modulated carrier is always a sine waveform with its frequency set in points. The first step in modulating a waveform is to generate an arbitrary waveform either from the standard function library or by downloading a waveform from the controller.

The command:

AM <value>

sets the internal modulation depth in percent. Select values from 1% to 200%. The default setting for AM depth is 50%.

The query:

AM?

queries the modulation depth and returns a value in percent.

The command:

AM:INTernal:FREQuency <value>

sets the frequency of the carrier sine waveform. The frequency of the carrier wave is programmed in points. Select from 10 to 500 points. The default setting for the carrier frequency is 100 points. The frequency of the carrier wave can be computed from the sampling clock frequency divided by the number of points in the active segment. Use the FREQ:RAST? command to determine the current sampling clock frequency. The maximum carrier frequency is the sampling clock frequency divided by 10 points. The envelope frequency should be less than the carrier frequency.

The query:

AM:INTernal:FREQuency?

queries the carrier frequency and returns a value in points.

The command:

AM:EXECute

enables amplitude modulation. To ensure proper operation, enable the amplitude modulation after setting up the other modulation parameters. Amplitude modulation cannot be turned on and off. Therefore, ensure that the original arbitrary waveform is available in another memory segment as a back-up.


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## Using Sweep Mode

The key to using Sweep Mode efficiently is to place the 3152A into a mode other than SWEep (FIX, USER or SEQ) while sending the 3152A the sweep parameters. Once the parameters are set, switch the 3152A to sweep mode using the command:

FUNC:MODE SWEep

and the specified sweep waveform will be output. This is because the 3152A relies on its sequencer and segmented waveform memory to implement sweep.

***WARNING:***

**Placing the 3152A in Sweep Mode overwrites any waveforms, segments or sequences that are currently stored in 3152A memory.**

The other key to using Sweep Mode efficiently is to optimize the number of sweep steps. Sweep steps are the number of different discrete frequencies that the 3152A will output as it completes a sweep cycle (start to stop frequency or stop to start frequency). Set the number of sweep steps using the:

[:SOURce]:SWEep:STEP <integer_value>

command. Finding the optimal number of steps is a tradeoff between speed of execution of the sweep command and granularity of the sweep itself. This parameter can range from 10 to 2000 with a default value of 20.

The 3152A has a number of other sweep settings that should also be set before entering sweep mode:

[:SOURce]:SWEep:DIRection < UP | DOWN>

The UP parameter causes a sweep from the start frequency to the stop frequency. The DOWN parameter reverses this direction.

[:SOURce]:SWEep:SPACing < LINear | LOGarithmic >

The LINear parameter causes the sweep function to dwell on each discrete intermediate frequency for the same amount of time at each frequency. The LOGarithmic parameter causes the sweep function to dwell on each discrete frequency for differing amounts of time according to the logarithmic function.

[:SOURce]:SWEep:FREQuency[:STARt] <value>



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This command specifies the frequency that the sweep function starts with when SWE:DIR UP is enabled and ends with when SWE:DIR DOWN is enabled.

[:SOURce]:SWEep:FREQuency:STOP <value>

This command specifies the frequency that the sweep function ends with when SWE:DIR UP is enabled and starts with when SWE:DIR DOWN is enabled.

[:SOURce]:SWEep:FREQuency:MARKer <value>

The 3152A's sweep function can be synchronized with external events using the marker facility. Choose a frequency between the specified STARt and STOP as the location for the marker. During each sweep cycle, the 3152A will output a marker pulse in synchronization when the 3152A sweeps through the marker frequency. The pulse will be available at the 3152A's SYNC OUT jack or output to a TTL trigger line as specified using the OUTP:SYNC[:STATe] and OUTP:TTLTrg<N>[:STATe] commands.

[:SOURce]:SWEep:FUNCtion < SIN | SQU | TRI >

This selects the shape of the waveform to be swept.

The sample clock frequency of the 3152A may be controlled directly for the sweep function. Use the command:

[:SOURce]:SWEep:FREQuency:RASTer <value>

to accomplish this.

Finally, use the command:

[:SOURce]:SWEep:TIME <value>

to specify the duration of the sweep from start to end (or from end to start if SWE:DIR DOWN is selected).

To terminate sweep mode, either reset the 3152A (*RST) or select FUNC:MODE < FIX | USER | SEQ >.


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## System-Related Commands

System-related commands are used to place the instrument in a known state, clear the instrument to its defaults, or to query the generator for its errors or identity. The following is an overview of the system-related commands.

The query:

SYSTem:ERRor?

reads one error from the error queue. A record of up to 30 errors can be stored in the generator's error queue. Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. When all errors have been read from the queue, the generator returns +0, "No error".

If more than 30 errors have occurred, the last error stored in the queue (the most current error) is replaced with -350,"Too many errors". No additional errors are stored until all errors have been removed from the queue. The error queue is cleared only when power is cycled off or after the execution of a *CLS command. The *RST command does not clear the error queue.

The query:

SYST:ERR

queries the system error queue and returns a string with the following format: -102,"Syntax error". A complete list of errors that can be detected by the generator is given in **Chapter 4**.

The query:

SYSTem:VERSion?

queries the generator to determine the present SCPI revision and returns a string similar to "1993.0"

The query:

*IDN?

reads the generator's identification string. The generator returns four fields separated by commas. The first field is the manufacturer's name, the second field is the model number, the third field is not used (always "0") and the fourth field is the firmware version number. The command returns "Racal Instruments,3152A,0,1.0". (Assuming the firmware revision is "*0*")



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The commands:

RESet

*RST

reset the generator to its default state. The *RST and RES commands have no effect on status registers, VXIbus states, VXI address or SCPI command set.

The query:

*OPT?

queries the waveform memory length installed in the 3152A. The response is “1" for 512K.


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# Chapter 4

# SCPI AND HS COMMAND REFERENCE

## What's In This Chapter

This chapter contains reference information for programming the 3152A. Standard Commands For Programmable Instruments (SCPI) convention rules and syntax are explained in detail. **Table 4-1** lists all SCPI commands used for programming the 3152A. The command summary for each SCPI model is also included in this chapter.

This chapter teaches you how to use SCPI commands to control functions, modes, waveforms and other aspects of the instrument. Prior understanding of SCPI programming is necessary for low level programming of the 3152A.

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 the SCPI Language

Commands to program the instrument via the VXIbus are defined by the Standard Commands for Programmable Instruments (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 formats of command parameters and the formats of values returned by the instrument.

SCPI is an ASCII-based instrument command language designed for test and measurement instruments. SCPI commands are structured in a hierarchical a tree system. In this system, associated commands are grouped together under a common root, thus forming subsystems. Throughout this manual, the following conventions are used for SCPI command syntax.



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| | |
|---|---|
| **Square Brackets ( [ ] )** | Enclose optional keywords or parameters |
| **Braces ( { } )** | Enclose parameters within a command string |
| **Triangle Brackets ( < > )** | Substitute a value for the enclosed parameter |
| **Vertical Bar ( \| )** | Separate multiple parameter choices |
| **Bold Typeface Letters** | Designate factory default values |

Part of the OUTPut subsystem is shown below to illustrate the tree system:

```
OUTPut
    :FILTer
        [:LPASs]
            :FREQuency {20MHz|25MHz|50MHz}
        [:STATe] OFF|ON
    [:STATe] OFF|ON
```

OUTPut is the root keyword of the command; FILTer and STATe are second level keywords. FREQuency and STATe are third level keywords. 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, send 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.


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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. If an optional parameter is not specified, the synthesizer uses a default value.

## 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:SOUR:ADV INT;BURS ON;INT:RATE 5e-3

is the same as sending the following three commands:

TRIG:SOUR:ADV INT

TRIG:BURS ON

TRIG:INT:RATE 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:STAT ON

## The MIN and MAX Parameters

Substitute MINimum or MAXimum in place of a parameter for some 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.



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## 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 command sent to the instrument to generate the query response. In general, a response to a query contains current values or settings of the synthesizer. Commands that set values can be queried about their current value of the setting. Commands that set modes of operation can be queried about their current mode setting. IEEE-STD-488.2 common queries generate responses which are common to all instruments that are connected to the GPIB interface.

## SCPI Command Terminator

A command string sent to the function generator must terminate with a <new line> character. The IEEE-STD-488 EOI (end-or-identify) message is interpreted as a <new line> character. A <carriage return> followed by a <new line> is also accepted. 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 Types

The SCPI language defines several different data formats to be used in program messages and response messages.


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## Numeric Parameters

Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, 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 accepted 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 synthesizer accepts "OFF" or "0" for a false condition. The synthesizer 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 synthesizer's memory. Depending on which option is installed, the 3152A can accept binary blocks up to 523288 bytes. The following command uses an arbitrary block parameter that is loaded as binary data:

TRAC:DATA#564000<binary_block>



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## Alternative Command Set (HS Commands)

In addition to the SCPI command set, there is an alternative command set which may be invoked to increase the throughput of the 3152A by a typical factor of 2-3. Actual throughput improvements depend on the test program itself. Speed increases are obtained by using a system of numerical commands which completely bypass the SCPI parser and are sent directly to the "jump table."

HS commands correspond exactly with SCPI commands. A number is substituted for the SCPI command name and a number is substituted for any text type (discrete and boolean) SCPI parameter(s). Spaces between the command and its parameters are removed. For example, the command to close the output relay of the 3152A is:

OUTP ON

HS command syntax for the same command is:

0200A1

where 0200A is the OUTP command and 1 indicates ON.

Special rules for using HS commands are described in the next section. **Table 4-1** provides a complete cross-reference 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 FAST 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 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.


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## 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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## SCPI and HS Command Summary

**Table 4-1** summarizes the complete SCPI command tree along with the alternative HS command set available for programming of the synthesizer. Refer to earlier sections in this manual for more complete details on each command. Default HS command parameters are indicated in bold where applicable.


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## Table 4-1, VXIbus 3152A SCPI Command Summary

| Keyword | Parameter Format (Default,min,max) | SCPI 1993.0 | HS Commands bincmd<param(s)> |
|---|---|---|---|
| :FORMat | | Confirmed | |
| :BORDer | **NORMal** \| SWAPped | Confirmed | 0100A<**0**\|1> |
| :WAVE | **NORMal** \| USER | Not confirmed | 0101A<**0**\|1> |
| :INSTrument | | Confirmed | |
| :MODE | **NORMal** \| FAST | Not confirmed | 0150A<**0**\|1> |
| :OUTPut | **OFF** \| ON | Confirmed | 0200A<**1**\|0> |
| [:STATe] | **OFF** \| ON | Confirmed | 0200A<**1**\|0> |
| :SHUNt | **OFF** \| ON | Confirmed | 0250A<**0**\|1> |
| :FILTer | | Confirmed | |
| [:LPASs] | | Confirmed | |
| :FREQuency | **20MHz** \| 25MHz \| 50MHz | Confirmed | 0201A<**1**\|2\|3> |
| [:STATe] | **OFF** \| ON | Confirmed | 0202A<**0**\|1> |
| :ECLTrg<n> | **OFF** \| ON | Confirmed | 0210B<**0**\|1> |
| [:STATe] | **OFF** \| ON | Confirmed | 0210B<**0**\|1> |
| :TRIGger | | Not confirmed | |
| :SOURce | **BIT** \| LCOMplete \| INTernal \| EXTernal | Not confirmed | 0220A<**1**\|2\|3\|4> |
| :TTLTrg<n> | (**0**;0;7) | Confirmed | 0230B<**0**\|1\|2\|3\|4\|5\|6\|7,**0**\|1> |
| [:STATe] | **OFF** \| ON | Confirmed | 0230B<**0**\|1\|2\|3\|4\|5\|6\|7,**0**\|1> |
| :SYNC | | Not confirmed | |
| :SOURce | **BIT** \| LCOMplete \| SSYNc \| HCLock | Not confirmed | 0240A<**1**\|2\|3\|4> |
| [:STATe] | **OFF** \| ON | Not confirmed | 0241A<**0**\|1> |
| :POSition | (**N-6**;2;523288) (even #) | Not Confirmed | 0242A<long> |
| [:POINt] | (**N-6**;2;523288) (even #) | Not Confirmed | 0242A<long> |
| :WIDTh | (**2**;500;2) | Not Confirmed | 0243A<integer> |
| [:SOURce] | | Confirmed | |
| :APPLy | FREQ,AMPL,OFFS | Not confirmed | 0300C<float,float,float> |
| :SINusoid | FREQ,AMPL,OFFS,PHAS,POW | Not confirmed | 0301E<float,float,float,float,integer> |
| :TRIangle | FREQ,AMPL,OFFS,PHAS,POW | Not confirmed | 0302E<float,float,float,float,integer> |
| :SQUare | FREQ,AMPL,OFFS,DCYC | Not confirmed | 0303D<float,float,float,float> |



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| Keyword | Parameter Format (Default,min,max) | SCPI 1993.0 | HS Commands bincmd<param(s)> |
|---|---|---|---|
| :PULSe | FREQ,AMPL,OFFS,DEL,WIDT,LEAD,TRA | Not confirmed | 0304G<float,float,float,float,float,float, float> |
| :RAMP | FREQ,AMPL,OFFS,DEL,LEAD,TRA | Not confirmed | 0305F<float,float,float,float,float,float> |
| :SINC | FREQ,AMPL,OFFS,NCYC | Not confirmed | 0310D<float,float,float,integer> |
| :GAUSsian | FREQ,AMPL,OFFS,EXP | Not confirmed | 0306D<float,float,float,integer> |
| :EXPonential | FREQ,AMPL,OFFS,EXP | Not confirmed | 0307D<float,float,float,integer> |
| :DC | DC_AMPL | Not confirmed | 0308A<float> |
| :USER | SEG<n>,SCLK,AMPL,OFFS | Not confirmed | 0309D<integer,float,float,float> |
| :FREQuency | (**1E6**;100E-6;50E6) \| MINimum \| MAXimum | Confirmed | 0400A<float> |
| [:CW] | (**1E6**;100E-6;50E6) \| MINimum \| MAXimum | Confirmed | 0400A<float> |
| :RASTer | (**1E6**;100E-3;100E6) \| MINimum \| MAXimum | Not confirmed | 0410A<float> |
| :SOURce | **INT** \| EXT \| ECLtrg0 | Not Confirmed | 0411A **3**\|4\|16 |
| :EXTernal? | | Not confirmed | 0420@? |
| :VOLTage | (**5.000**;10E-3;16.00) | Confirmed | 0500A<float> |
| [:LEVel] | | Confirmed | |
| [:IMMediate] | | Confirmed | |
| [:AMPLitude] | (**5.000**;10E-3;16.00) | Confirmed | 0500A<float> |
| :OFFSet | (**0**;-7.190;+7.190) | Confirmed | 0501A<float> |
| :FUNCtion | | Confirmed | |
| :MODE | **FIXed** \| USER \| SEQuence \|SWEep | Confirmed | 0610A<**0**\|1\|2\|3> |
| :SHAPe | **SIN** \| TRI \| SQU \| PULS \| RAMP \| SINC \| GAUS \| EXP \| DC | Confirmed | 0600A<**0**\|1\|2\|3\|4\|5\|6\|7\|8\|9> |
| :SINusoid | | Not Confirmed | |
| :PHASe | (**0**;0;360) | Not Confirmed | 0700A<float> |
| :POWer | (**1**;1;9) | Not Confirmed | 0701A<integer> |
| :TRIangle | | Not Confirmed | |
| :PHASe | (**0**;0;360) | Not Confirmed | 0710A<float> |
| :POWer | (**1**;1;9) | Not Confirmed | 0711A<integer> |
| :SQUare | | Not Confirmed | |
| :DCYCle | (**50**;1;99.9) | Not Confirmed | 0720A<float> |
| :PULSe | | Confirmed | |



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| Keyword | Parameter Format (Default,min,max) | SCPI 1993.0 | HS Commands bincmd<param(s)> |
|---|---|---|---|
| :DELay | (**10**;0;99.9) | Confirmed | 0730A<float> |
| :WIDTh | (**10**;0;99.9) | Confirmed | 0731A<float> |
| :TRANsition | (**10**;0;99.9) | Confirmed | 0732A<float> |
| [:LEADing] | (**10**;0;99.9) | Confirmed | 0732A<float> |
| :TRAiling | (**10**;0;99.9) | Confirmed | 0733A<float> |
| :RAMP | | Not Confirmed | |
| :DELay | (**10**;0;99.9) | Not Confirmed | 0740A<float> |
| :TRANsition | (**10**;0;99.9) | Not Confirmed | 0741A<float> |
| [:LEADing] | (**10**;0;99.9) | Not Confirmed | 0741A<float> |
| :TRAiling | (**10**;0;99.9) | Not Confirmed | 0742A<float> |
| :SINC | | Not Confirmed | |
| :NCYCle | (**10**;4;100) | Not Confirmed | 0790A<integer> |
| :GAUSsian | | Not Confirmed | |
| :EXPonent | (**10**;1;200) | Not Confirmed | 0750A<float> |
| :EXPonential | | Not Confirmed | |
| :EXPonent | (**-10**;-200;200) | Not Confirmed | 0760A<float> |
| :DC | (**100**;-100;100) | Not Confirmed | 0770A<float> |
| [:VOLTage] | | Not Confirmed | |
| [:IMMediate] | | Not Confirmed | |
| [:AMPLitude] | (**100**;-100;100) | Not Confirmed | 0770A<float> |
| :AM | (**50**;1;200) | Confirmed | 0780A<integer> |
| [:DEPTh] | (**50**;1;200) | Confirmed | 0780A<integer> |
| :INTernal | | Confirmed | |
| :FREQuency | (**100**;10;500) | Confirmed | 0781A<integer> |
| :EXECute | | Not confirmed | 07820 |
| :PHASe | | Confirmed | |
| :LOCK | **OFF** \| ON | Not confirmed | 0820A<**0**\|1> |
| [:STATe] | **OFF** \| ON | Not confirmed | 0820A<**0**\|1> |



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| Keyword | Parameter Format (Default,min,max) | SCPI 1993.0 | HS Commands bincmd<param(s)> |
|---|---|---|---|
| :NULL | | Not confirmed | 08500 |
| :ADJust | (**0**;0;360) | Confirmed | 0810A<float> |
| :SOURCe | **MASTer** \| SLAVe | Confirmed | 0800<**1**\|2> |
| :PLL | | Confirmed | |
| :LOCK | **OFF** \| ON | Not confirmed | 0920A<**0**\|1> |
| [:STATe] | **OFF** \| ON | Not confirmed | 0920A<**0**\|1> |
| :ADJust | (**0**;-180;+180) | Confirmed | 0900A<float> |
| :FINE | (**0**;-36;+36) | Not Confirmed | 0910A<float> |
| :SEQuence | | Not Confirmed | |
| :ADVance | **AUTOmatic** \| TRIGgered | Not Confirmed | 1300A<**0**\|1> |
| :DATA | #string | Not Confirmed | 13401#<string> |
| :DEFine | (**1**;1;4096),(**1**;1;4096),(**1**;1;1E6) | Not Confirmed | 13103<integer,integer,long> |
| :DELete | | Not Confirmed | 13201 |
| [:NAME] | (1;1;4096) | Not Confirmed | 13201 |
| :ALL | | Not Confirmed | 13210 |
| :SWEep | | Confirmed | |
| :TIME | | Confirmed | 1600A<float> |
| :DIRection | **UP** \| DOWN | Confirmed | 1601A<**0**\|1> |
| :SPACing | **LINEar** \| LOGarithmic | Confirmed | 1602A<**0**\|1> |
| :STEP | | Confirmed | 1603A |
| :FUNCtion | SINusoidal \| TRIangle \| SQUare | Confirmed | 1604A<**0**\|1\|2> |
| :FREQuency | | Confirmed | 1610A<float> |
| [:STARt] | | Confirmed | 1610A <float> |
| :STOP | | Confirmed | 1611A<float> |
| :RASTer | | Confirmed | 1612A<float> |
| :MARKer | | Confirmed | 1613A<float> |
| :RESet | | Confirmed | 14200 |
| :SYSTem | | Confirmed | |
| :ERRor? | | Confirmed | 1430@? |
| :VERSion? | | Confirmed | 1440@? |



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| Keyword | Parameter Format (Default,min,max) | SCPI 1993.0 | HS Commands bincmd<param(s)> |
|---|---|---|---|
| :TRACe | | Confirmed | 10001#<string> |
| [:DATA] | | Confirmed | 10001#<string> |
| :DEFine | (**1**;1;4096),(10;10;523288) (even #) | Confirmed | 10102<integer,long> |
| :DELete | (**1**;1;4096) | Confirmed | 09201<integer> |
| [:NAME] | (**1**;1;4096) | Confirmed | 09201<integer> |
| :ALL | | Confirmed | 10210 |
| :SELect | (**1**;1;4096) | Confirmed | 1030A<integer> |
| :SEGMent | | Not Confirmed | |
| :DATA | | Not Confirmed | 10501#<string> |
| :INITiate | | Confirmed | |
| :CONTinuous | OFF \| **ON** | Confirmed | 1110A<**0**\|1> |
| :TRIGger | | Confirmed | |
| :BURSt | **OFF** \| ON | Not Confirmed | 1120A<**0**\|1> |
| [:STATe] | **OFF** \| ON | Not Confirmed | 1120A<**0**\|1> |
| :COUNt | (**1**;1;1E6) | Confirmed | 1121A<long> |
| :DELay | (**0**;10;2E6) (even #, 0 or ≥10) | Confirmed | 1131A<long> |
| :LEVel | (**0**;-10.00;+10.00) | Confirmed | 1180A<float> |
| :SOURce | | Not Confirmed | |
| :ADVance | **EXTernal** \| INTernal \| TTLTrg<n> | Not Confirmed | 1140A<**4**\|3\|8\|9\|10\|11\|12\|13\|14\|15> |
| :GATE | | Not Confirmed | 1150A<**0**\|1> |
| [:STATe] | **OFF** \| ON \| 0 \| 1 | Not Confirmed | 1150A<**0**\|1> |
| :SLOPe | **POSitive** \| NEGative | Confirmed | 1160A<**0**\|1> |
| :TIMer | (**100e-6**;15e-6;1000) | Confirmed | 1170A<float> |
| [:IMMediate] | | Confirmed | 11000 |
| :SMEMory | | Not Confirmed | 1210A<**0**\|1> |
| :MODE | **READ** \| WRITe | Not Confirmed | 1200A<**0**\|1> |
| [:STATe] | **OFF** \| ON | Not Confirmed | 1210A<**0**\|1> |
| :TEST | | Confirmed | 1400@? |
| [:ALL]? | | Confirmed | 1400@? |
| *CLS | | Confirmed | 15000 |



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| Keyword | Parameter Format (Default,min,max) | SCPI 1993.0 | HS Commands bincmd<param(s)> |
|---|---|---|---|
| *ESE | (**0**;0;255) | Confirmed | 1501A<integer> |
| *OPC | | Confirmed | 15020 |
| *RST | | Confirmed | 14200 |
| *TRG | | Confirmed | 11000 |
| *ESE? | | Confirmed | 1501@? |
| *ESR? | | Confirmed | 1504@? |
| *IDN? | | Confirmed | 1506@? |
| *OPC? | | Confirmed | 1502@? |
| *SRE? | | Confirmed | 1503@? |
| *STB? | | Confirmed | 1508@? |
| *TST? | | Confirmed | 1500@? |

# Output Configuration Command Summary

Output Configuration commands control the output function, shape, frequency, amplitude, filter and state. Optional modes are omitted from these commands. Factory defaults after *RST are shown in bold typeface. Parameter low and high limits are given where applicable. Use the Standard Waveform parameters as described in **Using The APPLy Command**.

**Commands and Parameters** (Low Limit,High Limit,**Default**)

[SOURce:]

APPLy:SINusoid {<frequency>,[<amplitude>,[<offset>,[<phase>,[<power>]]]]}

APPLy:TRIangle {<frequency>,[<amplitude>,[<offset>,[<phase>,[<power>]]]]}

APPLy:SQUare {<frequency>,[<amplitude>,[<offset>,[<duty_cycle>]]]}

APPLy:PULSe {<frequency>,[<amplitude>,[<offset>,[<delay>,[<high_time>
,[<rise_time>,[<fall_time>]]]]]]}

APPLy:RAMP {<frequency>,[<amplitude>,[<offset>,[<delay>,[<rise_time>
<fall_time>]]]]]}

APPLy:SINC {<frequency>,[<amplitude>,[<offset>,[<number_cycles>]]]}

APPLy:EXPonential {<frequency>,[<amplitude>,[<offset>,[<exponent>]]]}

APPLy:GAUSsian {<frequency>,[<amplitude>,[<offset>,[<exponent>]]]}

APPLy:DC {<percent_amplitude>}

APPLy:USER {<segment_number>,[<sampling_clock>,[<amplitude>, [<offset>]]]}


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| **Commands and Parameters** | (Low Limit,High Limit,**Default**) |
|---|---|
| APPLy:<function_shape>? | |
| APPLy? | |
| FUNCTion:MODE {FIXed \| USER \| SEQuence \| SWEep} | (**FIX**) |
| FUNCTion:MODE? | |
| FUNCtion:SHAPe {SINusoid \| TRIangle \| SQUare \| PULSe \| RAMP \| SINC EXPonential \| GAUSsian \| DC } | (**SIN**) |
| FUNCtion:SHAPe? | |
| FREQuency {<frequency> \| MINimum \| MAXimum} | (100E-6,50E6,**1E6**) |
| FREQuency? | |
| FREQuency:RASTer {<frequency> \| MINimum \| MAXimum} | (100E-3,100E6,**1E6**) |
| FREQuency:RASTer? | |
| FREQuency:RASter:SOURce {EXT \| INT \| ECLtrg0} | (INT) |
| FREQuency:RASTer:SOURce? | |
| FREQuency:EXTernal? | |
| VOLTage {<amplitude>\| MINimum \| MAXimum} | (10.0E-3,16.0,**5.00**) |
| VOLTage? | |
| VOLTage:OFFSet <offset> | (-7.19,7.19,**0**) |
| VOLTage:OFFSet? | |
| OUTPut: | |
| FILTer:FREQuency {20MHz \| 25MHz \| 50MHz} | **20MHz** |
| FILTer:FREQuency? | |
| FILTer {OFF \| ON} | **OFF** |
| FILTer? | |
| [STATe] {OFF \| ON} | **OFF** |
| [STATe] SOURce? | |
| SYNC:SOURce {BIT \| LCOMplete \| SSYNc \| HCLock} | **BIT** |



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| | |
|---|---|
| SYNC:POSition <value> | (0,512K,**n-6**) |
| SYNC:SOURce? | |
| SYNC[:STATe] {OFF \| ON} | **OFF** |
| SYNC[:STATe]? | |
| ECLTrg<n>{OFF \| ON} | **OFF** |
| TTLTrg<n>{OFF \| ON} | **OFF** |
| TRIGger:SOURce {BIT \| LCOMplete \| INTernal \| External} | **BIT** |

## Standard Waveform Command Summary

The Standard Waveform Commands control the various parameters of the standard output functions. Optional modes are omitted from these commands. Factory defaults after *RST are shown in bold typeface. Parameter low and high limits are given where applicable. The Standard Waveforms parameters could be used for the APPLy command.

| Command and Parameters | Low Limit | High Limit | Default |
|---|---|---|---|
| [SOURce:] | | | |
| SINusoid:PHASe <value> | 0 | 360 | **0** |
| SINusoid:PHASe? | | | |
| SINusoid:POWer <value> | 1 | 9 | **1** |
| SINusoid:POWer? | | | |
| TRIangle:PHASe <value> | 0 | 360 | **0** |
| TRIangle:PHASe? | | | |
| TRIangle:POWer <value> | 1 | 9 | **1** |
| TRIangle:POWer? | | | |
| SQUare:DCYCle <value> | 1 | 99 | **50** |
| SQUare:DCYCle? | | | |
| PULSe:DELay <value> | 0 | 99.9 | **10.0** |
| PULSe:DELay? | | | |
| PULSe:WIDTh <value> | 0 | 99.9 | **10.0** |
| PULSe:WIDTh? | | | |
| PULSe:TRANsition <value> | 0 | 99.9 | **10.0** |


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| | | | |
|---|---|---|---|
| PULSe:TRANsition? | | | |
| PULSe:TRANsition:TRAiling <value> | 0 | 99.9 | **10.0** |
| PULSe:TRANsition:TRAiling? | | | |
| RAMP:DELay <value> | 0 | 99.9 | **10.0** |
| RAMP:DELay? | | | |
| RAMP:TRANsition <value> | 0 | 99.9 | **10.0** |
| RAMP:TRANsition? | | | |
| RAMP:TRANsition:TRAiling <value> | 0 | 99.9 | **10.0** |
| RAMP:TRANsition:TRAiling? | | | |
| SINC:NCYCle <value> | 4 | 100 | **10** |
| SINC:NCYCle? | | | |
| GAUSsian:EXPonent <value> | 1 | 200 | **10** |
| GAUSsian:EXPonent? | | | |
| EXPonential:EXPonent <value> | -200 | 200 | **-10** |
| EXPonential:EXPonent? | | | |
| DC <%_amplitude> | -100 | 100 | **100** |
| DC? | | | |

## Arbitrary Waveform, Sequence, and Shared Memory Command Summary

Arbitrary Waveform commands allow the definition of segments and their corresponding lengths, addition and deletion of segments, and the loading waveform data. Sequence commands control which segments are linked and the number of times each segment is repeated. The shared memory commands place the 3152A in a special data transfer mode where the 3152A's message-based interface is bypassed and data is loaded directly from the VXIbus. Optional modes are omitted from these commands. Defaults are shown in bold.

**Command and Parameters**

TRACe #<binary_block>

TRACe:DEFine {<segment_number>, <length>}

TRACe:DELete <segment_number>

TRACe:DELete:ALL

TRACe:SELect <segment_number>



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FORMat:BORDer {**NORMal** | SWAPped}

FORMat:BORDer?

SEQuence:DEFine <step_number>, <segment_number>, <#_repeats>

SEQuence:DATA #<data>

SEQuence:DELete <sequence_number>

SEQuence:DELete:ALL

SEQuence:SELect <sequence_number>

SEGMent:DATA #<data>

SMEMory:MODE {**READ** | WRITe}

SMEMory {**OFF** | ON}

## Modulation Command Summary

The Modulation Commands controls amplitude modulation parameters. Optional modes are omitted from these commands. Factory defaults after *RST are shown in bold typeface. Parameter low and high limits are given where applicable.

| Command and Parameters | Low Limit | High Limit | Default |
|---|---|---|---|
| [SOURce:] | | | |
| AM <value> | 0 | 200 | **50** |
| AM? | | | |
| AM:INTernal:FREQuency <value> | 10 | 500 | **100** |
| AM:INTernal:FREQuency? | | | |
| AM:EXECute | | | |



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## Trigger Command Summary

The Trigger commands control the trigger modes of the 3152A. The 3152A can be placed in Triggered, Gated or Burst mode. Trigger source is selectable from an external source, internal trigger generator, backplane TTLTrg 0-7, and software trigger. Optional modes are omitted from these commands. Factory defaults after *RST are shown in bold typeface. Parameter low and high limits are given where applicable.

| Command and Parameters | Low Limit | High Limit | Default |
|---|---|---|---|
| INITiate:CONTinuous {OFF \| ON} | | | ON |
| TRIGger:BURSt {OFF \| ON} | | | OFF |
| TRIGger:COUNt <value> | 1 | 1e6 | 1 |
| TRIGger:DELay <value> | 0/10 | 2e6 | 0 |
| TRIGger:DELay:STATe {OFF \| ON} | | | OFF |
| TRIGger:GATE {OFF \| ON} | | | OFF |
| TRIGger:LEVel <value> | -10 | 10 | 1.6 |
| TRIGger:SLOPe {POSitive \| NEGative} | | | POS |
| TRIGger:SOURce:ADVance {EXTernal \| INTernal \| TTLTrg<n>} | | | EXT |
| TRIGger:TIMer: <value> | 15e-6 | 1000 | 100e-6 |
| TRIGger:IMMediate | | | |
| *TRG | | | |

## Backplane Inter-Module Phase Synchronization Command Summary

Phase Synchronization commands control the phase offset between two or more modules. There is no limit on how many modules can be synchronized, as long as one module is programmed to be master and the rest of the modules are slaves. The location of the slave modules in relation to the master module does not affect the accuracy of the phase offset.

The commands are presented exactly as they should be typed in your program. Optional nodes were omitted from these commands. Factory defaults after *RST or front panel reset are shown in **bold typeface**. Parameter low and high limits are given where applicable.



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| Command and Parameters | Low Limit | High Limit | Default |
|---|---|---|---|
| PHASe:LOCK {OFF \| ON} | | | **OFF** |
| PHASe:ADJust <value> | 0 | 360 (*) | **0** |
| PHASe:SOURce {MASTer \| SLAVe} | | | **SLAV** |
| PHASe:NULL | | | |

(*) High phase offset limit is not always 360°. It depends on the number of points that were assigned to the active memory segment. Phase offset limits are specified in **Appendix A**.

## Front-Panel PLL Command Summary

Front-panel PLL commands control the PLL mode and the phase offsets with respect to an external reference. If the 3152A is placed in PLL mode, it can be used as a slave only. After lock, the synthesizer's output frequency is exactly equal to the frequency of the reference signal.

The commands are presented exactly as they should be typed in your program. Optional nodes were omitted from these commands. Factory defaults after *RST or front panel reset are shown in bold typeface. Parameter low and high limits are given where applicable.

| Command and Parameters | Low Limit | High Limit | Default |
|---|---|---|---|
| PLL:LOCK {OFF \| ON} | | | **OFF** |
| PLL:ADJust <value> | -180 | 180 | **0** |
| PLL:FINE <value> | -36.00 | 36.00 | **0** |

The PLL:FINE adjustment is always relative to the PLL:ADJ setting. For instance, programming PLL:ADJ 120 and PLL:FINE –1.55 will generate a phase offset of 118.45 degrees. Note that the PLL lock range depends on the number of waveform samples, sampling frequency and external reference frequency. The relationship between these parameters is show in **Appendix A**.


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## System-Related Command Summary

The system-related commands are not related directly to waveform generation but are an important part of operating the 3152A. These commands can reset or test the instrument, or query the instrument for system information.

**Command and Parameters**

SYSTem:ERRor?

SYSTem:VERSion?

RESet

*RST

TEST?

*TST?

*IDN?

*OPT?

## IEEE-STD-488.2 Common Commands and Queries

Since most instruments and devices in an ATE system use similar commands which perform similar functions, the IEEE-STD-488.2 document has specified a common set of commands and queries which 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.

The following is a complete listing of all common commands and queries which are used in the 3152A.

***CLS** - Clear the Status Byte summary register and all event registers.

***ESE** <enable_value> - Enable bits in the Standard Event enable register. The selected bits are then reported to the status byte.

***ESE?** - Query the Standard Event enable register. The synthesizer returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

***ESR?** - Query the Standard Event register. The synthesizer returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.



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***IDN?** - Query the synthesizer's identity. The returned data is organized into four fields, separated by commas. The synthesizer 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, 3152A's response to *IDN? is:

RACAL INSTRUMENTS,3152A,0,*x.x*.

Where *x.x* is the current firmware revision

***OPC** - Set the "operation complete" bit (bit 0) in the Standard Event register after the previous commands have been executed.

***OPC?** - Returns "1" to the output buffer after all the previous commands have been executed. *OPC? is used for synchronization 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 bus and the controller handshake are in a temporary hold-off state while the controller is waiting to read the *OPC? query response.

***OPT?** - Returns "1" if the Model has 512k of memory installed.

***RST** - Resets the synthesizer to its default state. Default values are listed in **Table 4-1**.

***SRE** <enable_value> - Enables bits in the Status Byte enable register.

***SRE?** - Query the Status Byte enable register. The synthesizer 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?** - Query the Status Byte summary register. The *STB? command is similar to a serial poll but is processed like any other instrument command. The *STB? command returns the same result as a serial poll, but the "request service" bit (bit 6) is not cleared if a serial poll has occurred.

***TRG** - Triggers the synthesizer from the remote interface. This command effects the synthesizer if it is first placed in the Trigger or Burst mode of operation and the trigger source is set to "BUS".


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***TST?** - Implements an internal self-test and returns a value as described below. Approximately 90% of the 3152A functionality is tested.

0 - Self-test passed

1 - DAC, DAC control, output amplifier or amplitude control failure.

2 - Offset amplifier or offset control failure

4 - CPU to peripheral communication failure

8 - Trigger circuit or internal trigger failure

16 - Sequence or burst generator failure

32 - Clock generator failure

More than one failure can be reported at one time. For example, the returned value “17" indicates both a DAC/Output Amplifier problem and a sequence/burst generator problem exist.

***WAI** - Wait for all pending operations to complete before executing any additional commands over the interface.

## The SCPI Status Registers

The 3152A uses the Status Byte register group and the Standard Event register group to record various instrument conditions. **Figure 4-1** shows the SCPI status system.

An Event Register is a read-only register that reports defined conditions within the synthesizer. 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 that 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.



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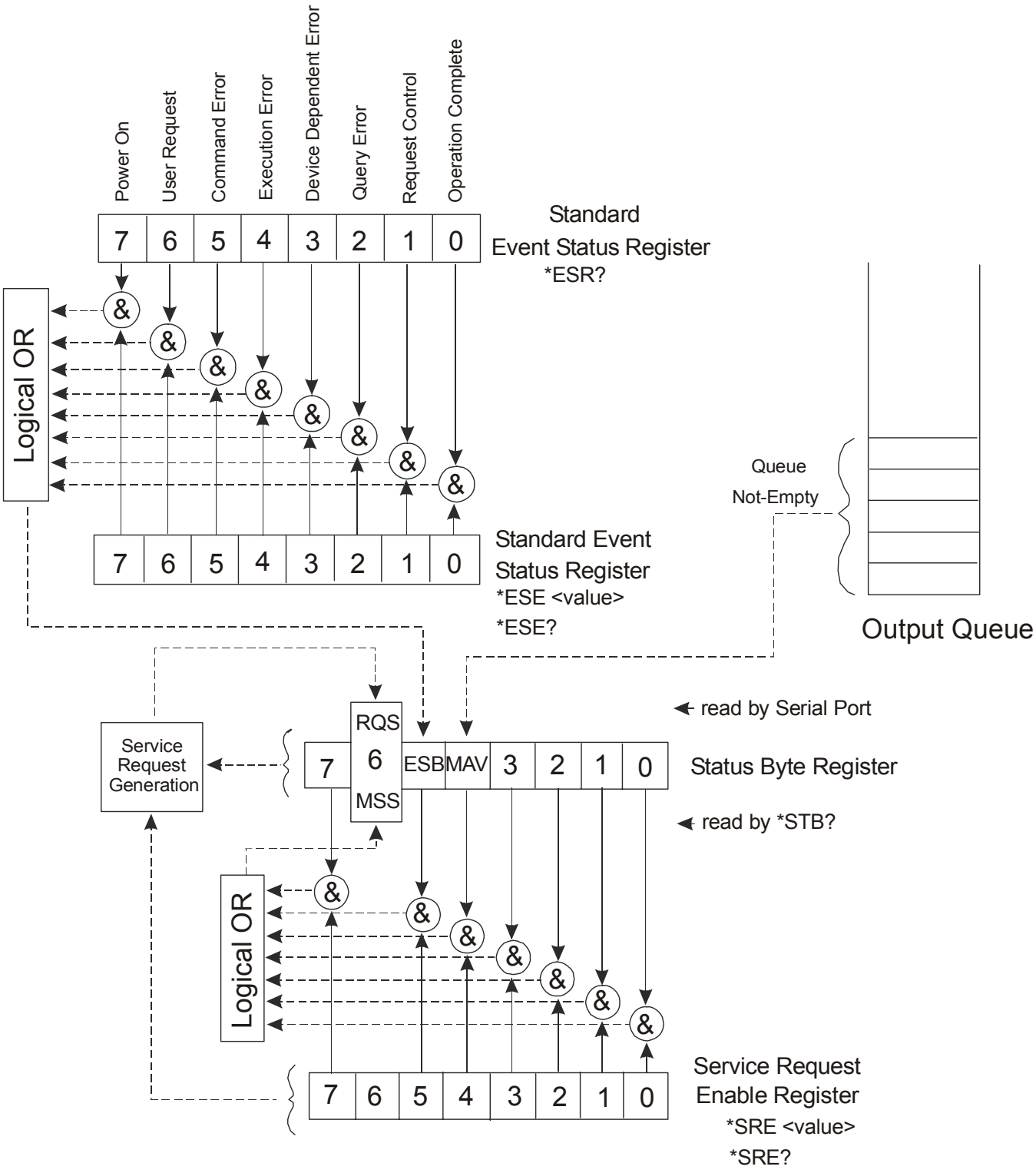



**Figure 4-1, SCPI Status Registers**



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## The Status Byte Register (STB)

The Status Byte summary register contains conditions from the other registers. Query data waiting in the synthesizer'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.

**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 synthesizer 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.



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## Clearing the Status Byte Register

The entire Status Byte register can be cleared by removing the reasons for service from Auxiliary Status registers. 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 synthesizer 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 synthesizer always ignores the value of bit 6. Summary of *SRE commands is given in the following.

***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.


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## 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 3152A.

**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 7.25;:VOLTage:OFFSet 4.1

Both of the above parameters are legal and within the specified limits, however, the synthesizer 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 synthesizer.

**Bit 5** - Command Error. This bit indicates the synthesizer 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 synthesizer 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 3152A 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 synthesizer responds with a 0,"No error" message.


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If more than 30 errors have occurred, the last error stored in the queue is replaced with -350, “Too many errors". No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the synthesizer 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?

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 synthesizer is given below.

-100,"Command error". When the synthesizer 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 synthesizer 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.



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-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. An offset value which is outside the amplitude level window may have been sent.

-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 synthesizer.

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,"Too many errors". 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.

## Device-Specific Commands

The 3152A conforms to the 1993.0 version of the SCPI standard. Some of the commands used are not included in the 1993.0 version. However, these commands are designed with the SCPI standard in mind and they follow all of the command syntax rules defined by the standard. **Table 4-1** lists all device-specific commands that were designed specifically for the 3152A as not confirmed SCPI 1993.0 commands.


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# Chapter 5

# MAINTENANCE AND PERFORMANCE CHECKS

## Maintenance Overview




This chapter provides maintenance, service information, performance tests, and the information necessary to adjust and troubleshoot the 3152A Waveform Synthesizer.

***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.**

## Disassembly Instructions

If it is necessary to troubleshoot the instrument or replace a component, use the following procedure to remove the side panels

Using a Phillips head screw driver, remove the two screws on each side of the instrument, and one screw at the rear of the instrument that secures the side panels.

Grasp one side panel and carefully slide and lift it off the instrument. Use the same procedure to remove the other side panel. After removing the side panels from the instrument, access the component side for calibration and checks, and the solder side when replacing components.

When replacing the side panels, reverse the above procedure.



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## Special Handling of Static Sensitive Devices




MOS devices are designed to operate at very high impedance levels for low power consumption. As a result, any normal static charge that builds up on your person or clothing may be sufficient to destroy these devices if they are not handled properly. When handling such devices, use precaution to avoid damaging them as described below:

MOS IC=s should be transported and handled only in containers specially designed to prevent static build-up. Typically, these parts are received in static-protected containers of plastic or foam. Keep these devices in their original containers until ready for installation.

Ground yourself with a suitable wrist strap. Remove the devices from the protective containers only at a properly grounded work station.

Remove a device by grasping the body; do not touch the pins

Any printed circuit board into which the device is to be inserted must also be grounded to the bench or table.

Use only anti-static type solder suckers.

Use only grounded soldering irons.

Once the device is installed on the PC board, the device is adequately protected and normal handling may resume.

## Cleaning

The 3152A should be cleaned as often as operating conditions require. To clean the instrument, use the following procedure:

Thoroughly clean the inside and outside of the instrument.

When cleaning inaccessible areas, remove dust with low pressure compressed air or a vacuum cleaner.

Use alcohol applied with a cleaning brush to remove accumulation of dirt or grease from connector contacts and component terminals.

Clean the exterior of the instrument and the front panel with a mild detergent mixed with water, applying the solution with a soft, lint-free cloth.


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## Repair and Replacement

Repair and replacement of electrical and mechanical parts must be accomplished with great care and caution. Printed circuit boards can become warped, cracked or burnt from excessive heat or mechanical stress. The following repair techniques are suggested to avoid inadvertent destruction or degradation of parts and assemblies:

Use a 60/40 solder and temperature-controlled 35 - 40 watt pencil-type soldering iron on the circuit board. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the circuit from the base material.

Keep the soldering iron in contact with the PC board for a minimum time to avoid damage to the components or printed conductors.

To desolder components, use a commercial "solder sucker" or a solder-removing SOLDER - WICK, size 3.

Always replace a component with an exact duplicate as specified in the parts list.

## Performance Checks

The following performance checks verify proper operation of the instrument and should normally be used:

As a part of the incoming inspection of the instrument specifications;

As part of the troubleshooting procedure;

After any repair or adjustment before returning the instrument to regular service.

## 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. Always perform a self-test sequence before commencing with the performance checks. The self-test, if executed without any failure, ensures proper operation of the synthesizer. If self-test failures have been encountered, the instrument first needs to be serviced and the source of failure removed. Instructions on how to perform self-test is given later in this chapter in the **Self-Test** section.



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## 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 3152A 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 3152A to factory defaults, send either of the following commands:

RESet, or *RST.

## Recommended Test Equipment

Recommended test equipment for troubleshooting, calibration and performance checking is listed below. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

| Test Instrument & Accessories | Minimum Specification |
|---|---|
| Universal Counter | 100MHz, 10ppm accuracy |
| DMM | ACV, 0.2%; DCV, 0.1% accuracy |
| Distortion Analyzer | 10 Hz to 100KHz |
| Spectrum Analyzer | 1GHz bandwidth, 1KHz resolution |
| Pulse/Function Generator | 20 MHz, 10ns pulsewidth |
| Oscilloscope | 2 channels, 400MHz analog bandwidth |
| Feedthrough termination | 50Ω, 1% |
| BNC Cables | 1 meter long, 50Ω impedance |
| 20dB feedthrough attenuator | 50Ω, 1% |
| “T” BNC Connector | 50Ω, 1% |


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## Performance Check Procedures

Use the following procedures to check the 3152A against the specifications. A complete set of specifications is listed in **Appendix A**. The following paragraphs show how to set up the instrument for the 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 has to be calibrated or tested to find the source of the problem.

## Frequency Accuracy

Accuracy Specifications: 0.01% of reading to 50.00 MHz

Equipment**:** Counter

1. Configure the 3152A as follows:

   Function: Square

   Frequency: 10 Hz

   Amplitude: 1 V

   Remote Commands: :RES

   :OUTP ON

   :FUNC:SHAP SQU

   :FREQ 10

   :VOLT 1

2. Set the counter to frequency measurement.

3. Connect the 3152A output to the counter=s input. Change the frequency setting as required for the test and verify the reading on the counter display as follows:

| **3152A SETTING** | **COUNTER READING** |
|---|---|
| 10.00000 Hz | 9.999000 Hz - 10.00100 Hz |
| 100.0000 Hz | 99.99000 Hz - 100.0100 Hz |
| 1.000000 KHz | 999.9000 Hz - 1.000100 KHz |
| 10.00000 KHz | 9.999000 KHz - 10.00100 KHz |
| 100.0000 KHz | 99.99000 KHz - 100.0100 KHz |
| 1.000000 KHz | 999.9000 KHz - 1.000100 KHz |
| 10.00000 MHz | 9.999000 MHz - 10.00100 MHz |
| 50.00000 MHz | 49.99500 MHz - 50.00500 MHz |



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## Amplitude Accuracy

Accuracy Specifications (1 KHz):

± (1% of reading +200 µV), to 160 mV

± (1% of reading +2 mV), to 1.6 V

± (1% of reading +20 mV), to 16 V

Equipment**:** DMM, 50Ω feedthrough termination

1. Configure the 3152A as follows:

| | |
|---|---|
| Function: | Sine |
| Frequency: | 1.000 KHz |
| Amplitude: | 15 V |
| Remote Commands: | :RES |
| | :OUTP ON |
| | :FUNC:SHAP SIN |
| | :FREQ 1000 |
| | :VOLT 15 |

2. Set the DMM to ACV measurements (RMS).

3. Connect the 3152A output to DMM input. Terminate the output with a 50Ω feedthrough termination. Set the amplitude and verify DMM reading as follows:

| **3152A SETTING** | **DMM READING** |
|---|---|
| 15.00 V | 5.373 V - 5.230 V |
| 1.500 V | 537.3 mV - 523.0 mV |
| 150.0 mV | 53.73 mV - 52.30 mV |

## DC Offset Characteristics

Accuracy Specifications**:**

± (1% of reading +1% of amplitude +200 µV), ∀80 mV window

± (1% of reading +1% of amplitude +2 mV), ∀800 mV window

± (1% of reading +1% of amplitude +20 mV) ∀8 V window

Equipment**:** DMM, 50Ω feedthrough termination



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1. Configure the 3152A as follows:

   Function: Sine

   Frequency: 1.000 MHz

   Amplitude: 1.61 V

   Remote Commands: :RES

   :OUTP ON

   :FUNC SIN

   :FREQ 1e6

   :VOLT 1.61

   :VOLT:OFFS 5

2. Set the DMM to DCV measurements

3. Connect the 3152A output to the DMM input. Terminate the output with a 50Ω feedthrough termination. Set the 3152A offset and verify the DMM reading as follows:

| OFFS SETTING | DMM READING |
|---|---|
| ±5.000 V | ±5.070 V to ±4.930 V |

4. Change the 3152A AMPL setting to 161 mV. Set VOLT:OFFS and verify the DMM reading as follows:

| OFFS SETTING | DMM READING |
|---|---|
| ±500.0 mV | ±507.0 mV to ±493.0 mV |

5. Change the 3152A AMPL setting to 16.1 mV. Set VOLT:OFFS and verify the DMM reading as follows:

| OFFS SETTING | DMM READING |
|---|---|
| ±50.00 mV | ±50.70 mV to ±49.30 mV |



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## Squarewave Characteristics

Specified Transition Time: 5ns typical (10% to 90% of amplitude)

Specified Aberration: <5% of amplitude

Equipment: Oscilloscope, 20dB attenuator

1. Configure the 3152A as follows:

| | |
|---|---|
| Function: | Square wave |
| Frequency: | 1.000 MHz |
| Amplitude: | 10 V |
| Remote Commands: | :RES |
| | :OUTP ON |
| | :FUNC:SHAP SQU |
| | :FREQ 10e6 |
| | :VOLT 10 |

Connect the 3152A output to the oscilloscope input. Use the 20 dB attenuator and set the oscilloscope input impedance to 50Ω.

Set the oscilloscope and verify that the rise and fall times are less than 6 ns. Verify that overshoot and ringing are less than 5% of amplitude.

## Sine Characteristics

**Specified Total Harmonic Distortion:** <0.1% from 10.00Hz to 100.0KHz (with a 4000 point waveform).

Specified Harmonic Signals:

<5MHz, ≤10Vp-p, -50dBc

<5MHz, ≤16Vp-p, -45dBc

<10MHz, ≤10Vp-p, -40dBc

<10MHz, ≤16Vp-p, -35dBc

<50MHz, ≤10Vp-p, -28dBc

<50MHz, ≤16Vp-p, -23dBc



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**Equipment:** Krohn-Hite 6900 (or equivalent) Distortion Analyzer, RF Spectrum Analyzer, 50Ω feedthrough termination (or 20dB 50Ω attenuator if required).

1. Connect the 3151 output to distortion analyzer input.

2. Set the distortion analyzer to distortion measurements, set the 3151 frequency setting, and verify the distortion reading as below.

3. Configure the 3151 as follows:

| | |
|---|---|
| Function: | USER Waveform |
| Frequency: | 10.00Hz |
| Amplitude: | 5V |
| Remote Commands | ::RES |
| | :OUTP ON |
| | :FUNC:MODE USER |
| | :TRAC:DEF 4000 |
| | :TRAC:SEL 1 |
| | :FREQ:RAST 40e3 |
| | :VOLT5 |

Using WaveCAD, change the axis (Setup | Axis) to have 4000 points (0 to 3999) for the first 4 steps below and 1000 points (0 to 999) for step 5 below. Download a 1k or 4k sine waveform (Wave | Sine | OK) into segment 1.

| FREQ:RAST | # of Points | Frequency | Distortion Reading |
|---|---|---|---|
| 40e3 | 4000 | 10Hz | < 0.1% |
| 40e4 | 4000 | 100Hz | < 0.1% |
| 40e5 | 4000 | 1kHz | < 0.1% |
| 40e6 | 4000 | 10kHz | < 0.1% |
| 100e6 | 1000 | 100kHz | < 0.1% |

Tune the spectrum analyzer to the carrier frequency and adjust the gain so the fundamental corresponds to 0 dB.

Connect the 3152A output to spectrum analyzer input through a 20dB feedthrough attenuator.



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Set the 3152A FREQ setting and verify the harmonic distortions levels as follows:

| FREQ SETTING | HARMONICS LEVEL |
|---|---|
| 5.000 MHz | <48 dB |
| 50.00 MHz | <28 dB |

## Sine Flatness

Level Flatness: ±1% to 1.000 MHz; ±5% to 10.00 MHz; ±15% to 50.00 MHz

Equipment**:** Oscilloscope

1. Configure the 3152A as follows:

   | | |
   |---|---|
   | Function: | Sine wave |
   | Frequency: | 1.000 KHz |
   | Amplitude: | 6 V |
   | Remote Commands: | :RES |
   | | :OUTP ON |
   | | :FREQ 10e3 |
   | | :VOLT 6 |

2. Connect the 3152A OUTPUT to the oscilloscope, set the oscilloscope input impedance to 50Ω, and set the oscilloscope to display the sinewave within exactly 6 vertical divisions.

3. Change the 3152A FREQ setting to 1.000 MHz. Verify that peak-to-peak of the displayed sinewave is within 5.9 to 6.1 divisions.

4. Change the 3152A FREQ setting to 10.00 MHz. Verify that peak-to-peak of the displayed sinewave is within 5.7 to 6.3 divisions.

5. Change the 3152A FREQ setting to 50.00 MHz. Verify that peak-to-peak of the displayed sinewave is within 5.1 to 6.9 divisions.


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## Trig, Gate and Burst Characteristics

Triggered - Each transition at the front panel TRIG IN connector stimulates the 3152A to generate one complete output waveform.

Gated - External signal at the TRIG IN connector enables the 3152A output. The last cycle of the output waveform is always completed.

Burst - Each transition at the front panel TRIG IN connector stimulates the 3152A to generate a burst of pre-selected number of cycles.

Equipment**:** Pulse/function generator (8021), oscilloscope.

**Trigger**

1. Configure the 3152A as follows:

   | | |
   |---|---|
   | Function: | Sine wave |
   | Frequency: | 1.000 MHz |
   | Operating Mode: | Triggered |
   | Remote Commands: | :RES |
   | | :OUTP ON |
   | | :FREQ 1e6 |
   | | :INIT:CONT OFF |

2. Set the external pulse/function generator frequency to 10 KHz and connect its SYNC connector. Set the oscilloscope and verify on the oscilloscope that the

The 3152A outputs a triggered signal. Leave the external pulse generator connected to the 3152A for the next test.

**Gate**

1. Configure the 3152A as follows:

   | | |
   |---|---|
   | Function: | Sine wave |
   | Frequency: | 1.000 KHz |
   | Operating Mode: | Gated |
   | Remote Commands: | :RES |
   | | :OUTP ON |
   | | :FREQ 1e3 |



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:INIT:CONT OFF

:GATE:STAT ON

Set the oscilloscope and verify that the 3152A outputs a gated signal. Leave the external pulse generator connected to the 3152A for the next test.

**Burst**

1. Configure the 3152A as follows:

   Function: Sine wave

   Frequency: 1.000 KHz

   Operating Mode: Burst

   Remote Commands: :RES

   :OUTP ON

   :FREQ 10e3

   :INIT:CONT OFF

   :BURST:STAT ON

   :TRIG:COUN 10

2. Set the oscilloscope and verify that the 3152A outputs a burst of 10 complete output waveforms. Remove the external pulse generator connection from the 3152A for the next test.


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## PLL Characteristics

Accuracy: 5.4 x frequency (in MHz) + resolution / 2 ±5°

Equipment: Oscilloscope, Counter, Pulse/Function Generator, Feedthrough Terminator, 3 BNC Cables, 50Ω Tee Connector

1. Configure the 3152A as follows:

   Function: Square wave

   Mode: Front Panel PLL

   Frequency: 1.000 KHz

   Amplitude: 2 V

   Trigger Level: 0 V

   Remote Commands: :RES

   :OUTP ON

   :FUNC:SHAP SQU

   :PHAS2:LOCK ON

   :TRIG:LEV 0

   :VOLT 2

2. Make the following connections:

   a. Connect function generator output to the input of the 50Ω Tee Connector.

   b. Connect one end of the 50Ω Tee Connector to the 3152A TRIG IN and the other end to the counter Channel A input.

   c. Connect 3152A OUT to the counter Channel B input.

3. Set counter to phase measurements. Terminate counter inputs with 50Ω.

4. Set Pulse/Function generator to output 2 Vp-p square waveforms. Change 3152A and Pulse/Function generator frequency and verify counter phase readings as shown below.



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**3152A FREQ. PULSE GENERATOR**

| SETTING | FREQ. SETTING | COUNTER READING |
|---|---|---|
| 10.00 MHz | 10.00 MHz | 0° ±77° |
| 1.000 MHz | 1.000 MHz | 0° ±12.2° |
| 100.0 KHz | 100.0 KHz | 0° ±5.72° |
| 10.00 KHz | 10.00 KHz | 0° ±5° |

5. Change the 3152A PHAS2:ADJ setting to 180°. Change 3152A and Pulse/Function generator frequency and verify counter phase readings as shown below.

**3152A FREQ. PULSE GENERATOR**

| SETTING | FREQ. SETTING | COUNTER READING |
|---|---|---|
| 10.00 KHz | 10.00 KHz | 180° ±5° |

6. Change the 3152A PHAS2:ADJ setting to -180°. Change 3152A and Pulse/Function generator frequency and verify counter phase readings as shown below.

**3152A FREQ. PULSE GENERATOR**

| SETTING | FREQ. SETTING | COUNTER READING |
|---|---|---|
| 10.00 KHz | 10.00 KHz | -180° ±5° |

7. Change the 3152A PHAS2:ADJ setting to 0°. Change 3152A and Pulse/Function generator frequency and verify counter phase readings as shown below. Note the exact phase reading.

**3152A FREQ. PULSE GENERATOR**

| SETTING | FREQ. SETTING | COUNTER READING |
|---|---|---|
| 10.00 KHz | 10.00 KHz | 0° ±5° (Note and record the exact reading) |

8. Change the 3152A PHAS2:ADJ setting to 0E and PHAS2:FINE setting to 36°. Verify counter phase readings as shown below. Note the exact phase reading.

**3152A FREQ. PULSE GENERATOR**

| SETTING | FREQ. SETTING | COUNTER READING |
|---|---|---|
| 10.00 KHz | 10.00 KHz | Recorded result from step 7 +36° ±0.36° |


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# Adjustments

## Environmental Conditions

Adjustments should be performed under laboratory conditions having an ambient temperature of 25°C ±5°C and relative humidity of less than 80%. If the instrument has been outside this range, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure. Between adjustments, always leave the top cover on the unit to keep the internal temperature as stable as possible.

## Warm-Up Period

Most equipment is subject to a small amount of drift when first turned on. To ensure long term calibration accuracy, turn on the power to the 3152A and allow it to warm-up for at least 30 minutes before beginning the adjustment procedure.

## Recommended Test Equipment

Recommended test equipment for calibration is listed at the beginning of this chapter in the section entitled **Recommended Test Equipment**. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

## Adjustment Procedures

All adjustments are performed with the POWER ON. The side covers should be removed to allow access to test points and adjustments.

***WARNING:***

**Special care should be taken to prevent contact with live circuits or the power line area. This could cause an electrical shock resulting in serious injury or death. Use an isolated tool when making adjustments.**

**When necessary, refer to the component layouts for determining adjustment points. Follow the procedure in the sequence indicated as some adjustments are interrelated and dependent on the proceeding steps.**

**Verify that the waveform generator is functioning according to the performance checks. Ensure that all results are within or close to the range of the required specifications; otherwise, refer to the troubleshooting procedures given later in this section.**

**Perform the following adjustment procedure. If an adjustment cannot be made to obtain a specific result, refer to the troubleshooting procedures.**



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***NOTE:***

**If not otherwise specified, configure the instrument to factory defaults before each adjustment by sending the *RST command. Always connect the output BNC connector through a 50Ω feed through termination.**

## Pulse Response Adjustment

Equipment: Oscilloscope (2465B), 20dB Attenuator

1. Configure the 3152A as follows:

| | |
|---|---|
| Function: | Square |
| Frequency: | 1 MHz |
| Amplitude: | 10 V |
| Remote Commands: | :RES |
| | :OUTP ON |
| | :FUNC:SHAP SQU |
| | :FREQ 1e6 |
| | :VOLT 10 |

2. Connect the 3152A output through 20dB attenuator to the oscilloscope input.
3. Set the oscilloscope input impedance to 50Ω.
4. Set the oscilloscope vertical gain and time base, and adjust R36 and C19 for the best pulse response.
5. Change the 3152A frequency setting to 10.00 KHz.
6. Set the oscilloscope vertical gain and time base, and adjust R22 for best pulse flatness.
7. Change the 3152A frequency setting to 1.000 KHz and retouch R22 for best flatness in this range. Repeat Steps 5 and 6 until the best result is obtained in both steps.


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## Amplitude Adjustment

Equipment: DMM, 50Ω feedthrough termination

1. Configure the 3152A as follows:

| | |
|---|---|
| Function: | Sine |
| Frequency: | 1 KHz |
| Amplitude: | 16 V |
| Remote Commands: | :RES |
| | :OUTP ON |
| | :FREQ 1E3 |
| | :VOLT 16 |

2. Connect the 3152A output to the DMM input through the 50Ω feedthrough termination. Set the DMM to AC Volt measurements and 2 V range.
3. Adjust R44 until the DMM reading is 5.657 V ±20 mV.
4. Change the 3152A amplitude setting to 2.0 V.
5. Adjust R44 until the DMM reading is 0.707V ±6 mV.
6. Repeat Steps 4 and 5 until the best result is obtained in both steps.

## Offset Adjustment

Equipment: DMM, 50Ω feedthrough termination

1. Configure the 3152A as follows:

| | |
|---|---|
| Function: | Sine |
| Frequency: | 1 MHz |
| Amplitude: | 1.61 V |
| Offset: | +7.19V |
| Remote Commands: | :RES |
| | :OUTP ON |
| | :FREQ 1e6 |
| | :VOLT 1.61 |
| | :VOLT:OFFS 7.19 |



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2. Connect the 3152A output to the DMM input through the 50Ω feedthrough termination. Set the DMM to DCV measurements and 10 V range. Record this reading.

3. Change the offset setting to -7.19 V and adjust R85 to have the exact reading as was recorded in the previous step (with reversed polarity).

4. Adjust R62 until the DMM reading is -7.190 V ±30 mV.

5. Repeat Steps 3 and 4 until the best result is obtained in both steps.

## VCO Adjustment

Equipment: DMM

1. Configure the 3152A as follows:

| | |
|---|---|
| Function: | Sinewave |
| Output: | On |
| Remote Commands: | :RES |

2. Connect the DMM “V” input to U515 pin 1 and the DMM “common” nput to case ground. Set the DMM to DCV measurements.

3. Adjust R536 until the DMM reading is 0 V ±500 mV.

## PLL Adjustment

Equipment: Oscilloscope, Counter, Pulse/Function Generator, Feedthrough Terminator, 3 each BNC Cables, 50Ω Tee Connector

1. Configure the 3152A as follows:

| | |
|---|---|
| Function: | Square wave |
| Mode: | Front Panel PLL |
| Frequency: | 10.00 KHz |
| Mode: | PLL |
| Phase Offset | 45° |
| Amplitude: | 2 V |
| Trigger Level: | 0 V |
| Remote Commands: | :RES |


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:OUTP ON

:FUNC:SHAP SQU

:FREQ 10.00E3

:PHAS2:LOCK ON

:PHAS2:ADJ 45

:TRIG:LEV 0

:VOLT 2

2. Make the following connections:

   a. Connect function generator output to the input of the 50Ω "T" Connector.

   b. Connect one end of the 50Ω "T" Connector to the 3152A TRIG IN and the other end to the counter Channel A input.

   c. Connect the 3152A OUT to the counter Channel B input.

3. Set counter to phase measurement. Terminate counter inputs with 50Ω.

4. Set Pulse/Function generator to output a 2 Vp-p, 10KHz square waveform.

5. Adjust R535 for a counter reading of 45°, ±3° Note and record the exact counter reading for the next adjustment.

6. Set 3152A PHAS2:FINE to 36. Adjust R537 until reading falls within the following reading:

7. Value recorded in step 5 + 36°, ±2°.

## Troubleshooting

The troubleshooting instructions contained in this section are intended for qualified personnel having basic understanding of analog and digital circuitry. The individual should also be experienced at using typical test equipment as well as ordinary troubleshooting procedures. The information presented here has been written to assist in isolating a defective circuit or circuit section. Isolation to a specific component is left to the technician.



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## Recommended Test Equipment

Recommended test equipment for troubleshooting and adjustment of the 3152A are listed in the section entitled **Recommended Test Equipment** in the beginning of this chapter. Other equipment such as a logic analyzer, an in-circuit emulator, etc., could also be helpful in a difficult situation.

## Power-Up Tests

Upon power-up, the 3152A performs a set of tests. If the instrument locks up after power on, proceed with the troubleshooting procedure given in the following paragraphs.

## Self-Test

An advanced feature of the 3152A is its self-test capability. This feature helps in reducing troubleshooting time of faulty circuits to the minimum. If the instrument fails its self-test procedure, it will generate an error bit. *TST? initiates the self-test procedure. If the instrument executes its self-test without errors, 0 is placed at the output queue. Non-zero indicates self-test failure.

The self-test procedure is intended to verify general operation of the 3152A. It does not test for accuracy. Therefore, it should be used as an indication that the 3152A operates, in general. The self-test procedure checks about 90% of the 3152A hardware. If the self-test procedure fails to respond correctly, troubleshooting the 3152A is suggested using the procedure given below.

The troubleshooting procedure should also be initiated whenever the synthesizer fails to perform either completely or partially. It is also required to troubleshoot the 3152A whenever the instrument fails to fully comply with its published specifications. The information given in the following does not intend to replace full scale troubleshooting, but merely to direct the Service Technician to the area were the source of the trouble is located.

## Main Board Circuit Checkout

The 3152A is made of two boards. The large board (Part Number 7100-2370) is the main board. There is a smaller board mounted on the main board with three connectors (Part Number 7100-2360). This smaller board is called the “engine board.” The following checks are made on the main board. To gain access to components below the engine board, it may be necessary to remove this board entirely. To do so, remove the three screws that tie the engine board to the main board, grasp the engine board from both sides and pull away from the main board.


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## Power Supply Checkout

It is suggested that the first step in troubleshooting the 3152A would be to check the power supply rails. If the various supply voltages within the instrument are not within the required limits, troubleshooting the remaining circuits can be very difficult.

The supply voltages are supplied to the 3152A through the backplane. In case of a "dead short" between one of the supplies to the common ground, disconnect the entire supply section from the remaining circuitry, and then determine whether the problem is in the power supply or in the remaining circuits.

A few preliminary checks could help here. First remove the 3152A from the VXIbus chassis. Turn on the VXIbus chassis and verify that the supply voltages are available directly on the backplane sockets. Check the following supplies: +24V, -24V, +12V, -12V, +5V, and -5.2V. Check the ripple on these lines using an oscilloscope.

Plug an extension card into one of the slots and plug the 3152A into the extension card. Turn the chassis power on and repeat the supply voltage tests as above. If one of the voltages is missing or not within the specified range, it is possible that one of the supply lines is shorted inside the 3152A. Remove the filter chokes L12 and L13 if there are problems on the +24V or -24V lines; remove L8 or L9 if there are problems on the +5V or -5.2V lines, or remove L10 or L11 if there are problems on the +12V or -12V lines.

## CPU and VXI ASIC Checkout

The most important section to be verified after power supply checkout is the CPU and the VXI ASIC section with its various clocks, address, data lines, and chip select serial data communication components. Problems with the digital part could cause erratic operation or erroneous response to word serial commands.

Problems in the CPU and the digital circuit may cause a complete malfunction of the entire instrument. The CPU would not start generating control signals. This makes it impossible to troubleshoot the remaining circuits. Check the various components associated with the CPU circuitry, its clocks, and the components associated with the VXI ASIC using the information given in **Table 5-1**.



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**Table 5-1, CPU and VXI Interface Checkout Procedure**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | CPU Clock - U87 pin 19 | 16 MHz TTL level clock |
| 2 | VXI Clock - U109 pin 159 | 16 MHz TTL level clock |
| 3 | ALE - U85 pin 11 | Positive going pulses; period 375 ns, pulse width 120 ns |
| 4 | PSEN - U74a and U74b | 2.67 MHz TTL level pulses |
| 5 | Load a 10000-point wave and perform the following tests during load time | |
| 6 | RD - U87 pin 16 | Negative going 400 ns width pulses |
| 7 | WR - U87 pin 17 | Negative going 400 ns width pulses |
| 8 | LDACK - U87 pin 5 | Negative going 6.5 µs width pulses |
| 9 | ASIC LCS - U104 pin 11 | Negative going 6.5 µs width pulses |
| 10 | LR/W - U93 pin 19 | Negative going 60 µs width pulses |

## Output Amplifier and Amplitude Control Checkout

Problems with the output amplifier and amplitude control circuits can be detected if the 3152A accepts word serial commands and responds correctly to word serial queries, but fails to output the correct waveform with correct amplitude and offset levels. If there is a problem with the output amplifier or with the amplitude control circuit, proceed with the checkout procedure given in **Table 5-2**.

Before starting the following procedure, reset the 3152A to the factory defaults using the *RST command. Then send the command OUTPUT ON.


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**Table 5-2, Output Amplifier and Amplitude Control Checkout Procedure**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | Junction of R57 and R58 | 750 mVp-p sinewave, 1 MHz |
| 2 | Junction of R18 and R19 | 10 Vp-p sinewave, 1 MHz |
| 3 | Voltage across R37, R41, R46, and R49 | Approximately 1.6 V |
| 4 | CE voltage on Q9 | Approximately 2.8 V |
| 5 | U7, pin 1 | Approximately -1.1 V |
| 6 | U7, pin 7 | Approximately 400 mV |
| 7 | Change amplitude setting to 1.61V and offset setting to 7V | |
| 8 | U8, pin 1 | Approximately -320 mV |
| 9 | U8, pin 7 | Approximately -2 V |

## Clock Synthesizer Checkout

Problems with the clock synthesizer circuits can be detected if the 3152A accepts word serial commands and responds correctly to word serial queries, but fails to output the correct waveform frequency. If there is a problem with the clock synthesizer circuit, proceed with the checkout procedure given in **Table 5-3**.

Before you start with the following procedure, reset the 3152A to the factory default using the *RST command and change frequency setting to 1 MHz.



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**Table 5-3, Clock Synthesizer Checkout Procedure**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | U510 pin 7 | 100 MHz ECL level clock |
| 2 | U16 pin 15 | 50 MHz ECL level clock |
| 3 | U16 pin 2 | 25 MHz ECL level clock |
| 4 | U505 pin 21 | 1.5625 MHz TTL level clock |
| 5 | U506 pin 6 | 1.5625 MHz ECL level clock |
| 6 | U506 pin 2 | 1.5625 MHz square waves 2 Vp-p |
| 7 | U503 pin 1 | 1.5625 MHz ECL level clock |
| 8 | U503 pin 2 | 1.5625 MHz ECL level clock |
| 9 | Q502, Q503 collector | 1.5625 pulses 3 Vp-p on 5 V offset |
| 10 | U516 pin 6 | Approximately 12 VDC |
| 11 | U17 pin 15 | 100 MHz ECL level clock |

## Sequence Generator Checkout

Problems with the sequence generator circuits can be detected if the 3152A accepts word serial commands and responds correctly to word serial queries, but fails to output sequences or bursts. If there is a problem with the sequence generator circuits, proceed with the checkout procedure given in **Table 5-4**.

Before starting the following procedure, reset the 3152A to the factory default using the *RST command. Configure the 3152A to sequenced output mode and load three different waveforms - 100 points long, to segments 1, 2, and 3, respectively. Program each step to repeat once. Use the following commands after loading the waveforms.

Remote Commands: :FUNC:MODE SEQ

:SEQ:DEF 1,1

:SEQ:DEF 2,1

:SEQ:DEF 3,1

:OUTP ON


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**Table 5-4, Sequence Generator Checkout Procedure**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | U45 pin 1, U42 pin 11 | Negative going pulses; 2 ns width, 100 µs period |
| 2 | U46 pin 1, and 3 | Same as above |
| 3 | U42 pin 12 | Negative going pulses; 100 µs width, 200 µs period |
| 4 | U42 pin 8, U43 pin 14 | Negative going pulses; 2 µs width, 100 µs period |
| 5 | U44 pin 14, U47 pin 14 | Same as above |
| 6 | U47 pin 5 | Negative going pulses; 2 µs width, alternating 100 µs and 200 µs periods |
| 7 | U47 pin 2, and 3 | Positive going pulses; 100 µs width, 200 µs period |

The next checkout is done on the 3152A configured to operate in burst mode with 5 bursts. Use the following command to configure the 3152A:

Remote Commands: :FUNC:MODE USER

:TRAC:SEL 1

:INIT:CONT OFF

:TRIG:BURS: ON

:TRIG:COUN 5

:OUTP ON

Connect an external trigger source to the front panel TRIG IN connector. Set external trigger frequency to 1 KHz. Proceed with the checkout procedure given in **Table 5-5**.



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**Table 5-5, Burst Generator Checks**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | U56 through U60 pin 2 | Five negative going pulses; 2 ns width, 100 µs period, repeated every 1 ms |
| 2 | U56 through U60 pin 9 | Positive going pulses; 200 µs width, 1 ms period |
| 3 | U49 pin 2 | Positive going pulses; 400 µs width, 1 ms period |
| 4 | U49 pin 5 | Positive going pulses; 300 µs width, 1 ms period |

## PLL Checkout

Problems with the phase lock loop circuits can be detected if the 3152A accepts word serial commands and responds correctly to word serial queries, but fails to lock to a valid external signal. If there is a problem with the PLL circuits, proceed with the checkout procedure given in **Table 5-6**.

Before starting the following procedure, reset the 3152A to the factory default using the *RST command. Configure the 3152A to PLL mode, 10 MHz frequency and square waveform. Use the following commands after loading the waveforms.

Remote Commands:

:RES

:OUTP ON

:FREQ 10E6

:PHAS2:LOCK ON

:TRIG:LEV 0

Connect an external 10 KHz, 2 Vp-p square waveform to the TRIG IN BNC. Proceed with the checkout procedure given in **Table 5-6**.

**Table 5-6, PLL Checkout Procedure**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | U513 pin 6 | 0 KHz square waveform, ECL logic level |
| 2 | U513 pin 11 | 20 µs width positive going pulses; 100 µs period, ECL |
| 3 | Q502, Q503 collectors | 3 Vp-p narrow pulses on 5 V offset |


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## Engine Board Circuit Checkout

As described in the paragraph **Main Board Circuit Checkout**, the 3152A is made of two boards. If the engine board is removed from the main board, reinstall it before continuing with the following checks. The following circuit checks are performed on the engine board only.

## Engine Board Checkout

The "engine board" is the analog heart of the 3152A. It contains the waveform memory circuit, high frequency clock drives, and circuitry that drives the D/A converter. The output of the D/A converter is routed directly from the engine board to the output amplifier located on the main board.

Problems with the engine board circuits can be detected if the 3152A accepts word serial commands and responds correctly to word serial queries, however, fails to generate waveforms. If there is a problem with the engine board circuits, proceed with the checks given in **Table 5-7a**.

Before starting the following procedure, reset the 3152A to the factory default using the *RST command.



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**Table 5-7a, Engine Board Checkout Procedure - #1**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | U27 pin 2 | ±2.5 V squarewave, 1 MHz |
| 2 | U41 pins 1 to 11, pin 28 | -0.8 V to -1.8 V ECL level squarewave, 1 MHz |
| 3 | U41 pin 26 | ECL Level Negative going pulses; 2 ns width, 1 MHz |
| 4 | U29, U46, U51 pin 1 | TTL Level, 50 MHz |
| 5 | U17-U20 pins 13-21 | TTL Level, 1 MHz |
| 6 | U31,U32,U35,U36 pins 17 through 20 | TTL Level, 1 MHz |
| 7 | U53-U57 pins 13-21 | TTL Level, 1 MHz |
| 8 | U31-U32 pins 13-15 | TTL Level, Positive going pulses; 20 ns width, 1 MHz |
| 9 | U35-U36 pins 13-15 | TTL Level, Positive going pulses; 20 ns width, 1 MHz |
| 10 | U37,U38,U58,U60 pin 9 | TTL Level, Negative going pulses; 20 ns width, 1 MHz |
| 11 | U39 pin 5 | TTL Level, Positive going pulses; 20 ns width |
| 12 | U18 pin 4 | ECL Level 100 MHz |
| 13 | U18 pin 2 | ECL Level 100 MHz |
| 14 | U15 pin 2, U16 pins 2,3,14,15, U19 pins 2,3,9 14, U20 pin 14, U21 pin 6, 11, U22 pin 6 | ECL Level 100 MHz |

Change the 3152A setting to triggered. Use an external pulse generator to apply a TTL level, 200 KHz signal to the TRIG IN connector. Proceed with the checks given in **Table 5-7b**.


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**Table 5-7b, Engine Board Checkout Procedure - #2**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | U13 pin 16 | TTL Level, 200 KHz |
| 2 | U13 pins 8 | TTL Level Positive going pulses; 10 ns width, 200 KHz |
| 3 | U39 pin 13 | TTL Level Negative going pulses; 10 ns width, 200 KHz |
| 4 | U39 pin 8 | TTL Level Positive going pulses; 1 μs width, 200 KHz |
| 5 | U26 pin 11 | TTL Level Negative going pulses; 1 μs width, 200 KHz |
| 6 | U24 pin 1 | ECL Level Negative going pulses; 1 μs width, 200 KHz |

Change the 3152A setting to delayed trigger and change delay to 100. Use an external pulse generator to apply a TTL level and 200 KHz signal to the TRIG IN connector. Proceed with the checks given in **Table 5-7c**.

**Table 5-7c, Engine Board Checkout Procedure - #3**

| Step | Test Point | Expected Result |
|---|---|---|
| 1 | U14 to U8 pin 9 | TTL Level Positive going pulses; 1 μs width, 200 KHz |
| 2 | U10 pin 1, U39 pin 13 | TTL Level Negative going pulses; 10 ns width, 200 KHz |



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# Chapter 6
# PRODUCT SUPPORT

## Product Support

EADS North America Defense Test and Services, Inc. has a complete Service and Parts Department. If you need technical assistance or should it be necessary to return your product for repair or calibration, call 1-800-722-3262. If parts are required to repair the product at your facility, call 1-949-859-8999 and ask for the Parts Department.

When sending your instrument in for repair, complete the form in the back of this manual.

For worldwide support and the office closest to your facility, refer to the website for the most complete information http://www.eads-nadefense.com.

## Warranty

Use the original packing material when returning the 3152A to EADS North America Defense Test and Services, Inc. for calibration or servicing. The original shipping container and associated packaging material will provide the necessary protection for safe reshipment.

If the original packing material is unavailable, contact EADS North America Defense Test and Services, Inc. Customer Service at 1-800-722-3262 for information.



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## REPAIR AND CALIBRATION REQUEST FORM

To allow us to better understand your repair requests, we suggest you use the following outline when calling and include a copy with your instrument to be sent to the EADS North America Defense Test and Service, Inc. Repair Facility.

Model_____ Serial No._____ Date_____

Company Name_____ Purchase Order #_____

Billing Address_____

City

State/Province Zip/Postal Code Country

Shipping Address_____

City

State/Province Zip/Postal Code Country

Technical Contact_____ Phone Number ( )_____
Purchasing Contact_____ Phone Number ( )_____

1. Describe, in detail, the problem and symptoms you are having. Please include all set up details, such as input/output levels, frequencies, waveform details, etc.

_____
_____
_____
_____

2. If problem is occurring when unit is in remote, please list the program strings used and the controller type.

_____
_____
_____
_____

3. Please give any additional information you feel would be beneficial in facilitating a faster repair time (i.e., modifications, etc.)

_____
_____
_____
_____

4. Is calibration data required? Yes No (please circle one)

Call before shipping
Note: We do not accept "collect" shipments.

Ship instruments to nearest support office.



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# Appendix A
# 3152A SPECIFICATIONS

## VXIbus General Information

| | |
|---|---|
| Module Form | Single slot VXIbus C-size module |
| Connectors | P1, P2 |
| Protocol | A16/A24/A32/D16 Slave, Message-Based |
| VXIbus Revision | 1.4 |
| SCPI Revision | 1993.0 |
| Optional Command | 3152, 3152S1619, Tektronix VX4750 (all optional) |
| Emulation Modes | |
| Alternate Command Set | High speed numerical commands |
| Logical Address Settings | 1 - 255, configured via DIP switches |
| Interrupt Level Settings | 1 - 7, configured dynamically (no DIP switch) |
| | Shared Memory<br>A24 or A32, D16, 512K points. Note: 1 point = 2 bytes, shared memory is the same as waveform memory. |



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## Synthesizer Reference Sources/Sample Clock

### Reference Sources

| | |
|---|---|
| External Reference Input from: | VXIbus CLK10 |
| Optional Internal Reference: | PCB layout provides for optional internal 10 MHz TCXO with 1 ppm accuracy |

### Sample Clock

External Clock Input from:

(1) Front Panel BNC, Frequency to 100 MHz, ECL compatible

(2) ECLTRG0, Synchronous Protocol, ECLTRG trigger acceptor requirements with regard to pulse width and frequency are waived.

External Clock Output to:

ECLTRG0, Synchronous Protocol, VXIbus ECLTRG trigger source requirements with regard to pulse width and frequency are waived.

## Triggering Characteristics

### Trigger Input

| | |
|---|---|
| Impedance | 1 kΩ, ±5% |
| Level | ±10 V |
| Resolution | 10 mV |
| Sensitivity | 100 mV rms |
| Accuracy | ±(5% of level + 150 mV) |
| Maximum Input Voltage | 30 V rms |
| Minimum Pulse Width | 20 ns |
| Slope | Positive or negative going edges, programmable |



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**Modes**

| | |
|---|---|
| Normal | Continuous waveform is generated |
| Triggered | Each input cycle generates a single output cycle |
| Internal Trigger | An internal timer repeatedly generates a single output cycle |
| Gated | External signal enables generator. First output cycle synchronous with the active slope of the triggering signal.Last cycle of output waveform is always completed. |
| External Burst | Preset number of up to 1 million cycles are stimulated by an internal, external, or manual trigger. |
| Internal Burst | An internal timer or software command generates one or more bursts of up to 1 million counted output cycles. |
| Delayed Trigger | 0 to 2 million clock cycles |

**Trigger Frequency**

| | |
|---|---|
| External | To 5 MHz or VXIbus trigger |
| Internal | From 15 µs to 1000 s |
| Accuracy | ±4%, 15 µs to 59 µs; |
| | ±2%, 60 µs to 0.99 ms; |
| | ±0.1%, 1 ms to 99.9 ms; |
| | ±0.01%, 100 ms to 1000 s |



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### Trigger Sources

Trigger functionality is optionally to:

(1) cause one complete cycle of the selected waveform to be output.

(2) gate the waveform output while the trigger signal is asserted.

| | |
|---|---|
| Software | IEEE-STD-488.2 *TRG, VXI Word Serial trigger |
| Internal | Internal programmable rate generator |
| System Delay | From External Trigger input to Waveform Output |
| Standard Waveforms | 120ns + 2 sample clock periods ± 1 sample clock period |
| Arbitrary Waveforms | 150ns + 2 sample clock periods ± 1 sample clock period |

External Input from:

1) Front panel BNC, TTL compatible, positive slope

2) TTLTRG0-7, Synchronous Protocol, negative slope, VXIbus TTLTRG trigger acceptor requirements:

Minimum pulse width (logic low - asserted) : 20 ns,

Minimum pulse width (logic high - unasserted) : 20 ns,

External Output to:

TTLTRG0-7, Synchronous Protocol, negative slope,

VXIbus TTLTRG trigger source requirements:

Minimum pulse width (logic low - asserted) : 30 ns

Minimum pulse width (logic high - unasserted) : 80ns

Maximum Clock Frequency : 50 MHz

Note: For the external trigger output, the trigger source is the programmable Synchronous Signal.



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For trigger operation when synchronized, the trigger circuit in the master module has control of the sample clock for all modules. Therefore, the master module must be triggered before any slave can output it's waveform.

## Backplane Multi-Module Synchronization

Multiple 3152A modules may be synchronized. A master 3152A module provides the necessary signals to slave 3152A modules to achieve synchronization. The signals required are sample clock (distributed on ECLTRG0) and another signal (distributed on TTLTRG1). Phase offset is settable (in degrees) for each slave module with respect to the master module output.

| | |
|---|---|
| Phase Offset Resolution (P.O.R.) | 360°/ Number of Points (min. # points = 10) |
| Phase Offset Range | 0° to 360° - 2880/n, where n = number of points |
| Phase Accuracy | ±[( 20 nS x 360°/PERIOD) + P.O.R.]<br>P.O.R. = phase offset resolution<br>PERIOD = 1/(output signal frequency)<br>Accuracy specified after PHAS:LOCK:NULL command |
| Jitter | None |

**Front Panel Indicator LED's**

| | |
|---|---|
| Fail | Red - Power-up self-test failure |
| Access | Amber - Module addressed on VXIbus |
| PLL On | Amber - 3152A is locked to external signal |
| Output On | Green - Output On/Off |



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### Front Panel Input/Output Connectors

| | |
|---|---|
| Main Output | Signal Output (BNC) |
| Marker/Sync Output | Marker/Sync Output (BNC) |
| Trigger Input | External Trigger Source Input (BNC) |
| Sample Frequency Input | Sample Frequency Input (BNC) |
| PM Input | Phase control Input (BNC) |

### Power

| VXIbus Rail | Peak Current | Dynamic Current |
|---|---|---|
| +24 V | < 250 mA | < 250 mA |
| +12 V | < 100 mA | < 100 mA |
| +5 V | < 3 A | < 150 mA |
| -5.2 V | < 2 A | < 150 mA |
| -12V | < 100 mA | < 100 mA |
| -24V | < 250 mA | < 150 mA |
| -2V | n/a | n/a |

Maximum Total Module Power < 45 W

### Self-Test Fault Coverage

Fault Coverage (%) 90%

### EMC

| | |
|---|---|
| Radiated Emissions (Close Field) | VXIbus B.8.6.3, Rev 1.4 |
| Radiated Susceptibility | VXIbus B.8.6.4, Rev 1.4 |
| Conducted Emissions | VXIbus B.8.7.3, Rev 1.4 |
| Conducted Susceptibility | VXIbus B.8.7.4, Rev 1.4 |


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**Mechanical**

| | |
|---|---|
| Dimensions | Per Racal Instruments VXIbus corporate package drawings |
| Weight | 3 lbs. 8 oz. (1.6 kg) |
| Airflow (for 10°C rise) | 3.7 l/S |
| Pressure (for 10°C rise) | 0.5 mm $H_20$ |

**Environmental**

| | |
|---|---|
| Operating Temperature | 0° C - 55° C |
| Storage Temperature | -40°C - +70°C |
| Humidity (non-condensing) | 11° C - 30° C 95% ±5% |
| | 31° C - 40° C 75% ±5% |
| | 41° C - 50° C 45% ±5% |
| Altitude | Operating 10000 ft |
| | Storage 15000ft |
| Vibration | 5 - 55 Hz sine (2g at 55 Hz), non-operating |
| Shock | 30g 11 ms half sine pulse, non-operating |
| Bench Handling | 4", any face, wooden surface, non-operating |

**Safety** — Designed to meet IEC 1010-1, UL 3111-1, CSA 22.2 #1010

**Workmanship Standards**

| | |
|---|---|
| PCB Assembly | Conform to IPC-A-610 |



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# Output Characteristics

| | |
|---|---|
| Output | Via front panel OUTPUT BNC terminal |
| Stand-By | Output Normal or Off |
| Impedance | 50Ω ±1% |
| Protection | Protected against temporary short to case ground |
| Glitch Energy | <1 nV-s at 16 Vp-p |
| Amplitude | 20 mV to 32 Vp-p, into open circuit |
| | 10 mV to 16 Vp-p, into 50Ω |
| Resolution | 4 digits |
| Accuracy (1 kHz) | ±(1%+20 mV) from 1.610 V to 16.00 V |
| | ±(1%+2 mV) from 161.0 mV to 1.600 V |
| | ±(1%+200 µV) from 10.00 mV to 160.0 mV |

**Offset**

| | |
|---|---|
| Dependency | Offset and Amplitude are independently adjustable within level windows: ±8 V, ±800 mV, and ±80 mV |
| Range | 0 to ±7.190 V within ±8 V window |
| | 0 to ±719.0 mV within ±800 mV window |
| | 0 to ±71.90 mV within ±80 mV window |
| Resolution | 4 digits |
| Accuracy | ±(1% +1% of amplitude +20 mV) ±8 V window |
| | ±(1% +1% of amplitude +2 mV) ±800 mV window |
| | ±(1% +1% of amplitude +200 µV) ±80mV window |
| Filters | 50 MHz 7-pole elliptic |
| | 25 MHz 7-pole elliptic |
| | 20 MHz 7-pole Gaussian |


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**Square Wave, Pulse**

| | |
|---|---|
| Rise/Fall time | 7 ns Typical, 10% to 90% of amplitude |
| Aberration | <5% |
| SYNC Output | Via front panel SYNC OUT BNC terminal |
| Level | TTL |
| Protection | Protected against temporary short-to-case-ground |

## Standard Waveforms

| | |
|---|---|
| Frequency Range | Waveform dependent |
| Source | Internal Synthesizer |
| Resolution | 7 digits |
| Accuracy | Same as frequency standard |
| Stability | Same as frequency standard |

**Sine**

| | |
|---|---|
| Frequency Range | 100 µHz to 50 MHz |
| Distortion | <0.1%, below 100 kHz (2000 points minimum) |
| Harmonics | <5 MHz, ≤10 Vp-p, -48 dBc |
| | <5 MHz, ≤16 Vp-p, -40 dBc |
| | <10 MHz, ≤10 Vp-p, -40 dBc |
| | <10 MHz, ≤16 Vp-p, -35 dBc |
| | <50 MHz, ≤10 Vp-p, -28 dBc |
| | <50 MHz, ≤16 Vp-p, -20 dBc |
| Band Flatness | 1%, to 1 MHz; 5% to 10 MHz; 15%, to 50 MHz |
| Programmable Parameters | |
| Start Phase | 0 to 360° |
| Power ($sine^X$) | 1 to 9 |



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**Triangle**

| | |
|---|---|
| Frequency Range | 100 µHz to 1 MHz, usable to 10 MHz |
| Adjustable Parameters | |
| Start Phase | 0 to 360° |
| Power | 1 to 9 |

**Square**

| | |
|---|---|
| Frequency Range | 100 µHz to 50 MHz |
| Adjustable Parameters | |
| Duty Cycle | 1% to 99.9% |

**Pulse/Ramp**

| | |
|---|---|
| Frequency Range | 100 µHz to 1 MHz |
| Adjustable Parameters | |
| Delay | 0% to 99.9% of period |
| Rise Time | 0% to 99.9% of period |
| High Time | 0% to 99.9% of period |
| Fall Time | 0% to 99.9% of period |

**Sinc (Sine(x)/x)**

| | |
|---|---|
| Frequency Range | 100 µHz to 1 MHz |
| Adjustable Parameters | |
| Cycles | 4 to 100 cycles |


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**Gaussian Pulse**

| | |
|---|---|
| Frequency Range | 100 µHz to 1 MHz |
| Adjustable Parameters | |
| Time Constant | 1 to 200 |

**Exponential Decaying/Rising Pulse**

| | |
|---|---|
| Frequency Range | 100 µHz to 1 MHz |
| Adjustable Parameters | |
| Time Constant | -100 to 100 |

**DC**

| | |
|---|---|
| Range | 1% to 100% of amplitude |

## Arbitrary Waveforms

| | |
|---|---|
| Waveform Memory | 512K points |
| Memory Segmentation | |
| Number of Segments | 1 to 4096 |
| Min Segment Size | 10 points |
| Vertical Resolution | 12 bits (4096 points) |

**Sampling Clock**

| | |
|---|---|
| Source | Internal synthesizer, external clock, ECLTRG0 |
| Range | |
| Internal | 100 mHz to 100 MHz |
| External | To 100 MHz |
| Internal Reference | 10 MHz, fixed internal crystal clock frequency |
| Resolution | 7 digits |
| Accuracy | Same as frequency standard |
| Stability | Same as frequency standard |



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## Sequenced Waveforms

| | |
|---|---|
| Operation | Permits division of the memory bank into smaller segments. Segments may be linked and repeated in user-selectable fashion to generate extremely long waveforms |
| Sequencer steps | From 0 to 4096 |
| Segment loops | From 0 to 1 million. |
| Segment Duration | Minimum 100 ns for more than one loop |

**Sampling Clock**

| | |
|---|---|
| Source | Internal synthesizer, external clock, ECLTRG0 |
| Range | |
| Internal | 100 mHz to 100 MHz |
| External | To 100 MHz |
| Internal Reference | 10 MHz, fixed internal crystal clock frequency |
| Resolution | 7 digits |
| Accuracy | Same as frequency standard |
| Stability | Same as frequency standard |

## Swept Waveforms

| | |
|---|---|
| Operation | Utilizes the 3152A's sequencer and waveform memory to implement a frequency sweep from one frequency to another. Note: Sweep mode is volatile in that any arbitrary waveforms or sequences stored in memory are deleted when sweep is invoked. |


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| | | |
|---|---|---|
| Sweep Parameters | | |
| | Waveforms | Sine, square or triangle |
| | Sweep Spacing | Linear or log |
| | Sweep Direction | Up or down |
| | Sweep Duration | .01 to 1000s |
| | Sweep Frequency Range | 1mHz to 10MHz |
| | Discrete Sweep Steps | 10 to 1000 |
| Trigger Modes | | Same as for sequenced mode |

**Sampling Clock**

| | | |
|---|---|---|
| Source | | Internal synthesizer, external clock, ECLTRG0 |
| Range | | |
| | Internal | 100 mHz to 100 MHz |
| | External | To 100 MHz |
| | Internal Reference | 10 MHz, fixed internal crystal clock frequency |
| Resolution | | 7 digits |
| Accuracy | | Same as frequency standard |
| Stability | | Same as frequency standard |

## PLL Characteristics

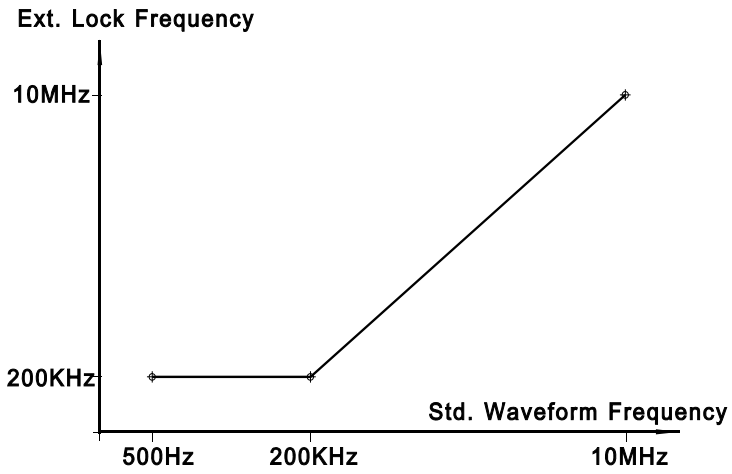
| | |
|---|---|
| Operation | Automatically locks to external signal |
| PLL Input Characteristics | Same as TRIG IN |
| External Lock Frequency Range | |
| Standard Waveforms | 500 Hz to 200 kHz; frequency setting 500 Hz to 200 kHz; |
| | 500 Hz to same value as |



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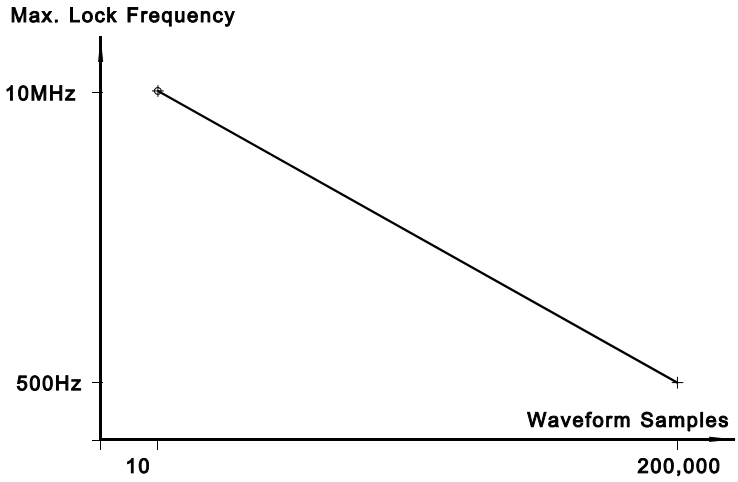
internal frequency setting,

200 kHz to 10 MHz; See graph below.




Arbitrary Waveforms

500 Hz to 100 MHz divided by number of waveform samples. See graph below.






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**Coarse Phase Offset Control**

| | |
|---|---|
| Range | ±180° |
| Resolution | |
| Std. Waveforms | 0.72°, frequency setting from 500 Hz to 200 kHz;<br>360° x frequency (in MHz) / 100, frequency setting from 200 kHz to 10 MHz |
| Arbitrary Waveforms | 360° / waveform samples |
| Accuracy | 5.4 x frequency (in MHz) + resolution / 2 ±5 |

Fine Phase Offset Control

| | |
|---|---|
| Range | ±36° around coarse phase offset setting |
| Resolution | 0.01° |
| Accuracy | 10%, typical |

Frequency Counter

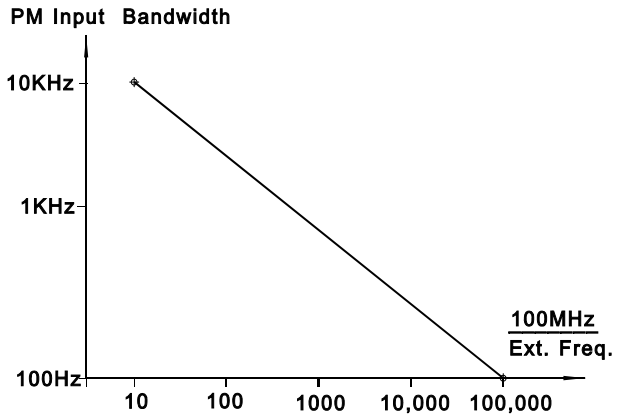
| | |
|---|---|
| Operation | Made available to the user in PLL mode only. Frequency reading is valid only when PLL ON LED is lit. |
| Range | Same as External Lock Frequency Range above |
| Resolution | 4 digits |



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## PM Characteristics

| | |
|---|---|
| Operation | External signal offsets phase. This input is operational in PLL mode. |
| Bandwidth | See graph below |




**PM Input**

| | |
|---|---|
| Impedance | 100 kΩ, ±5% |
| Sensitivity | 20°/ V, nominal |
| Accuracy | ±30% |


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# Appendix B
# TEKTRONIX VX4750 EMULATION

The table below cross-references the Tektronix VX4750 command set with the 3152A (with TEK option) emulation command set. In cases where there are limitations or restrictions on the use of the 3152A's emulation version of a command, these limitations are listed.

| Command | Description | 3152A Limitations (if any) |
|---|---|---|
| AM | Set external modulation to AM and set the AM modulation index. | Not implemented. |
| AMPL | Specify the amplitude of the function output. | No restrictions. |
| AMPL? | Query the amplitude of the function output. | No restrictions. |
| BRST | Set the burst count. | No restrictions. |
| BRST? | Query the burst count. | No restrictions. |
| BUF | Place the module in buffered mode. | No restrictions. |
| DAT | Load data into the module for use in generating arbitrary waveforms. | No restrictions. |
| DFREQ | Change the output by the specified amount, phase continously. | No restrictions. |
| DINT | Disable VXI Interrupt generation. | No restrictions. |
| DPHAS | Change phase of output by the specified amount, phase continuous. | No restrictions. |
| ERR? | Query for error conditions. | No restrictions. |
| FILT | Enable or disable a low pass filter to the output waveform. | VX4750: 12MHz filter selected<br>3152A: 20MHz filter selected. |
| FM | Set external modulation to FM and set the FM peak deviation. | Not implemented. |
| FREQ | Specify the frequency of the output waveform. | No restrictions. |
| FREQ? | Query the frequency specified in last valid FREQ command. | No restrictions. |
| FSK | Set external modulation to FSK and set the FSK frequencies. | Not implemented. |
| FSK? | Query the FSK frequencies. | Not implemented. |
| IMP | Specify the load impedance connected to the arb. | No restrictions. |



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| | | |
|---|---|---|
| INT | Enable VXI event generation from the module. | No restrictions. |
| IST | Initiate a self-test | 3152A error codes are returned. |
| ISWP | Specify internal linear sweep parameters. | VX4750: 1mHz to 10MHz/7MHz to 25MHz<br>3152A: 1mHz to 10MHz |
| LSWP | Specify internal log sweep parameters. | VX4750: 1mHz to 10MHz/7MHz to 25MHz<br>3152A: 1mHz to 10MHz |
| NBUF | Place the module in non-buffered mode. | No restrictions. |
| OFST | Specify the DC offset of the output waveform. | No restrictions. |
| OFST? | Query the DC offset of the output waveform. | No restrictions. |
| PHAS | Specify the phase of the output waveform. | No restrictions. |
| PHAS? | Query the phase of the output waveform. | No restrictions. |
| PM | Set external modulation to PM and set the max PM phase deviation. | Deviation not settable. Lock signal must be provided. |
| PSK | Encode data on the output waveform using PSK modulation. | Not implemented. |
| PWM | Set external modulation to PWM and set max DC deviation from 50%. | Not implemented. |
| REFI | Selects a frequency reference source. | No restrictions. |
| REFO | Selects 10MHz or 33MHz to be output to the REF OUT connector. | Not implemented. |
| REV? | Return the firmware revision. | Returns the 3152A firmware revision. |
| RST | Reset the module to its power-up state. | No restrictions. |
| SPER | Specify the sample period to use to generate arbitrary waveforms. | No restrictions. |
| SPER? | Query the sample period used to generate arbitrary waveforms. | No restrictions. |
| SWP OFF | Disable sweep. | No restrictions. |
| TRGI | Select a trigger input source and polarity of front panel trigger. | No restrictions. |
| TRGO | Select trigger output and polarity of front panel trigger output. | No restrictions. |
| TRIG | Trigger the module to output a pre-defined waveform. | No restrictions. |
| XSWP | Set to external sweep and define start/stop frequencies. | Not implemented. |
| XSWP? | Query the start/stop frequencies of external sweep. | Not implemented. |
| WAVE | Specify the type of function generator waveform used. | No restrictions. |


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