User Manual

Model 5251

250 MS/s PXIbus

Arbitrary Waveform Generator

Publication No. 100520

Tabor Electronics Ltd.

9 Hatasia Street, Nesher, Israel 20302

TEL: (972) 4 821 3393, FAX: (972) 4 821 3388

[www.taborelec.com]

PUBLICATION DATE: May 20, 2010

REVISION: 1.0

WARRANTY STATEMENT

Products sold by Tabor Electronics are warranted to be free from defects in workmanship or materials. Tabor Electronics will, at its option, either repair or replace any hardware products, which prove to be defective during the warranty period. You are a valued customer. Our mission is to make any necessary repairs in a reliable and timely manner.

Duration of Warranty

The warranty period for this Tabor Electronics hardware is one year, except software and firmware products designed for use with Tabor Electronics Hardware is warranted not to fail to execute its programming instructions due to defect in materials or workmanship for a period of ninety (90) days from the date of delivery to the initial end user.

Return of Product

Authorization is required from Tabor Electronics before you send your product for service or calibration. Call your nearest Tabor Electronics support facility. A list is located on the last page of this manual. If you are unsure where to call, contact Tabor Electronics Customer Support Department.

Limitation of Warranty

Tabor Electronics shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than authorized Tabor Electronics service personnel or without the written consent of Tabor Electronics.

Tabor Electronics expressly disclaims any liability to its customers, dealers and representatives and to users of its product, and to any other person or persons, for special or consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, handling, repair, maintenance, replacement or use of said products.

Representations and warranties made by any person including dealers and representatives of Tabor Electronics, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitations of the liability of Tabor Electronics as set forth above), shall not be binding upon Tabor Electronics unless reduced to writing and approved by an officer of Tabor Electronics

Except as stated above, Tabor Electronics makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and except to the extent stated above, Tabor Electronics shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

PROPRIETARY NOTICE

DECLARATION OF CONFORMITY

We: Tabor Electronics Ltd.
9 Hatasia Street, Tel Hanan
ISRAEL 36888

declare, that the 250MS/s Single Channel Arbitrary Waveform Generator

Model 5251

meet the intent of the requirements of the Electro Magnetic Compatibility 89/336/EEC as amended by 92/31/EEC, 93/68/EEC, 92/263/EEC and 93/97/EEC and the Low Voltage Directive 73/23/EEC amended by 93/68/EEC. Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

Safety:
IEC/EN 61010-1 2nd Edition: 2001+ C1, C2

EMC:
EN55022:2001 Class A Radiated and Conducted Emission
IEC61000-3-2:2001(Am1) Harmonics
IEC61000-3-3:2002(Am1) Flickers
IEC61000-4-2:2001(Am1+Am2) ESD : Contact Discharge ±4Kv
Air Discharge ±8Kv
IEC61000-4-3:2002(Am1) Radiated immunity - 3V/m (80MHz-1000MHz)
IEC61000-4-4:2001 (Am2) Electrical Fast Transient and Burst ±1.0kV, 5KHz
IEC61000-4-5:2001 (Am1) Surges DM ±1.0kV CM ±2.0Kv
IEC61000-4-6:2003 Current injection immunity - 3Vrms
IEC61000-4-8:2001 Magnetic field 1Amper
IEC61000-4-11:2001 Voltage dips and variation

The tests were performed on a typical configuration.

Table of Contents

Chapter	Title	Page

Appendices

List of Tables

List of Figures

Chapter 1
Getting Started

Title	Page

What's In This Chapter

This chapter contains general and functional description of the Model 5251 Arbitrary Waveform Generator. It also describes the front panel connectors and operational modes and provides description of all features available with the instruments.

Conventions Used in this Manual

The following conventions may appear in this manual:

NOTE

A Note contains information relating to the use of this product

CAUTION

A Caution contains information that should be followed to avoid personal damage to the instrument or the equipment connected to it.

WARNING

A Warning alerts you to a potential hazard. Failure to adhere to the statement in a WARNING message could result in personal injury.

The following symbol may appear on the product:

CAUTION:
Refer to Accompanying Documents

This refers you to additional information contained in this manual. The corresponding information in the manual is similarly denoted.

Introduction

Model 5251 is a single-channel PXI-based Arbitrary Waveform Generator. It is a high performance waveform generator that combines five powerful instruments in one small package: function generator, waveform generator, pulse generator, modulation generator and a counter/timer. Supplied free with the instrument is ArbConnection software, which is used for controlling the 5251 and for generating, editing and downloading waveforms from a remote computer. The following highlights the 5251 and ArbConnection features.

TE5251 Feature Highlights

- Single Slot PXI Module
- Generates six types of waveforms: standard, arbitrary, sequenced, pulse, modulated and half-cycle waveforms
- 250 MS/s sample clock frequency
- 100 MHz sine and square waveforms
- 14 digits frequency setting, limited by 1 μS/s
- Extremely low phase noise
- 1 ppm clock stability
- 16-bit vertical resolution
- 2 Meg memory depth
- Ultra fast waveform downloads
- Frequency hops, sweep, FM, FSK, ASK, PSK and amplitude modulation
- Trigger delay and period-controlled auto re-trigger
- Built-in counter/timer

Figure 1-1, the Model 5251

ArbConnection Feature Highlights

- Three powerful tools in one software package: Instrument control panel, Waveform composer and FM signal composer
- Detailed virtual front panels control all 5251 functions and modes
- Wave, modulation and pulse composers for generating, editing and downloading complex waveforms
- Automatic detection of active instruments
- Equation editor generates waveforms from equations
- SCPI command and response editor simulates ATE operation
- Translates waveform coordinates from ASCII and other formats
- Simplifies generation of complex sequences

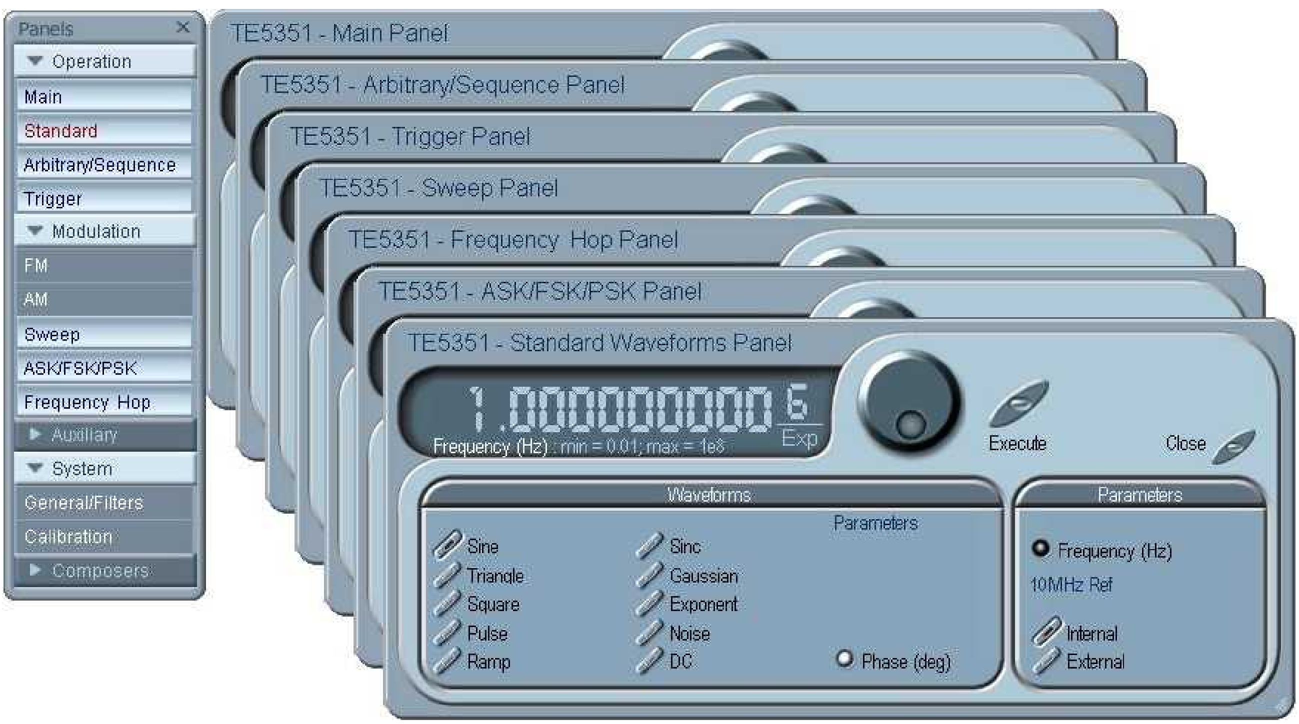

Figure 1-2, ArbConnection - Control Panels

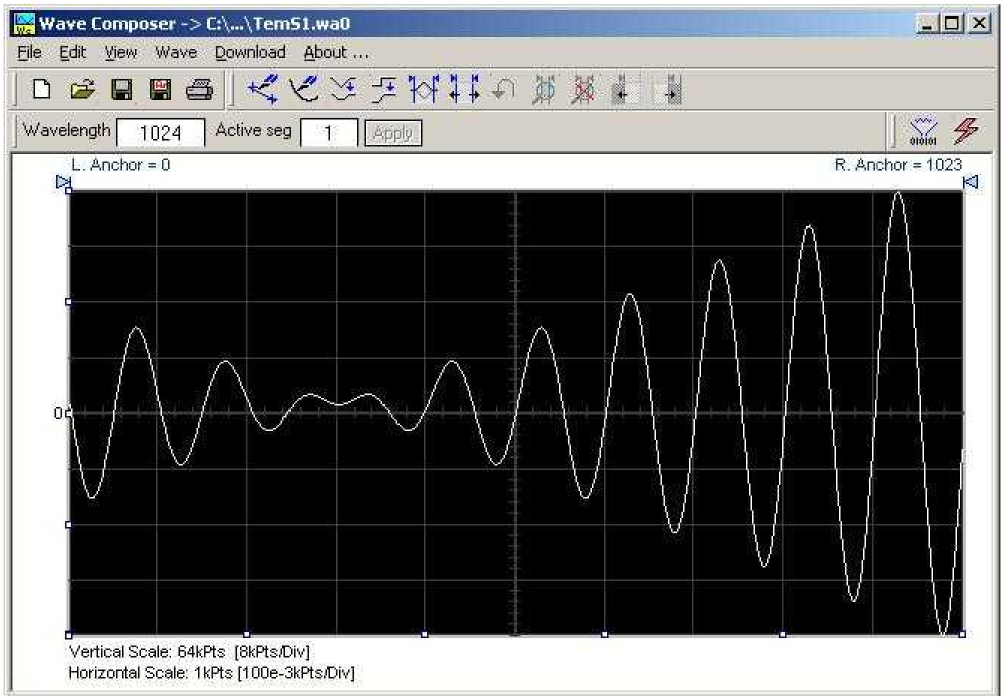

Figure 1-3, ArbConnection - Wave Composer Example

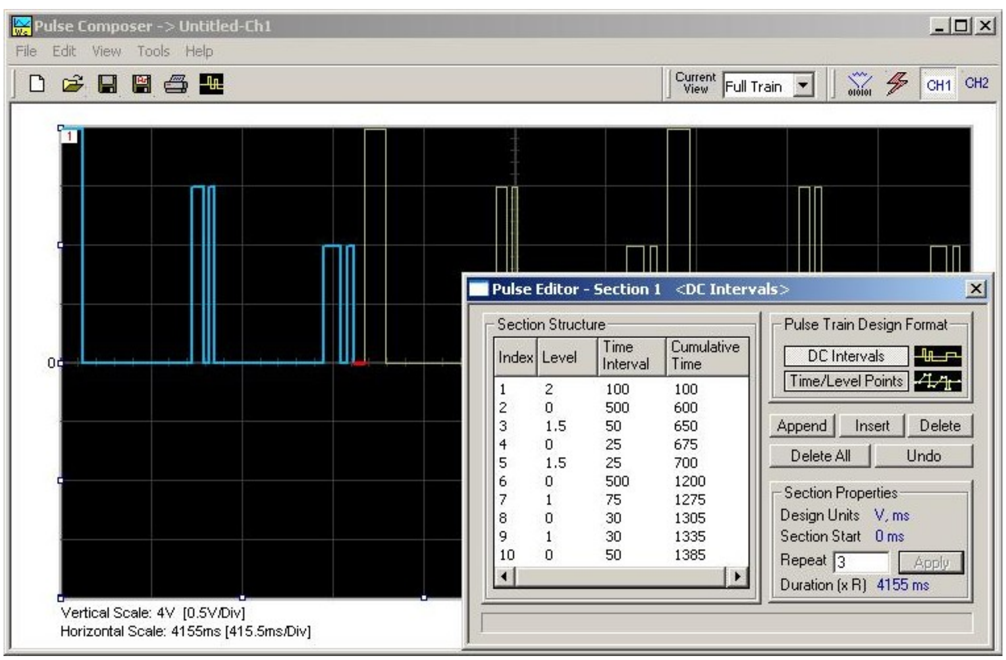

Figure 1-4, ArbConnection – Pulse Composer Example

Functional Description

Detailed functional description is given following the general description of the features and functions available with the 5251.

Output Functions

Model 5251 is completely digital. There are no analog functions resident in its hardware circuits. Data has to be downloaded to the instrument for it to start generating waveforms. The instrument can generate a few standard functions such as sine wave, triangular wave and square wave. Each time that a standard function is required, the instrument calculates its coordinates and places them in the waveform memory. Therefore, every time a standard function is selected, minimal time is required for the controller to compute the function and load its data to the waveform memory.

Frequency

Waveform frequency and sample clock are programmed with 14 digits, limited only by 1 μS/s. Frequency accuracy of the output waveform is determined by the clock reference, CLK10, which provides 1 ppm accuracy and stability over time and temperature.

Amplitude

The output level may be programmed from 200 mV to 20 Vp-p into open circuit, or 100 mV to 10 V into 50Ω. Offset may be applied to the output to shift the signal either positive or negative. Offset and amplitude are inter-related, so make sure you understand the offset-amplitude ranges before you apply offset to your signal.

Trigger Modes

Besides its normal continuous mode, the 5251 responds to a variety of trigger sources. The output waveform may be gated, triggered, or generate a counted burst of waveforms. A built-in re-trigger generator has a programmable delay time. Once triggered, the firmware issues automatic trigger intervals. The re-trigger interval is measured from the end of the signal to the start of the next signal. Having this feature eliminates the need for external trigger sources. The re-trigger generator can be programmed from 200 ns to 20 seconds intervals with incremental resolution of 20 ns.

Arbitrary Waveforms

The Model 5251 generates arbitrary waveforms with 16 bits of vertical resolution. Any waveform it generates must first be loaded to its waveform memory. The arbitrary waveform memory is a bank of 16-bit words. Each word represents a point on the horizontal scale. Each word has a horizontal address that can range from 0 to 2,097,152 and a vertical address that can range from -16383 to +16384 (16 bits). Using a high speed clocking circuit, the digital contents of the arbitrary waveform memory is extracted and routed to the Digital to Analog Converter (DAC). The DAC 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.

Memory Segmentation There is no need to use the entire memory every time an arbitrary waveform is generated. The waveform memory can be divided into smaller segments and different waveforms can be loaded into individual segment. The various segments may then be loaded into a sequence table to generate long and complex waveforms. The sequence table can link up to 10k segments, while each segment can loop up to 1 M times.

Remote Control The instrument must be used in conjunction with a host computer. All of its functions, modes and parameters are fully programmable using SCPI commands and syntax. There are three ways to program the Model 5251, the first being low-level programming of each individual parameter, using SCPI commands. The second alternative is to use ArbConnection for high-level programming. ArbConnection is a software package supplied with the 5251 that simulates a mechanical front panel. It has all the necessary push buttons, displays and dials to operate the instrument as if you were using it on the bench. The third alternative is using application specific drivers, such IVI or LabVIEW drivers.

The 5251 must be programmed to generate waveforms. Therefore, it is recommended that the user becomes familiar with its basic features, functions and programming concepts as described in this and subsequent chapters.

Frequency Agility The instrument generates its sample clock from a DDS circuit (direct digital synthesis). The DDS circuit enables frequency agility through the complete frequency range of the 5251. Having such an enormous range opens the door for a wide range of applications such as wide band sweep, FSK, frequency hops and frequency modulation. The 5251 can also generate AM, ASK, PSK and wireless modulation signals.

Supplied Accessories

The instrument is supplied with a CD that includes an Instruction Manual, ArbConnection for Windows 2000/XP/NT and plug & play drivers.

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 50 Ω 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.

Functional Description

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

Front Panel Connectors

The 5251 has 3 BNC connectors on its front panel: main and SYNC outputs and trigger input. There are also 2 SMB connectors: sample clock and 10 MHz reference clock inputs. These connectors are described below.

Output

The output connector outputs fixed (pre-defined) waveforms to 100 MHz, user (arbitrary) and sequenced waveforms with sampling clock to 250 MS/s. Output impedance is 50 Ω, that is, the cable connected to this output should be terminated with 50 Ω load. Amplitude accuracy is calibrated when connected to a 50 Ω load. The amplitude is doubled when the output impedance is above 1 MΩ.

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 location of the SYNC signal along the waveform is programmable. The SYNC output is also used as marker output when the sweep, or other modulation functions are turned on.

TRIG IN

In general, this input accepts signals that stimulate generation of output waveforms. The trigger input is inactive when the generator operates in continuous mode. When placed in trigger, gated or burst modes, the trigger input is made active and waits for the proper 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 5251. The direction of the transition is programmable. In gated mode, the trigger input is level sensitive, i.e., the generator is gated when the logic level is high and idle when the level is logic low. Trigger level for this input is programmable within the rage of -5V to +5 V.

The same input is used in FSK, ASK and PSK mode, where the output hops between two frequencies, amplitude and phases. The output generates carrier frequency, amplitude and phase when the trigger input level is false and consequently, shifted frequency, amplitude and phase when the trigger input level is true.

SCLK IN

This SMB connector accepts sample clock signals from an external source. Signal range is from dc to 250 MHz and amplitude level is PECL (positive ECL level). The purpose of this input is to replace the internal clock generator either for low noise applications or for synchronization purpose. The sample clock input is active only after selecting the external sample clock source mode.

REF IN

This SMB connector accepts 10 MHz. Signal level can be either TTL or 0 dBm, depending on the selection made on the jumper settings that is made on the board. The instrument is supplied with TTL input setting. Changing to 0 dBm can be done only when the card is removed from the chassis and only by qualified service engineer.

The external reference input is available for those applications requiring better accuracy and stability reference than the one provided inside the 5251. The reference input is active only after selecting the external reference source mode.

Run Modes

The 5251 can be programmed to operate in one of four run modes: continuous, triggered, gated and (counted) burst. These modes are described below.

Continuous Mode

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

Triggered Mode

In triggered mode, the 5251 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. When triggered, the generator outputs one waveform cycle and remains idle at an amplitude level equal to the voltage of the first point of the waveform. The instrument can be armed to receive triggers from the front panel connector or using a trigger soft command. The re-trigger mode require only one trigger signal, which automatically generate a series of triggers spaced by an interval that is determined by the re-trigger delay parameter.

The trigger signal, whether it comes from the front panel or from a soft command, has to pass through some electrical circuits. These circuits cause small delay known as system delay. System delay cannot be eliminated completely and 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.

Gated Mode

In gated mode, the 5251 circuits are armed to generate output waveforms as long as a gating signal is present. Unlike the triggered mode, the gated mode is level sensitive. When the gating signal goes low, the waveform at the output connector is first completed and the output reverts to an idle state. The idle amplitude level, after the gating signal goes low, is the last point on the waveform.

Burst Mode

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

Output Type

The 5251 can output six types of waveforms: standard (Fixed), arbitrary (User), sequenced, modulated, pulse and half-cycle waveforms. Description of the various waveform types that the instrument can generate is given below.

Standard (FIXED) Waveforms

The 5251 must pre-load its memory before it can generate waveforms. On power up, the waveform memory has no specific data. The sine waveform, being the default waveform on power on, is computed and loaded to the waveform memory as part of the reset procedure. From this moment on, every time that another waveform is selected, it is being computed and loaded to the waveform memory.

Waveforms are written from the same start address. Therefore, every time that a new waveform is selected, there is some minimal time for the processor to compute and download the data to the memory.

The 5251 can be programmed to output one of nine standard waveform shapes: sine, triangle, square, pulse/ramp, sine(x)/x pulse, gaussian pulse, rising/decaying exponential pulse, noise and dc. There are some parameters associated with each waveform, which modify the shape of the waveform to better suit your needs. For example, different start phase for the sine waveform can be programmed for each channel to create phase offsets between the two instruments.

Arbitrary (User) Waveforms

The arbitrary waveform memory is capable of storing one or more user-defined waveforms. As was discussed before, the 5251 is supplied with 2 Meg memory bank. There are up to 2 Meg points that can be allocated to one single waveform. On the other hand, there is no need to use the entire memory for only one waveform; The memory can be divided into smaller segments and loaded with different waveforms and the instrument can be programmed to output one segment at a time.

Loading data to arbitrary waveform memory can be a time-consuming task, especially if all 2 Meg points are loaded in one shot. The 5251 utilizes a DMA (direct memory access) concept that speeds data transfer from host computer to the instrument.

Sequenced Waveforms

The sequence generator is a powerful tool that lets you link and loop segments in any way you desire. As a simple example of a sequenced waveform, look at Figures 1-5a through 1-5c. The waveforms shown in these figures were placed in memory segments 1, 2 and 3, respectively. The sequence generator takes these three waveforms links and loops them in a predefined order to generate the waveform shown in Figure 1-5d.

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

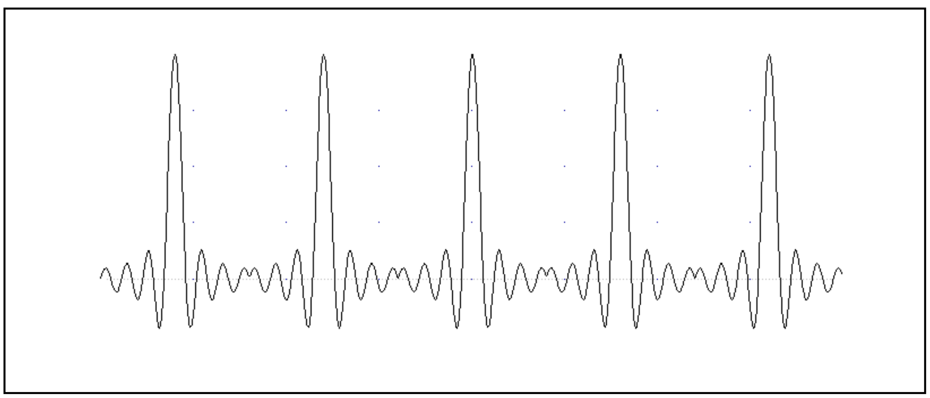

Figure 1-5a, Segment 1 – Sin (x)/x Waveform

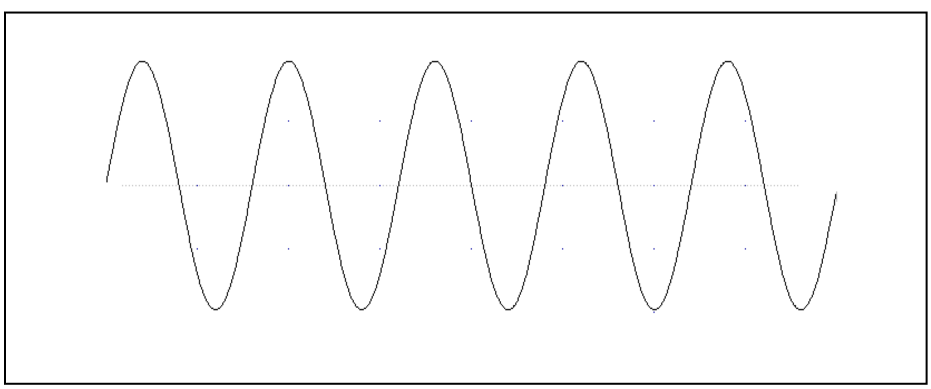

Figure 1-5b. Segment 2 – Sine Waveform

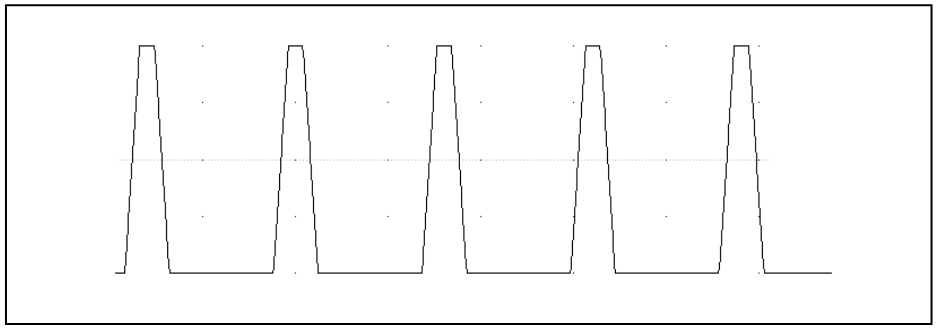

Figure 1-5c Segment 3 – Pulse Waveform

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

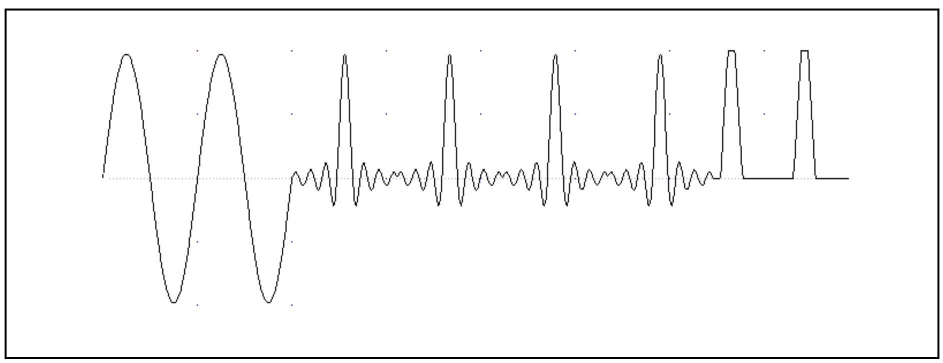

Figure 1- 5d. Sequenced Waveforms

Modulated Waveforms

Using the latest DDS (direct digital synthesis) technology, the 5251 is extremely agile. Operations like sweep, FSK and FM are directly derived from the DDS circuit by controlling its input bits. The modulated waveform schemes are described below.

Sweep

The 5251 can sweep from minimum to maximum sample clock frequency boundaries. You may select to sweep up or down using linear or logarithmic increments. Sweep time is programmable from 10 μHz to 100 MHz and sweep times can be set from 1.4 μs to 40 seconds. You may use the sweep in continuous, triggered, or gated modes.

FM

The FM function modulates the 5251 carrier output in the frequency domain. You can modulate the output using the built-in waveforms standard waveforms, or download complex waveforms to the modulation memory. FM can be used in continuous, triggered and gated modes. The 5251 can generate two types of frequency modulation: 1) Standard and 2) Arbitrary. In standard mode, the modulating waveform is selected from a built-in library of 4 standard waveforms: sine, triangle, square and ramp. In arbitrary mode, complex modulating signals are loaded to the modulation waveform memory. There are 10,000 points allocated specifically for the arbitrary memory that is used for arbitrary frequency modulation and hence 10k unique frequency values may be used for this function.

AM

The AM function modulates the 5251 carrier output in the amplitude domain. There are four standard modulating waveforms that can be used for the modulation scheme: sine triangle, square and ramp. AM can be used in continuous, triggered and gated modes.

Frequency Hop

The frequency hop function causes the output frequency to hop through a frequency list. The interval that the 5251 dwells on a specific frequency is programmable for each hop. The dwell time could also be set uniformly over the entire frequency list.

The frequency hop table can contain up to 1000 different frequency values of which could range from 10 Hz to 100 MHz.

FSK

FSK (frequency shift keying) function shifts the carrier frequency between two frequency settings. The trigger input is used for programming the frequency value. Trigger false state generates base frequency and trigger true state generates shifted frequency. For positive true trigger state select the positive trigger slope and for negative true trigger state select the negative trigger slope.

PSK

PSK (Phase shift keying) function shifts the phase of the carrier frequency between two phase settings 0° and 180°. The trigger input is used for programming the phase value. Trigger false state generates 0° and trigger true state generates 180°. For positive true trigger state select the positive trigger slope and for negative true trigger state select the negative trigger slope.

ASK

ASK (amplitude shift keying) function shifts the amplitude of the carrier frequency between two amplitude settings. The trigger input is used for programming the amplitude value. Trigger false state generates base amplitude and trigger true state generates shifted amplitude. For positive true trigger state select the positive trigger slope and for negative true trigger state select the negative trigger slope.

3D

The 3D function is operated from an external utility only, such as ArbConnection. The carrier waveform can be programmed to sweep in three dimensions: frequency, amplitude and phase.

Pulse Waveforms

Using the arbitrary memory, one may use the 5251 as a stand-alone pulse generator. All pulse parameters are adjustable including period, pulse width, delay, rise and fall times as well as double pulse parameters, just as you would program parameters on a standard pulse generator. Pulse structure is limited only by the resolution of the sample clock and the number of waveform points that are required to create the pulse shape.

Just as it is on a standard pulse generator, the pulses that are generated from this function are limited to one or two pulses in a pulse train and cannot change amplitude from train to train. For applications that require complex pulse trains where multiple pulse sequences that have variable amplitude profiles for each pulse, one may use the Pulse Composer program that is available in ArbConnection.

Half Cycle Waveforms

There are three half cycle waveforms that the 5251 generates: sine, triangle and square. Frequency range is 10 mHz to 1 MHz and the delay between the half cycles is programmable from 200 ns to 20 seconds with increments of 20 ns. One may also program the start phase of the waveforms from 0.1° to 359.9°.

Counter/Timer

The 5251 can be made to operate as a stand alone counter/timer. It can measure the following functions: frequency, period, period averaged, pulse width and it also can accumulate and totalize incoming pulses. The counter/timer can measure frequencies to over 100 MHz within gate times of 100 μs to 1 s. Frequency and period averaged are measured and display 7 digits in one second of gate measurement time and with accuracy of 1 ppm.

Output State

The main outputs can be turned on or off. The internal circuit is disconnected from the output connector by a mechanical switch (relay). This feature is useful for connecting the main outputs to an analog bus. For safety reasons, when power is first applied to the chassis, the main output is always off.

Filters

Two filters are built into the 5251. These filters are available for use in various applications such as the creation of high frequency sine waves and removing the staircase effect from waveforms that are generated with high frequency clock rates. The filters are also used for reconstructing the standard sine waveform.

Programming The 5251

The 5251 does not have front panel control capability. Also, waveform data and sequence tables must be loaded to the 5251 from a host computer before it can be output arbitrary or sequenced waveforms. There are a number of ways to “talk” to the instrument. They all require that an appropriate software driver be installed in the host computer. The rest is a matter of practice and knowledge of the language in use. These topics are discussed in later chapters.

Low level programming of the 5251 is accomplished using SCPI (Standard Commands for Programmable Instruments) language. Programming aspects are covered in Chapter 4.

Supplied with the 5251 is a PC software package called ArbConnection. This software provides a user interface that allows interacting with and controlling the 5251 directly. Details on how to use ArbConnection are given in Chapter 3.

This page was intentionally left blank

Chapter 2
Configuring the Instrument

Title	Page

Installation Overview

This chapter contains information and instructions necessary to prepare the Model 5251 for operation. Details are provided for initial inspection, grounding requirements, repackaging instructions for storage or shipment and installation information.

Unpacking and Initial Inspection

Unpacking and handling of the generator requires normal precautions and procedures applicable to handling of sensitive electronic equipment. The contents of all shipping containers should be checked for included accessories and certified against the packing slip to determine that the shipment is complete.

Safety Precautions

The following safety precautions should be observed before using this product and associated PXI chassis. 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 persons who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. The following sections contain information and cautions that must be observed to keep the 5251 operating in a correct and safe condition.

CAUTION

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 chassis. 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.

Operating Environment

The 5251 is intended for operation within a PXI chassis chassis as a plug-in module. Ensure the PXI chassis being used to host the 5251 fully conforms to the latest PXI specifications, including 3.3V supply rail.

The 5251 is intended for indoor use and should be operated in a clean, dry environment with an ambient temperature within the range of 0 °C to 40 °C.

WARNING

The 5251 must not be operated in explosive, dusty, or wet atmospheres. Avoid installation of the module close to strong magnetic fields.

The design of the 5251 has been verified to conform to EN 61010-1 safety standard per the following limits:

Installation (Overvoltage) Category I (Measuring terminals)
Pollution Degree 2

Installation (Overvoltage) Category I refers to signal level, which is applicable for equipment measuring terminals that are connected to source circuits in which measures are taken to limit transient voltages to an appropriately low level.
Pollution Degree 2 refers to an operating environment where normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected

Power Requirements

The 5251 operates from a PXI chassis. DC Voltages are supplied to the instrument from the PXI connector. The instrument requires a variety of DC voltages as outlined in the Specifications section (Appendix A). Ensure the PXI bus is capable of delivering required voltages and has sufficient current to drive the generator.

CAUTION

Disconnect power to the PXI Chassis before installing or removing the 5251.

Grounding Requirements

To conform to the applicable safety and EMC requirements, ensure that the 5251 instrument panel and the PXI chassis are “earth” grounded.

CAUTION

The outer shells of the front panel terminals (OUTPUT, SYNC OUT, TRIG IN, SCLK IN, 10M REF IN) are connected to the instrument's chassis and therefore to the safety ground.

CAUTION

Do not attempt to float the OUTPUT from ground as it may damage the 5251 and other equipment connected to the 5251 I/O connectors.

Calibration

The recommended calibration interval is two years. Calibration should be performed by qualified personnel only.

Abnormal Conditions

Operate the 5251 only as intended by the manufacturer. If you suspect the 5251 has been impaired, remove it from the PXI chassis and secure against any unintended operation. The 5251 protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

WARNING

Any use of the 5251 in a manner not specified by the manufacturer may impair the protection provided by the instrument

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 Tabor Electronics representative or the Tabor Electronics Customer Service Department.

1. 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.
2. Be sure the carton is well sealed with strong tape or metal straps.
3. 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 Tabor Electronics 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 returned authorization order number (RMA) as well as the date and method of shipment. ALWAYS OBTAIN A RETURN AUTHORIZATION NUMBER FROM THE FACTORY BEFORE SHIPPING THE INSTRUMENT TO Tabor Electronics.

Preparation For Use

Preparation for use include removing the instrument from the bag, installing the 5251 inside the PXI chassis, copying instrument drivers to the computer and installing the graphical interface (ArbConnection).

Removing the Instrument from the Bag

The 5251 is supplied in an antistatic bag. Check the seal on the bag to make sure the bag was not opened in a static-unsafe environment. Place the enveloped card on static free surface and hook yourself up with a grounding strap. Only then break the seal and remove the card from the envelope. Hold the card at the metal panel end. Refrain from touching the instrument with your finger at all times.

Installation

Plug the 5251 into your PXI's chassis bus. Push the card firmly until the PXI connector until the metal panel makes contact with the metal edge of the PXI chassis. Using a suitable screwdriver, tighten the retaining screw.

CAUTION

Disconnect power to the PXI Chassis before installing or removing the 5251. An attempt to insert or remove the instrument while the power is connected to the chassis will result in severe damage to the instrument and will automatically revoke your warranty.

CAUTION

Once the 5251 is installed in the chassis cover all remaining open slots to ensure proper airflow. Using the 5251 without proper airflow will result in damage to the instrument.

Installing Instrument Drivers

The 5251 is a Plug & Play instrument, meaning that after you install it in your PXI chassis, Windows will automatically detect its presence and will ask you to supply the appropriate drivers to operate this instrument. After you copy the drivers, Windows will add the drivers to the device manager and will assigns resources for the instrument.

The 5251 is supplied with a CD that contains the *inf file for installing the necessary drivers for operating the instrument on your computer. Follow the instructions below to install the driver to your computer.

Minimum System Requirements

Minimum host system requirements for the instrument are as follows:

1. Windows XP
2. 128 MB of RAM, 250MB or more recommended
3. 20 MB hard drive space

Windows Software Installation

Note

The install program will automatically detect older software version and you will be provided with a choice of either removing it and installing newer versions, or keeping your old installation intact. The install program will not remove instrument drivers. In case you want to remove the instrument driver from your computer, go to the Windows Device Manager and remove the Arbitrary Waveform Generator Model 5251 under the Tabor Electronics heading.

In general, installation is very similar for different Windows variants however, you should follow the exact procedure as applicable for you’re your computer. The following paragraphs will guide you through device driver installation for Windows XP.

Windows XP Device Driver Installation

A device driver is necessary for the 5251 software to communicate with PXI boards. The 5251’s installation CD includes instrument drivers for supporting the required Windows platform. In Windows XP, the installation package cannot automatically assign device drivers for PXI devices and therefore leaving for the Plug & Play Manager the responsibility for detecting devices and prompting the user for the correct driver. To assign a driver to a device, Windows refers to an *.INF file. The *.INF file provides instructions for Windows as to which driver files to install and which registry entries to insert. To install a driver for your 5251, complete the following steps:

1. Power down your computer and PXI chassis.

2. Insert the 5251 board into a free PXI slot.
3. Power on your PXI chassis
4. Power on the computer. Windows should first detect the new hardware device with a “Found New Hardware Wizard” message box.
5. Windows then displays the “Found New Hardware Wizard” as shown in Figure 2-1, which will search for new drivers
6. Follow the procedure as shown below.

Figure 2-1 – The Welcome to the Found New Hardware Wizard

Press Next and select one of the options in the dialog box below. We recommend that you check the “Search for a suitable driver for my device” option as shown in Figure 2-2.

Figure 2-2 – Install Hardware Device Drivers

Press Next and you'll now be prompted to select the location of your driver files on your computer as shown in Figure 2-3. Check the “Specify a Location” option only.

Figure 2-3 – Locate Driver Files

The 5251 is supplied with an installation At this time, CD. Insert this CD into your CD-ROM drive. If you already have the instrument drivers installed somewhere on your computer, you can specify your custom location. Either type in the complete path or click on the Browse button to identify your driver location.

NOTE

After you insert the installation CD, Windows XP will automatically load the autorun program and the CD interface will show on your screen. The CD menu is not required for the driver installation so you can either leave the menu on screen and ignore it for now or click on Exit to remove the application from your desktop. The installation CD must be left in the CD-Rom drive for the continuation of the installation process.

Press Browse… and specify the subfolder W2kdrv located in the Drivers folder on your installation CD, as shown in Figure 2-4. Press OK to acknowledge the selected path.

Figure 2-4 – Copying Device Drivers

Windows displays the Driver Files Search Results as shown in Figure 2-5. Click Next and then Finish completing the installation process.

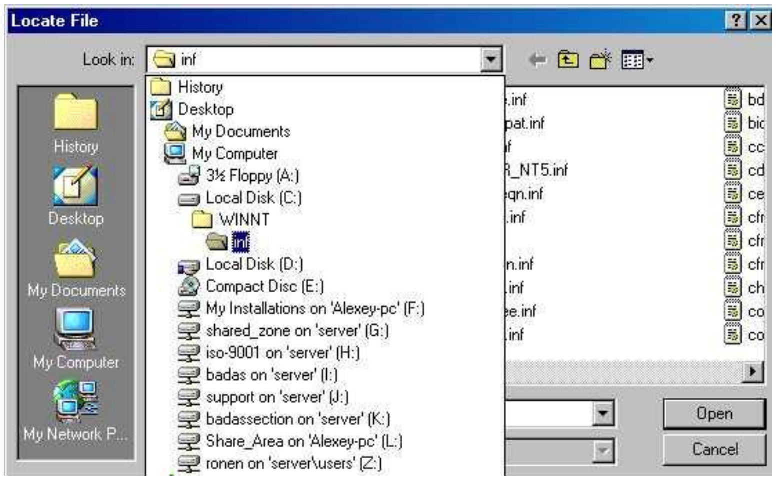

Figure 2-5 – Driver Files Search Results

Figure 2-6 – Completing the Found New Hardware Wizard

The next step is necessary to verify that the device driver was installed properly and is displayed correctly in the System Device Manger. Do the following:

1. Click on the Start button, then Settings and then Control Panel.
2. In the Control Panel dialog box, find the icon labeled System.
3. Double click on the System icon and then on the Hardware
4. On the Hardware tab click on the Device Manager button.
5. Click on Tabor Electronics. If you installed the driver properly, your device manager should show the Arbitrary Waveform Generator Model 5251 as shown in figure 2-7.

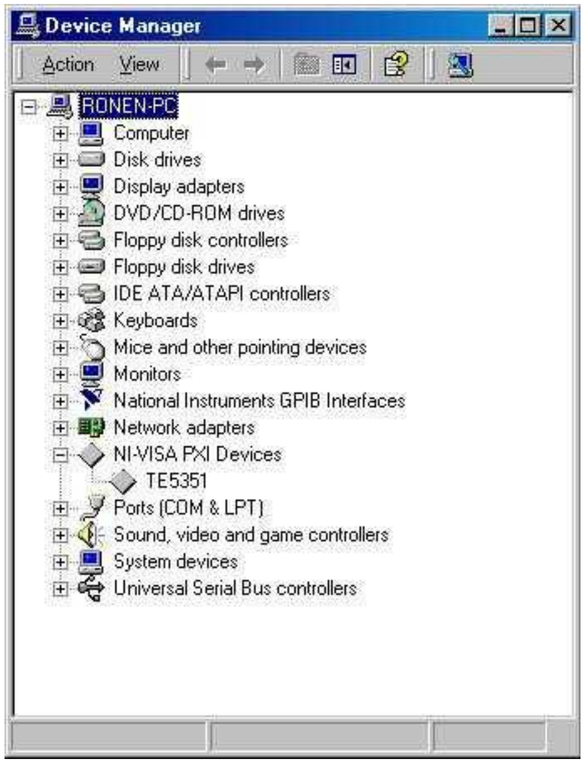

Figure 2-7 – Device Manager

Click on "X" to remove the System Properties dialog box from the screen.

Installing Software Utilities

The 5251 is supplied with a CD that contains the following programs: IVI Driver, ArbConnection, device driver and some other utilities to aid you with the operation of the instrument, including a manual in pdf format. It is recommended that you stow away the CD in a safe place after you load the drivers and the necessary utilities to control the 5251.

The *IVI driver* is a useful utility that provides standard communication and commands structure to control the 5251 from remote. Programming examples are also available to expedite your software development. The IVI driver comes free with the 5251 however, you'll need the IVI engine and visa32.dll run time utilities to be able to use the IVI driver. The additional utilities can be downloaded for free from NI's (National instrument) web site – www.ni.com.

ArbConnection is a user friendly program that lets you control instruments functions and features from a remote computer. It also lets you generate and edit arbitrary waveforms on the screen, build sequence tables, modulating signals and much more and then download the signals to your 5251 without the hustle of writing complex programs and utilities. This is also a great tool for you to experiment simple, or complex command string to gain experience before you write your own code. ArbConnection has a command editor feature that allows direct low-level programming of the 5251 using SCPI commands, just as you will be using them in your program. Installation of ArbConnection is simple and intuitive and only requires that visa32.dll runtime file be added to your Windows system folder. Download the file from NI's (National instrument) web site – www.ni.com. Installation and operating instruction for ArbConnection are given in Chapter 4.

The *Device* driver is mandatory to operate the 5251. If you do not intend to use any of the IVI or ArbConnection software utilities, you must copy the dll to your development folder. If you install the IVI driver and ArbConnection, the dll is automatically installed in your Windows->System32 sub-folder.

Installing IVI Drivers and ArbConnection

ArbConnection or the IVI drier are two software utilities that one of them must be installed on your computer for you to be able to operate and control the 5251. ArbConnection has three basic function: 1) Control instrument setups, 2) Create, edit and download complex arbitrary waveforms to your instrument and 3) Create, edit and download complex (frequency) modulating waveforms.

Advanced users may want to write their own applications to control the 5251 functions and features. For this purpose, C++ libraries and DLL's are available on the CD and can be copied to your application folder. This is done automatically when installing the IVI driver. However, if you are first time user and can't wait to get your hands on some controls and waveforms, it is recommended that you install ArbConnection now. ArbConnection and waveform generation aspects are covered in other sections of this manual.

To proceed with the installation process, insert the supplied CD into your CD-ROM drive and wait for a GUI (Graphical User Interface) to pop up on your screen. If you wait for a long time and the GUI fails to load it is possible that your computer is not set up to load CD programs automatically. In this case, Invoke Run and type:

```
N:\Autorun.exe  (where N is your CD drive letter)
```

To install the software click on "Install Software Utilities" and follow the install program as shown in Figure 2-8. The preparing phase will check few things such as if your computer has any previous installations installed on.

If you are an advanced user and in preparation to write your own code and application, you'll have to copy support libraries and some DLL's from the installation CD. In this case, select the "Copy Developer Libraries" option and specify the folder location for your application. The function of the libraries and other programming aspects are cover in the programming section of this manual.

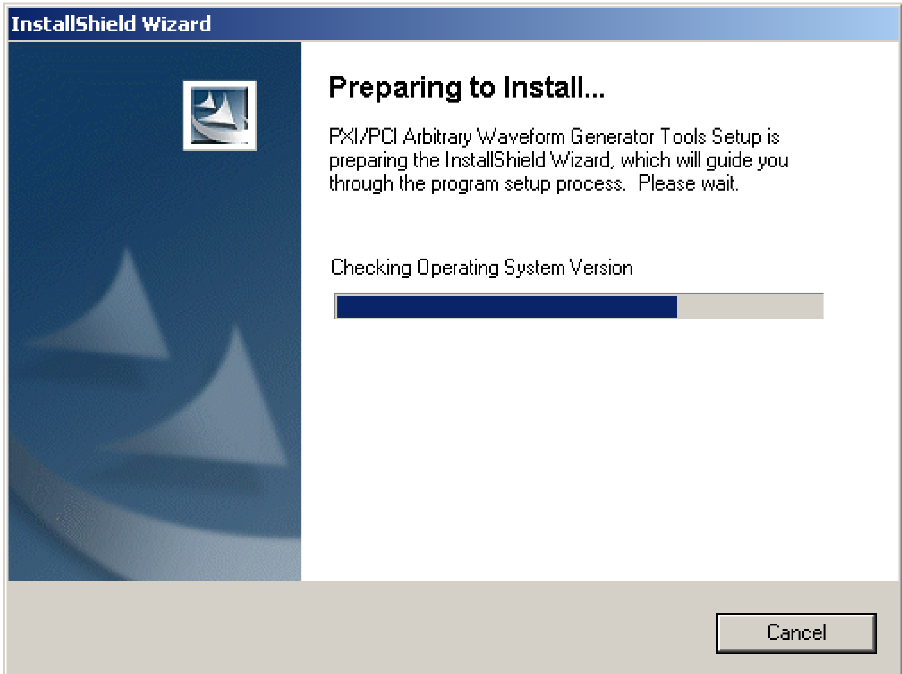

Figure 2-8 – Install preparation

After finishing the “Preparing to Install” phase, the install wizard shown in Figure 2-9 will take you to the first installation step assuming that no problems were detected.

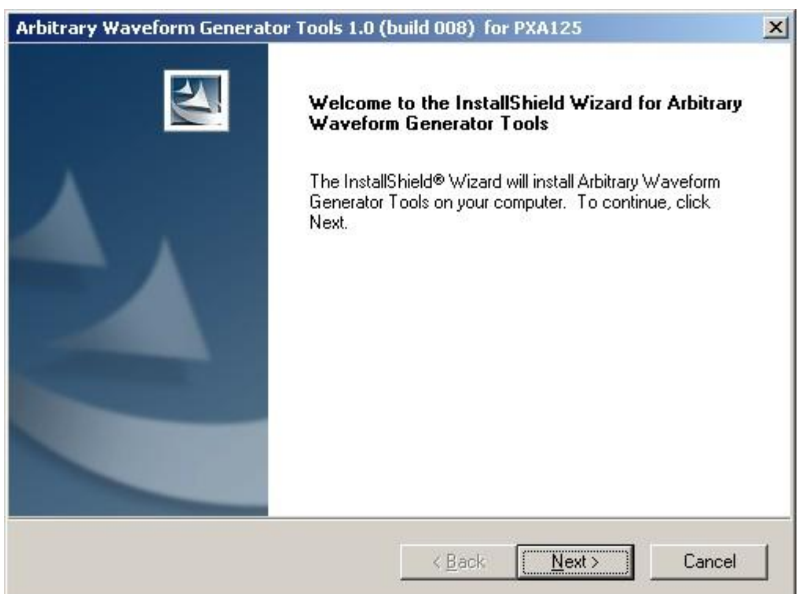

Figure 2-9 – First Installation Step

Press Next and type the customer details at the "Customer Information" Window, as shown in Figure 2-10.

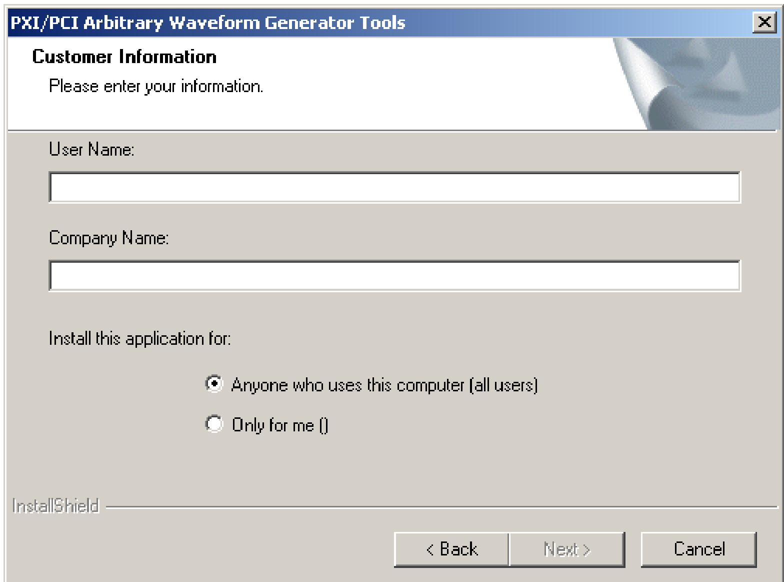

Figure 2-10 – Customer Information Step

After typing the customer details press Next and select the Setup Type. You can select from three options: 1) Select 5251 if you purchased and are installing the 5251, or 2) Select Custom if you are an advanced user and want to refine your installation process.

We recommend that you install using option above and complete the installation process by clicking on the Next button and then Finish. If you select the Custom option, then you'll have to type in some other parameters such as new path for your destination folder and choosing which feature to install, as shown in Figures 2-11.

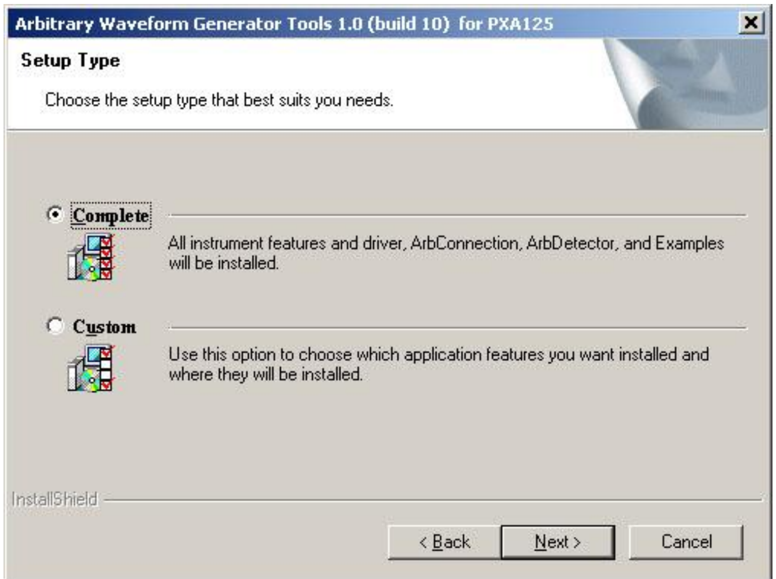

Figure 2-11 – Selecting Setup Type

If you select the Custom option, proceed to change your Destination Folder, as shown in Figure 2-12, by pressing the Browse button, select the appropriate path, press OK and then press Next.

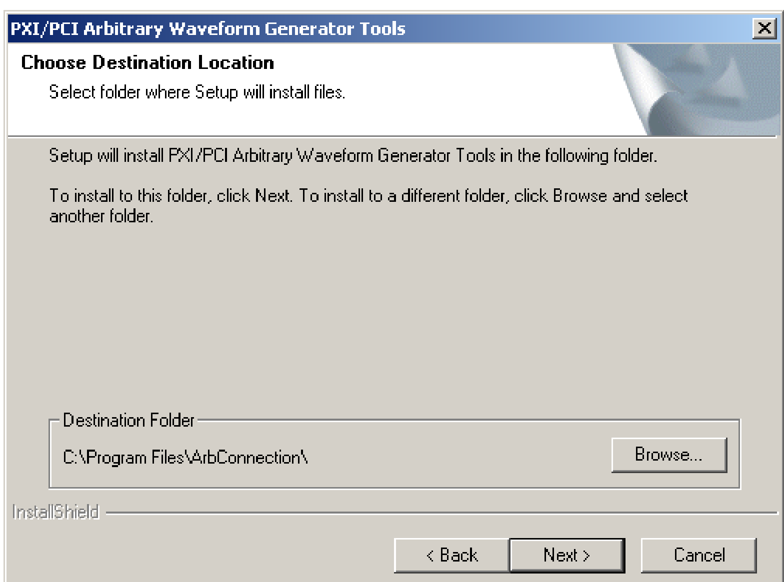

Figure 2-12 – Selecting Destination

The final step to complete the installation process, you'll be prompted to restart your computer. You can select to either restart your computer immediately or do it later, but remember that the software will not function properly if you do not restart your computer.

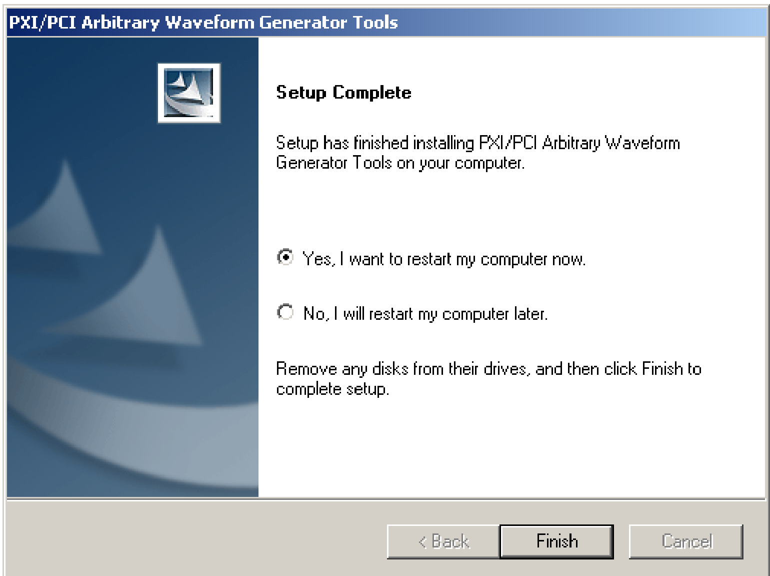

Figure 2-13 – Setup Complete

Chapter 3
ArbConnection

Title	Page

What's in This Chapter?

This Chapter contains information how to install, invoke and use ArbConnection. Introduction to ArbConnection and examples how to program instrument controls and parameters and how to generate waveforms and download them to the 5251 are also given in the following sections.

Introduction to ArbConnection

In general, ArbConnection is a utility program that serves as an aid for programming the Model 5251. ArbConnection has many functions and features of which all of them share a common purpose – controlling 5251 functions from remote. As minimum, to use ArbConnection, you'll need the following tools:

1. Computer, Pentium III or better
2. Windows 2000/XP, or higher
3. High resolution screen, at least, 1024 x 768 pixels
4. Pointing device, mouse or ball
5. Visa 2.6, or higher installation
6. Last, but not least, some basic knowledge how to operate computers and Windows-based programs.

ArbConnection operation is divided into three main functions: 1) Front panel control, 2) Waveform generation and editing and 3) Low level SCPI editing. These operating options are described in this chapter however, you must install ArbConnection before you can use it. The next paragraphs describe installation and first steps before going into in-depth operation.

Installing ArbConnection

The installation program installs ArbConnection on a logical drive of your choice. The default is drive C. It automatically creates a new directory and copies the files that are required to run the program. Before you install ArbConnection, make sure that there is at least 10 megabytes of available memory on your hard disk drive.

To install ArbConnection, insert the distribution CD in the CD drive and follow the on-screen instructions to install ArbConnection. If your computer fails to detect the CD, access the CD from My Computer and invoke the Setup command.

The install program does the complete job far you and creates a workgroup and icons to start ArbConnection.

Quitting ArbConnection

Before you start roaming through menus and editing commands, we strongly recommend that you make yourself familiar with ArbConnection basics and concept. For now quit the program and spend some more time with this section of the manual. Point the mouse cursor to the File menu and press the left mouse button. Move the mouse cursor to the Exit command and press the left mouse button.

For the New and Advanced Users

For the New User
Learning to use ArbConnection is easy, intuitive and quick, even if you have never used such programs before. After you have installed ArbConnection on your computer read the following paragraphs to learn how to find your way around ArbConnection's menus.

Once you are familiar with the basics, you'll continue to learn about features, programming, and editing commands. If you can't find the answer to a question in this guide, call your distributor or the LeCroy customer support service near you and we'll gladly assist you with your problems.

For the Advanced User
If you are already familiar with computer conventions and have basic knowledge of Windows programming, you may want to skip some of the following paragraphs.

Conventions Used in This Manual

This manual uses certain typographical conventions to make it easier for you to follow instructions. These conventions are described in the following:

[Enter, or ↵] Press the Enter or Return key.

[Esc] Press the Escape key.

[Alt-F] Press the Alt key and the key that follows, simultaneously. In this example the key that follows is F.

[Ctrl-S] Press the Control key and the letter that follows, simultaneously. In this example, the letter is S. The control key also appears in the menus as a target sign.

[↑] [↓] [→] [←] Press the Arrow key with the symbol pointing in the direction specified (i.e., up, down, left, or right).

<+> Press the key for the character or word enclosed in angle brackets. In this case, the Plus sign key.

The Opening Screen

Invoke ArbConnection by double clicking on the icon. If you cannot find the icon on your desktop, click on Start, Programs and ArbConnection. The opening screen will show. If you installed the program correctly, your screen should look as shown in Figure 3-1.

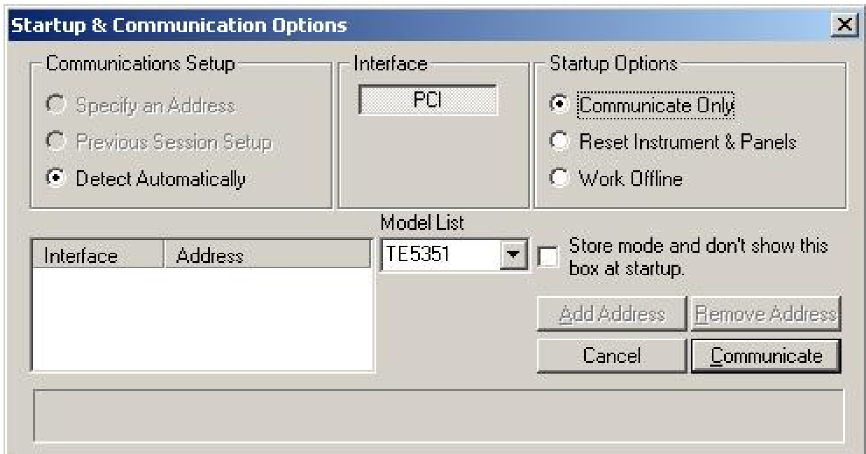

Figure 3-1, Startup & Communication Options

The Startup & Communication Options dialog box is displayed. You can check the “Store mode and don’t show…” so next time you invoke ArbConnection, this dialog box will not be displayed. The purpose of this dialog box is to update the program in the way you intend to use it. For example, if you are using two cards in your computer but intend to use a specific device, you can click on the Specify an Address option and type in the required address so the next time you use ArbConnection, the program will automatically resume communication with the same card address as was originally detected.

If you chose to hide this dialog box, you can still access and change the options from the System command, at the top of the screen.

Make your selection and click OK. The Startup & Communication Updater dialog box will be removed from the screen. And the Main panel will now be accessible. But before we go into panel operation, let’s look at the toolbars at the left top of the screen as shown in Figures 3-2 and 3-3.

Figure 3-2, ArbConnection's Toolbars

The standard Windows **Menu Bar** is the top bar. It provides access to main system controls like saving files, and viewing or removal of screen images.

The second bar is called **Link** bar. It provides direct access to different instruments that are active on the active interface bus. ArbConnection can control a number of 5251 units simultaneously. If the instruments were connected to the interface while invoking ArbConnection, they will automatically be detected by the program and will be placed in the Link pull-down window. The active instrument is displayed with its associated address. If you run ArbConnection in offline mode, the Link bar will show 5251, Offline.

The **Panels** toolbar, as shown in Figure 3-3, provides direct access to instrument control panels. The individual control panels are explained later in this chapter. The Main, Standard, Arbitrary, Trigger and the other buttons will bring up to the screen panels that are associated with these names. The Composers button provides access to the Waveform and Pulse composers. The first time you launch ArbConnection, the opening screen will have the Main panel open. Click on other buttons and interactively get the feel how ArbConnection opens and closes control panels.

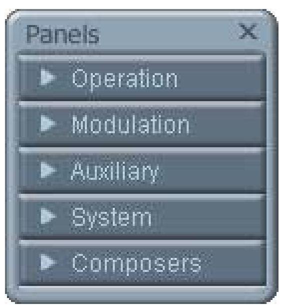

Figure 3-3, the Panels Toolbar

ArbConnection Features

ArbConnection's main purpose is controlling 5251 functions and parameters. The 5251 can generate standard waveforms from a built-in library, arbitrary waveforms from user-downloaded coordinates, modulated waveforms, digital patterns and much more. The only way to access all of these features is through software utilities such as Plug & Play drivers, and soft front panels. ArbConnection is built to provide complete control over the 5251.

ArbConnection has three main screens: control panels, waveform composers and various utility control panels. The various screen images along with instructions how to access and use them are described below in detail.

The Control Panels

The control panels look and feel just as if you would operate an instrument from its front panel. They even look like instrument front panels, so operating function and changing parameters is easy and intuitive. Let’s look at the first panel that shows at the opening screen. This panel, as shown in Figure 3-5, is called the Main Panel.

To begin with, let’s explore the panel controls to see how they feel, react and what they do. All other panels share almost the same feel, so the description of how to operate the Main Panel can serve as general guide for controlling the rest of the panels.

Looking at the panel you can identify the following controls: Push buttons, LED’s, radio buttons, Dial and Digital display. The function of each control is described below.

Push Buttons – These are used for toggling a function on and off. For example, the Output Enable button in the Output group toggles the output on and off. The first mouse click will push the button inwards and will turn on a red bar at the center of the button, indicating that the function is on. The second mouse click will turn the function off.

Radio Buttons – Are used for changing operating modes, or selecting between mode options. One of the radio buttons is always on with a red dot in its center, indicating its state condition.

LED’s – The LED’s indicate which of the parameters are displayed on the Digital Display. Red LED indicates that the parameter name next to this LED is selected. Only one LED can be ON at a time.

HINT

LED’s are turned on by clicking on the LED or the text next to it. The selected parameter is flagged by a darker LED shade.

Dial – Use the dial to modify displayed reading. To use the dial, press and hold the mouse cursor on the dial and move the mouse in a clockwise circle to increase the number, or counterclockwise circle to decrease the displayed number. The dial modifies digits at the cursor position and will allow modification within the legal range of the displayed parameter. If you reach the end of the range, the dial will have no further effect on the display. If you do not want to use the dial, you can still change the display reading by using the [↑], or [↓] keys, or simply type the required number using the standard keyboard features.

NOTE

After you change the displayed readout, the 5251 will be updated with the new parameter only after you press the Execute button.

Digital Display – The display is used for displaying and reading various 5251 parameters, just as you would use it on your instrument.

Note

Normal color of the digital reading is dark blue. If you modify the reading, the color changes to a lighter shade of blue, indicating that the 5251 has not been updated yet with the new parameter. Pressing Execute will update the instrument and will restore the color of the digital readout to dark blue, indicating that the displayed value is the same as the generator setting.

Also note that the digital readout has an autodetect mechanism for the high and low limits. You cannot exceed the limits if you are using the dial but only if you use the keypad. In case you do, the program will not let you download an illegal parameter and you'll be requested to correct your setting.

The Operation Panels

The Operation tab provides access to a group of panels that control the basic operation of the generator. From this group you can set the output function, run mode, turn the outputs on and off and adjust the parameters for the various functions. There are four panels in this group: Main, Standard, Arbitrary/Sequence and Trigger. The Main panel is always visible because this is the panel that controls operating functions, run modes and sets the outputs on and off. The other panels can be made visible by clicking on the appropriate tab in the Operation group. The Operations Panels bar is shown in Figure 3-4 and the operation panels are described below.

Figure 3-4, the Operations Panels

Main

The Main Panel, as shown in Figure 3-5, is the first panel you see after invoking ArbConnection. Notice how buttons and LED's are grouped; this is done specifically so that common parameters are placed in functional groups. The Main Panel groups allow (from left to right) adjustment of amplitude and offset, selection of waveform mode, selection of run mode and control over SYNC and Main output parameters. Controls, where applicable, are provided for each channel separately.

Figure 3-5, the Main Panel

If you are connected properly to a PC and ArbConnection has detected your instrument, then every time you press a button, you are getting an immediate action on the 5251. It is different if you are changing parameters on the display; Doing this, you'll have to press the Execute button for the command to update the instrument. The functional groups in the Main Panel are explained below.

Parameters

The Parameters group has two parameters for each channel: Amplitude and Offset. To access the required parameter, click on the LED or the text next to it to display the required parameter. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the 5251 with the new reading.

Function

The Function group is used for selecting between function types. The 5251 provides four types of waveforms: Standard, Arbitrary, Sequenced and Modulated. By pressing one of these buttons output waveform will change to the selected option. The default function type is Standard. If you want to change standard waveform parameters, you can select Standard from the Panels bar.

Run Mode

The Run Mode group is used for selecting the active run mode for the instrument. You can select between continuous, triggered, gated and burst modes. There is no additional panel associated with the continuous mode, but if you press one of the other run mode options, you'll be able to adjust the trigger parameters from the Trigger Panel.

Output Control

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

From this group you also control the position of the SYNC pulse.

The load impedance buttons allow you to adjust the display amplitude reading to your actual load impedance value. The default value is 50 Ω and the output range is calculated in reference to this value. If your actual load impedance is higher than 50 Ω and you increase the load impedance value in this group, the output of the 5251 will display the correct value as is measured on your load impedance.

Standard

The Standard Panel, as shown in Figure 3-6, is accessible after you click on the Standard button in the Panels bar. The Standard Waveform Panel groups allow (from left to right) adjustment of waveforms and their associated parameters. The functional groups in the Standard panel are described below.

Figure 3-6, the Standard Waveforms Panel

Waveforms

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

Note that by clicking a button in this group, you are immediately updating the 5251 output with this waveform shape.

Parameters

The parameters group contains buttons that control the source of the 10 MHz reference and the setting of the output frequency for the standard waveforms function.

The 10 MHz Ref controls toggle between an internal and external references. The default setting is internal, which provides frequency accuracy of 1 ppm. If such accuracy is not sufficient for your application, click on the external option but make sure that a reference source is applied to the rear panel connector; otherwise, the accuracy of the output will deteriorate completely.

The Frequency control lets you program the output frequency of the selected waveform shape. The frequency parameter may be modified when the LED illuminates. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the 5251 with the new reading.

Arbitrary/Sequence

The Arbitrary & Sequence panel, as shown in Figure 3-7, is invoked by pressing the Arb/Seq button on the Panels bar. Note that if you invoke the Arbitrary & Sequence Panel from the Panels menu, the 5251 will not change its output type. On the other hand, if you select the arbitrary, or the sequenced options from the Main Panel, the 5251 will immediately change its output to the selected waveform type. The functional groups in the Arbitrary Waveforms Panel are described below.

Parameters
The Parameters group contains three parameters: Amplitude, Offset and Segment. Actually, the amplitude and offset values exhibited in this group are exactly the same as in the Main Panel, so every time you change amplitude and offset in the Parameters group, the other panels are updated automatically. The segment parameter provides access to the active segment for each channel. By selecting a segment as active, the sync pulse is attached to this specific segment number.

To access the required parameter, click on the parameter name. The LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the 5251 with the new reading.

Figure 3-7, the Arbitrary & Sequence Panel

SCLK

The SCLK (Sample Clock) group is comprised of parameters that control the sample clock frequency. The sample clock setting affects the 5251 in arbitrary mode only.

The sample clock rate is programmed in units of S/s (samples per second) and will affect the instrument only when it is programmed to output arbitrary or sequenced waveforms. The SCLK parameter has no effect on the frequency of the standard waveforms.

The two switches in the SCLK group select between internal and external sample clock inputs. The internal is the default setting. When you select the external sample clock option, make sure an appropriate signal is connected to the external sample clock connector on the rear panel.

To access the required parameter, click on the button until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the 5251 with the new reading.

***10 MHz* Ref**

The 10 MHz Ref controls toggle between an internal and external references. The default setting is internal, which provides frequency accuracy of 1 ppm. If such accuracy is not sufficient for your application, click on the external option but make sure that a reference source is applied to the rear panel connector; otherwise, the accuracy of the output will deteriorate completely.

Sequence

The Sequence Advance Mode group provides control over advance modes for the sequence generator. Advance options are: Auto, Stepped, Single and Mixed. Refer to the 5251 manual to find out more when and how to use these advance modes. You should be careful while selecting modes because it is possible to cause settings conflict, for example, if you select the Single option before you modified the run mode to Triggered.

Memory Management

The memory management group provides access to the memory partition and waveform studio screens. The Waveform Partition button opens a screen as shown in Figure 3-8 and the Waveform Studio button opens a screen as shown in Figure 3-9. Information how to use these screens is given in the following paragraphs.

Using the Memory Partition Table

If you want to learn more about waveform memory and segment control, you should refer to section 2 of this manual. In general, the 5251 can generate arbitrary waveforms but, before it can generate waveforms, they must be downloaded to the instrument from a host computer. Waveforms are downloaded to the instrument as coordinates and are stored in the 5251 in a place designated as "waveform memory". The waveform memory has a finite size of 2M.

Having such long memory does not necessarily mean that you have to use the entire memory every time you download a waveform. On the contrary, the 5251 allows segmentation of the memory so that up to 10,000 smaller waveforms could be stored in this memory. There are two ways to divide the waveform memory to segments: 1) Define a segment and load it with waveform data, define the next and load with data, then the third etc. or 2) Use what ArbConnection has to offer and that is to make up one long waveform that contains many smaller segments, download it to the instrument in one shot and then download a memory partition table that splits the entire waveform memory into the required segment sizes. Want to use it? Here is how it is done. Point and click on the Memory Partition. A dialog box as shown in Figure 3-8 will pop up.

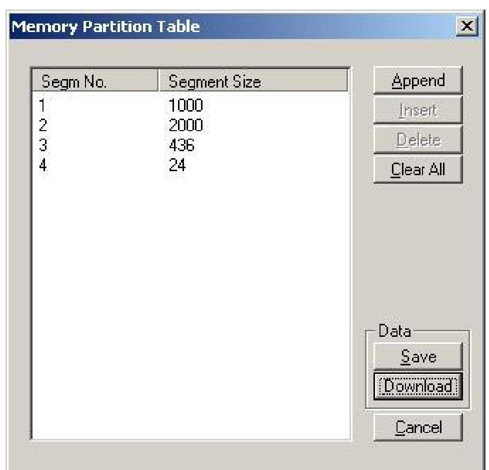

Figure 3-8, the Memory Partition Table

The two main fields in the segment table are Segment number and segment size. The **Seg No** (segment number) is an index field that can has values only, from 1 to 10,000. The **Segment Size** is always associated with the segment number. You can program any segment size from 16 to 2 M.

Use the **Append** key to add a segment at the end of the segment list. If you highlighted a segment, the Append key turns automatically to insert Use the **Insert** key to insert a segment at the cursor location. The **Delete** key is used for deleting a segment at the cursor position.

The **Clear All** key will remove all segments from the table and will let you start designing your segment table from fresh.

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

The **Save** key saves the current session so you can start the Memory Partition table from the same point after you close this session. The **Download** key updates the 5251 with the present segment table settings.

TIP

The Memory Partition table does not download waveforms. Use the memory partition table only if you merged a few waveforms to one. The partition table then divides the memory to the individual and original size of each waveform. If you download waveforms using the waveform studio, they already contain segment size and there is no need for further use of the memory partition table.

Using the Waveform Studio

The Waveform Studio, as shown in Figure 3-9 has two parts: 1) Segment Table and 2) Sequence Table. The purpose of the waveform studio is to provide access to waveform files that are already resident in the system. These files can be delegated to various segments and later be used as individual waveforms or combined into complex sequences.

The Segment Table
Using the Segment Table you may list and download waveform files that were previously stored on the computer. The table shows the segment number and its associated file name, length and its download status. There are other means to download waveforms to memory segments such as the Wave Composer and individual function calls; The waveform studio makes it easier by combining multiple and complex commands into one simple dialog box.

To access the Segment table, click anywhere on the Segment Table area. If it was not yet, it will turn white as opposed to the Sequence Table area that turns gray. The Segment Table area is divided into three parts: the table area, the waveform shape area and control buttons. When you point and click on one of the waveforms, its shape is shown in the Waveform Shape window.

The Segment Table has four fields:

The **Seg** field contains numbers from 1 through 2048, designating the programmed memory segment. Note that memory segments are numbered from 1 to 2048.

The **State** field shows the current status of the memory segment. It can be *Free*, if no file has yet been assigned to this segment number, or *Mapped*, if file name has been assigned to the segment but the Download button has not been used yet to move the file to the 5251 memory, or *Loaded*, if the process has been completed by pressing either the Download button or the All (download all) button.

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

The **Length** field displays the length of the selected memory segment. Memory segments size may be programmed from 16 to 2 M. Note that the length field is not accessible and shown for reference purpose only.

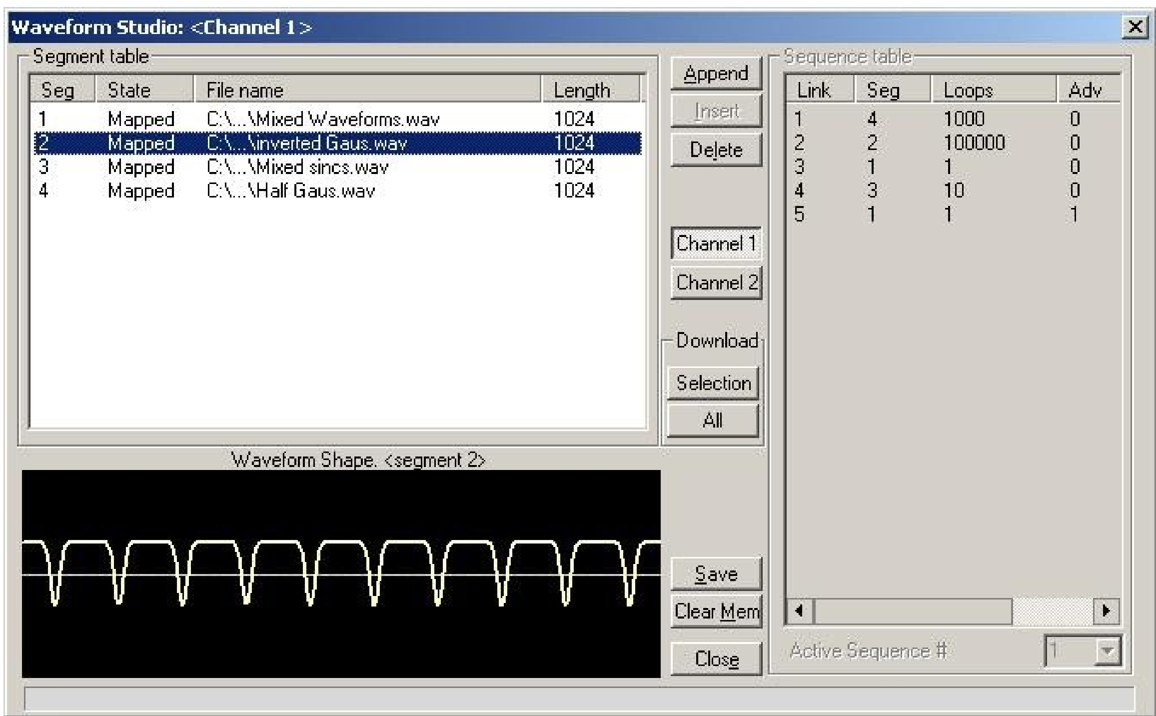

Figure 3-9, the Waveform Studio

TIP

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

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

Append – adds segment number at the end of the table

Insert – adds a segment above a highlighted segment line

Delete – removes a highlighted segment

Save – saves current table settings

(Download) Selection – downloads a highlighted segment only to the 5251 memory

(Download) All – downloads the complete table to the 5251 memory

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

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

The Sequence Table

As was explained in the above, the waveform memory can be divided into smaller segments and up to 2048 segments can be defined and used as individual arbitrary waveforms. Having a limited size of waveform memory can, for some applications, pose a limitation however, if sections of the waveform are repetitive, one may use the sequence generator to take these segments and replay them as part of the complete waveform without loosing valuable memory space and without scarifying waveform coherences, or integrity. The tool for using repetitive and multiple segments in one long waveform is called Sequence Generator. The 5251 has two separate sequence generators, one for each channel and ArbConnection has a special dialog box where sequences are designed. This tool is called – Sequence Table.

Using the Sequence table you can use waveforms that you already downloaded to the 5251 from the Segment table, link and loop in random order to create one long and complex waveform that combines the individual memory segments.

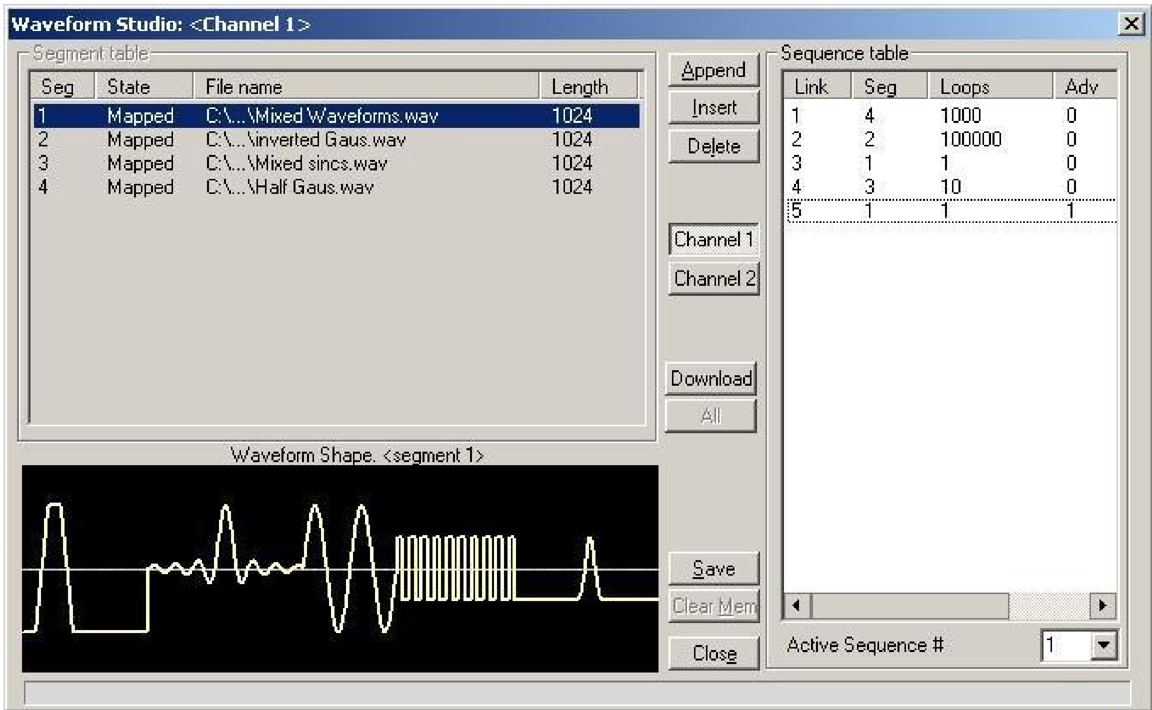

Figure 3-10, the Sequence Table

The Sequence Table is demonstrated in Figure 3-10. To access the Sequence table, click anywhere on the Sequence Table area. If it was not yet, it will turn white as opposed to the Segment Table area that turns gray.

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

Link - This parameter defines an index array for the sequence generator. When generating sequences, the instrument steps though the links in descending order therefore, make sure that you enter your waveform segments in exactly the order you would like them at the output.

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

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

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

Figure 3-9 shows an example of a 5-step sequence of which the first waveform is made of segment 2, which will loop 15 times; segment 4, looping 2 times; segment 1, looping 7 times; segment 2, once and segment 3, looping 4 times. The Adv bits on links 2 and 5 are set to 1 and therefore, external triggers are required for the sequencer to step through these links.

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

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

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

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

Active Sequence

The active sequence field let you select between 10 different sequence settings. You may program each sequence separately and replay them individually as required. The output is updated with the selected sequence number as soon as the active sequence is selected.

Trigger

The Trigger panel, as shown in Figure 3-11, is invoked by pressing the Trigger button on the Panels bar. Note that if you invoke the Trigger Panel from the Panels menu, the 5251 will not change its trigger mode. To modify the instrument run mode, use the Main Panel. The trigger parameters and setting in the Trigger Panel will have an effect on the 5251 only if an appropriate run mode setting has been selected. The Trigger Panel groups allow (from left to right) adjustment of Trigger Modifier and their associated Trigger Parameters. The functional groups in the Standard panel are described below.

Trigger Modifier

The Trigger modifier group provides access to delayed trigger state and its delay parameter, to the Re-trigger state and its parameter and to the burst counter.

To change trigger parameters, point and click on one of these LED's. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the 5251 with the new reading.

Trigger Parameters

Slope - The Slope group lets you select edge sensitivity for the trigger input of the 5251. If you click on Pos, the instrument will trigger on the rising edge of the trigger signal. Likewise, if you click on Neg, the instrument will trigger on the falling edge of the trigger signal.

Source - The 5251 can accept triggers from a number of sources: BUS, External or Mixed. When the Bus option is selected, only bus commands trigger the instrument. The External position is the default trigger option which enables the rear panel trigger input and the front panel manual trigger button. The Mixed position disables the rear-panel trigger input until a software command is executed, the trigger source then reverts to the rear-panel trigger input.

Manual - Use this button when an external generator is not available. Pressing the Manual button is stimulating the instrument as if an external trigger has been applied.

Trigger Level - Programs the trigger level parameter. Depending on the slope setting, the 5251 will be stimulated to output waveforms when the trigger level threshold has been crossed.

Figure 3-11, the Trigger Panel

The Modulation Panels

The Modulation functions were designed over five separate panels, as shown in Figures 3-13 through 3-17. The panels are invoked by pressing the Modulation header and then one of the modulation panels that appear below it (Figure 3-12). These panels provide access to the modulation functions. The modulation functions that are available on these panels are: FM, AM, Sweep, ASK/FSK/PSK and Frequency Hop.

The Modulation Group is common to all modulation panels. It contains an array of buttons that select the appropriate modulation scheme. It also provides access to the CW (Carrier Waveform) frequency setting. The CW frequency parameter is common to all of the modulation functions. The Baseline options control the level of which the carrier will reside when in idle mode (not modulated).

Figure 3-12, the Modulation Panels

FM

The FM group contains parameters for controlling the frequency modulation function. To turn the FM function on and off, click on the FM button in the Modulation group. The various controls in the FM group are described below.

Standard FM Parameters
Allow adjustment of the parameters that are associated with the standard modulating waveform. The controllable parameters are Modulation, Deviation and the Marker Frequencies.

Mod. Wave
Defines the shape of the modulating waveform. There are two basic options: Standard waveforms and Arbitrary waveforms. If you do not need exotic waveforms, you can use one of the built-in standard wave shapes: Sine, Triangle, Square, or Ramp. These waveforms can be adjusted for their frequency and deviation range. On the

other hand, you can select the arbitrary modulating wave option where you can use any shape however, you must load the modulating waveform from an external application, such as the FM composer in ArbConnection. Click on the button next to the required modulating waveform shape to select it.

Arbitrary FM Parameters
Allow adjustment of the sample clock of the modulating waveform. The shape of the modulating waveform must be downloaded from an external utility such as ArbConnection and the sample clock is programmed from this location.

To change the FM parameters, point and click on the required parameter. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to complete the process.

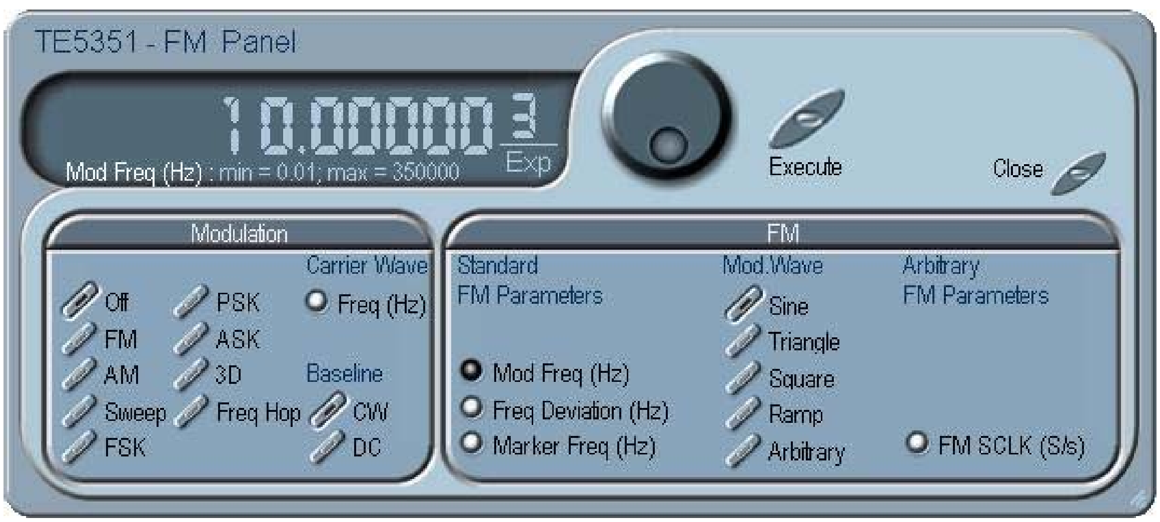

Figure 3-13, the FM Panel

AM

The AM group contains parameters for controlling the frequency modulation function. To turn the AM function on and off, click on the FM button in the Modulation group. The various controls in the AM group are described below.

Mod Wave
There is a list of 4 waveforms that can be selected to modulate the carrier waveform (CW). These are sine, triangle, square and ramp. The frequency and amplitude of the modulating waveforms are programmable

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

Depth
The Depth parameter programs the modulation depth, or index in percent of the un-modulated CW amplitude. The depth is symmetrical about the center of the CW amplitude.

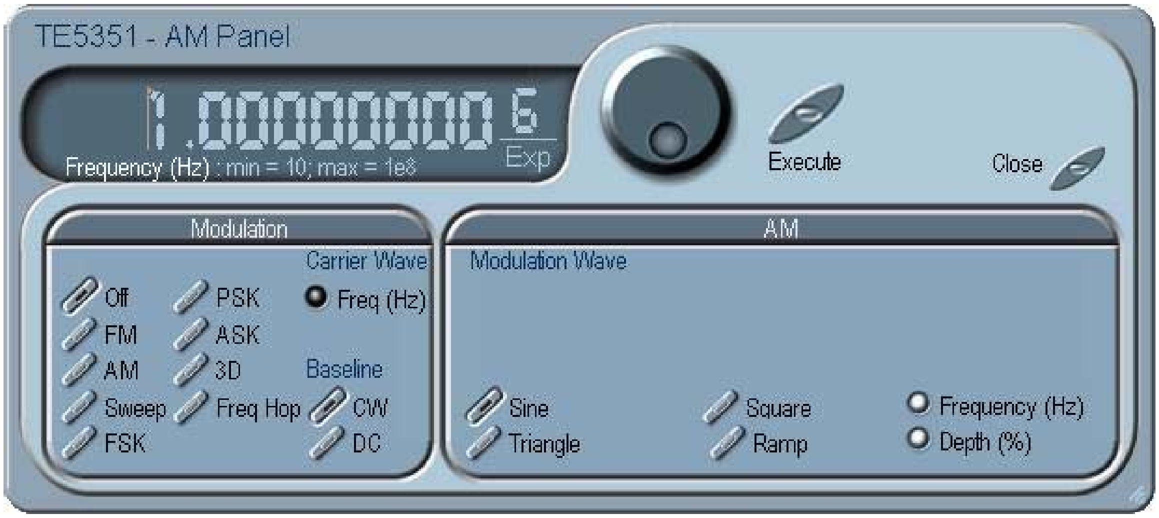

Figure 3-14, the AM Panel

Sweep

The Sweep group contains parameters for controlling sweep options. To turn the Sweep function on and off, click on the ***SWP*** button in Modulation group. The various parameters that control sweep features are described below.

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

Direction
Use these keys to program sweep direction. Up select sweep from Start to Stop sample clock setting and Down selects sweep from the Stop to Start sample clock setting.

Parameters
Allow adjustment of Sweep Start, Stop and Sweep Time. You can also place a marker at a position programmed by the Mark parameter. To access the required parameter, click on the button below parameters sub-group until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the 5251 with the new setting.

Figure 3-15, the Sweep Modulation Panel

ASK/FSK/PSK

The ASK/FSK/PSK panel contains parameters for controlling the ASK, FSK and the PSK functions. To select the required function, click on the appropriate button and adjust the parameters in the associated group. The various controls in the ASK/FSK/PSK groups are described below.

ASK

Control Data

The Control Data button in the ASK group provides access to the data string that controls the sequence of base amplitude and shifted amplitude. It contains a list of “0” and “1” and the output will repeatedly follow the amplitude shift keying sequence in the same order as programmed.

“0/1” Amplitude

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

Baud

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

Marker Index

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

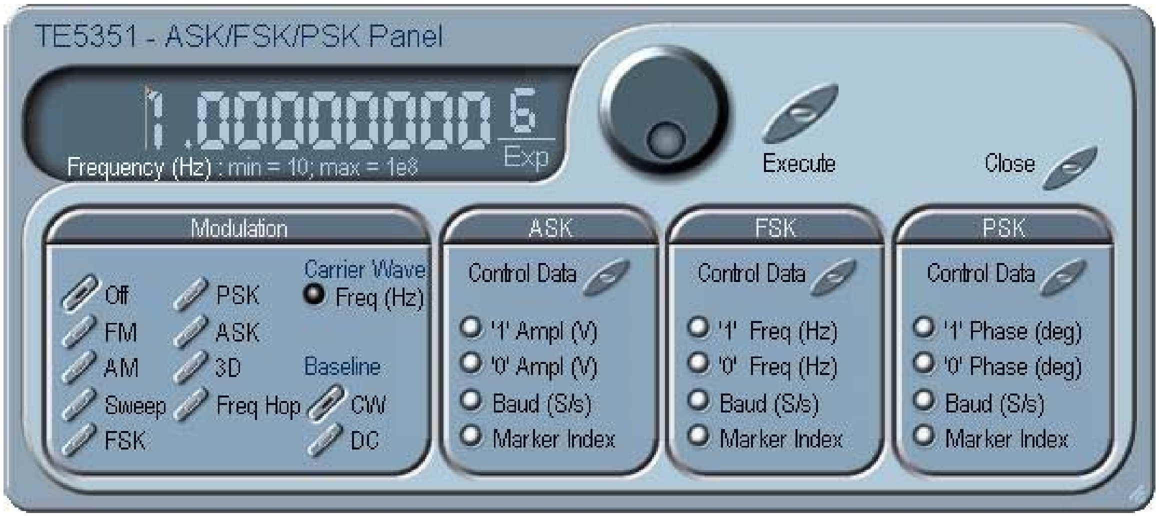

Figure 3-16, the ASK/FSK/PSK Modulation Panel

FSK

Control Data

The Control Data button in the FSK group provides access to the data string that controls the sequence of base frequency and shifted frequency. It contains a list of “0” and “1” and the output will repeatedly follow the frequency shift keying sequence in the same order as programmed.

“0/1” Frequency

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

Baud

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

Marker Index

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

PSK

Control Data

The Control Data button in the PSK group provides access to the data string that controls the sequence of base phase and shifted phase. It contains a list of “0” and “1” and the output will repeatedly follow the phase shift keying sequence in the same order as programmed.

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

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

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

To access the required parameter, click on the button below parameters sub-group until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the 5251 with the new reading.

Frequency Hop

The Frequency Hop panel contains parameters for controlling frequency hop options. To turn the frequency hop functions on and off, click on the ***Freq Hop*** button in the Modulation group. The various parameters that control frequency hop features are described below. The output has two hop options: Fixed and Variable. In the Fixed mode, the output steps through the pre-assigned hop values at a constant rate, as programmed using the dwell time parameter. In the variable mode, the output dwells on each step for a period of time that is programmed in the Dwell Time field in the hop data table that is programmed for the Variable Hold option.

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

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

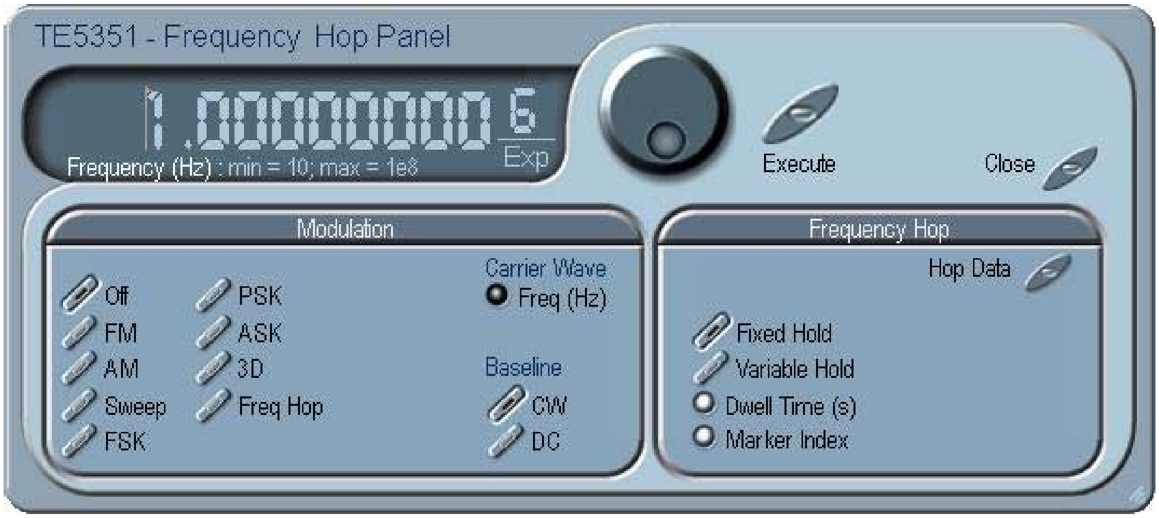

Figure 3-17, the Frequency Hop Panel

Variable Hold

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

Dwell Time

The Dwell Time parameter programs the period of time that will lapse before the frequency hops to the next frequency setting. The Dwell time is associated with the Fixed Dwell option only.

Marker Index

The marker setting programs a specific step (index) in the hop data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the hop marker output.

To access the required parameter, click on the button below parameters sub-group until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the 5251 with the new setting.

The Auxiliary Panels

The Auxiliary tab provides access to a group of panels that control some auxiliary and Utility functions.

There are six panels in this group: Counter/Timer, which provides access to the auxiliary Counter/Timer function; Pulse Generator, which provides access to the auxiliary digital pulse generator function; and Half Cycle, which provides access to the half cycle functions.

The Auxiliary set of panels is shown in Figure 3-18. Each of the panels is described below.

Figure 3-18, the Auxiliary Panels

Counter/Timer

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

State
The State Group has controls to turn the counter on and off. And to reset the counter and arm it for the next measurement cycle. Note that when the counter function is turned on, all other waveform generation features of the 5251 are purged.

Measurement Function
The measurement function group has control to select the measurement function for the counter/timer operation. The 5251 can measure the following function: Frequency, Period, Period Averaged, Pulse Width, and Totalize. The totalize function has two options. If Totalize Infinite function is selected the input will count every legal pulse at the counter input, for an indefinite period of time, and will display the total number of pulses until the counter has been reset. If Totalize Gated function is selected, the input will count every legal pulse at the trigger input for a period of time that is defined with the Gate Time parameter.

Figure 3-19, the Counter/Timer Panel

Display

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

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

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

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

Pulse Generator

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

Figure 3-20, the Digital Pulse Generator Panel

Pulse Mode

The Pulse Mode group has controls to turn on pulse generator functions, select of the output generates single or double pulse shape and selects the pulse polarity from one of the Normal, Complemented and Inverted options.

Polarity

The Polarity group has controls to select between Normal, Complemented and Inverted pulse shapes.

Pulse Parameters

In the pulse parameters group you adjust the complete set of parameters that builds up the pulse shape. Included are: period, rise and fall times, high time delay and high and low amplitude levels.

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

Half Cycle

The Half Cycle panel contains controls that select the half cycle functions and adjust the half cycle parameters.

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

Figure 3-21, the Half Cycle Panel

Shape

The shape group has controls that select the shape of the half cycle function. You may select from sine, triangle and square shapes. If you do not modify the start phase parameter, the half cycle sines and triangles will start from phase 0° and will stop at phase 180°. The second half cycle will commence at the end of the time interval that is programmed with the delay parameter.

Parameters

The parameters group has parameters that control frequency, amplitude, offset and delay. In this group, you can also program the sine and triangle start phase and the duty cycle of the square waveform.

Note that the frequency value is a bit different than the standard frequency parameter because it describes the frequency as if the two halves were combined (which is never the case). Since two halves are always separated by certain delay, the frequency value has a meaning as if the two halves were truncated.

The System Panels

The System tab provides access to a group of panels that control some general system parameters and provides access to the calibration. There are two panels in this group: General/System, which provides access to some system commands, utilities and filters; and Calibration, which provides access to the calibration remote calibration utility. Note however, that access to the calibration panel is permitted to qualified service persons and requires special user name and password. Information how to access the calibration panel is given in Adjustments and Software Updates chapter.

The System set of panels are shown in Figure 3-22. Each of the panels is described below.

Figure 3-22, the System Panels

General/Filters

The General/Filters panel provides access to some general system common commands, allows read back of information that is stored in the flash and provides means of adding filters to the output path. The General/Filters panel is shown in Figure 3-23 and the various parameters that control these functions are described below.

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

Reset – generates soft reset to the instrument controls and dialog boxes and modifies all parameters to factory default. A list of factory defaults is given in the programming chapter of this manual.

Query Error – queries the 5251 for programming errors. This command is normally no necessary because ArbConnection makes sure that programming errors cannot be made from the panels however, while executing commands from the Command Editor, errors can be generated and the only way to monitor the errors is by using this command.

Figure 3-23, the General/Filters Panel

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

General Information

This General Information group is used for displaying or monitoring of certain parameters that are stored in the flash memory. These are: Instrument serial number and last calibration date. You can also read the installed firmware revision, in case you want to verify that you have the latest firmware revision.

Filters

The filters can be turned on and off freely as long as you are not generating the standard sine waveform. The following filter options are available:

Off – no filter is applied to the output path
25MHz – a Bessel type filter that has 25 MHz cutoff frequency.
50MHz – a Bessel type filter that has 50 MHz cutoff frequency.
60MHz – an Elliptic type filter that has 60 MHz cutoff frequency.
120MHz – an Elliptic type filter that has 120 MHz cutoff frequency.

Calibration

The Calibration panel, as shown in Figure 3-24, provides access to remote calibration procedures. To access the remote calibration panel, you will need to have a valid User Name and Password and to quality to perform such calibration, you'll need to be trained and certified by Tabor Electronics. Information how to access the calibration panel and how to perform the calibration is given in the adjustment and firmware updates chapter. The picture below is just for reference how the calibration panel will look after you gain access to this panel.

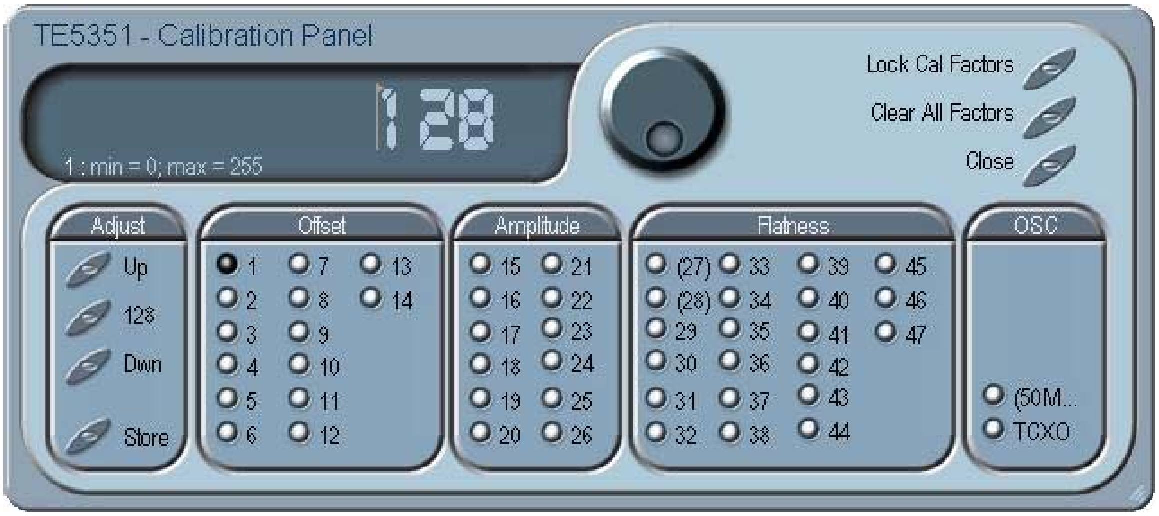

Figure 3-24, the Calibration Panel

The Composers Panels

The Composers tab provides access to a group of composers that allow generation and editing of arbitrary waveforms, pulse shapes, arbitrary frequency modulation and 3D profiling. Without utilities such as the above, the operation of an arbitrary waveform generator is extremely limiting.

There are four waveform composers built into ArbConnection:

Wave – for generating arbitrary waveforms. Arbitrary waveforms can be generated from standard libraries, from an equation editor, or imported to the composer from external utilities such as MatLAB. The waveforms can be edited and stored on hard or soft disks.

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

FM – for generating frequency modulation schemes. Unlike a standard frequency modulator, you can design and edit your own frequency modulation profiles.

3D – for generating simultaneous sweeps of amplitude, frequency and phase. This is specifically useful for generating complex chirps.

The Composers set of panels are shown in Figure 3-25. Each of the composers is described below.

Figure 3-25, the Composers Panels

The Wave Composer

Being an arbitrary waveform generator, the 5251 has to be loaded with waveform data before it can start generating waveforms. The waveform generation and editing utility is part of ArbConnection and is called – The Waveform Composer.

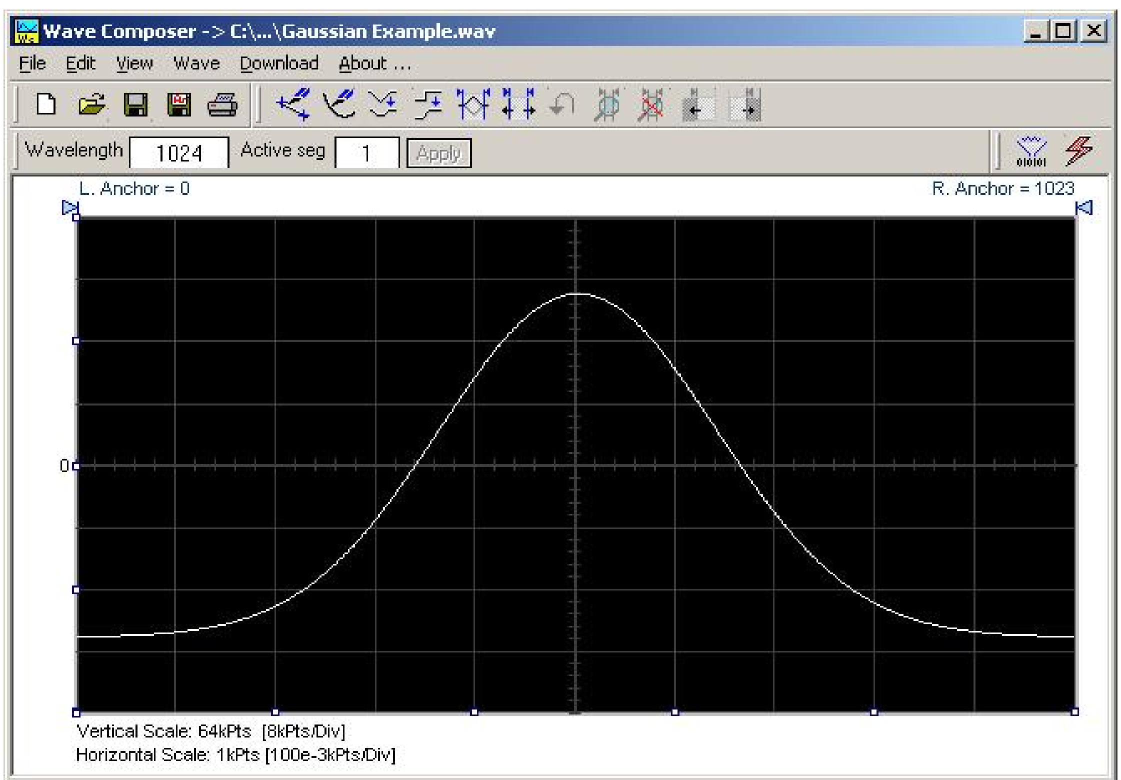

Figure 33-26, the Wave Composer Opening Screen

This program gives you tools to create definitions for arbitrary waveforms. It can also convert coordinates from other products, such as, oscilloscopes and use them directly as waveform data. The program is loaded with many features and options so use the following paragraphs to learn how to create edit and download waveforms to the 5251 using the Waveform Composer.

To launch the wave composer point and click on the Wave tab in the Panels bar. Figure 3-26 shows an example of the wave composer. The Wave Composer has main sections: Commands bar, Toolbar and Waveform screen. Refer to Figure 3-26 throughout the description of these sections.

The Commands bar

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

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

File Commands

The File command has 4 command lines that control waveform files. Also use this command to print the active waveform, or exit the wave composer program. Description of the various commands under File is given below.

New Waveform
The New Waveform (Ctrl+N) command will remove the waveform from the screen. If you made changes to the waveform area and use the New Waveform command, you should save your work before clearing the screen. The New Waveform command is destructive to the displayed waveform.

Open Waveform…
The Open Waveform… (Ctrl+O) command will let you browse your disk for previously saved waveform files and load these waveforms to the waveform area. This command is also very useful for converting waveform files to format that is acceptable by the Wave Composer. The Open Waveform command can convert ASCII.

*CSV (comma delimited text), *PRN (space delimited text) and *.0* (LeCroy binary format). The Open dialog box in Figure 3-31 shows the various file extensions that can be opened into the Wave Composer environment. The file that is opened is automatically converted to *.wav format and can later be saved as a standard ArbConnection file.

Save Waveform

The Save Waveform (Ctrl+S) command will store your active waveform in your 5251 directory, as a binary file with an *.wav extension. If this is the first time you save your waveform, the Save Waveform As… command will be invoked automatically, letting you select name, location and format for your waveform file.

Save Waveform As…

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

Print

With this command you may print the active Waveform Window. The standard printer dialog box will appear and will let you select printer setup, or print the waveform page.

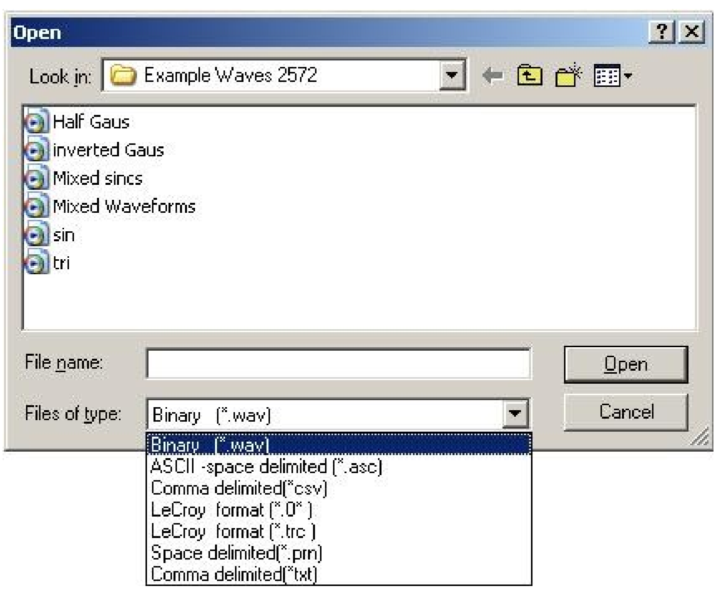

Figure 3-27, the Open Waveform Dialog Box

Exit

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

Edit Commands

The Edit commands are used for manipulating the waveform that is drawn on the screen. The editing commands are explained in the following paragraphs.

Autoline
The Autoline command lets you draw straight-line segments. To draw a line the left mouse button at the start point. Click again at the next point and then click on the right mouse button to terminate this operation.

Sketch
The Sketch command lets you draw free-hand segments. To draw a line using this command click and hold the left mouse button at the start point. Release the mouse button when you want to stop and then click on the right mouse button to terminate this operation.

Smooth
The Smooth command lets you smooth out rough transitions on your waveform. This is done mathematically by multiplying waveform coordinates by the non-linear portion of a cubic parabola.

The Smooth operation is done on segments of the waveform that are bound by anchors. Anchor operation is described later in this chapter. Place the anchors on the left and right of your waveform segment and select the Smooth command. The waveform will change its shape immediately to follow the mathematical pattern of a parabolic curve.

Note that small segments with fast transitions, when combined with parabolic expressions have tendencies to generate even larger transitions. Therefore, make sure you omit such sections of the waveform when you use this operation.

Filter
The Filter used with this command is moving average. This is done by recalculating each point as an average of symmetrical number of adjacent points. When you select the Filter command, a dialog box pops up, letting you program the filter spacing in number of adjacent points. You can filter the entire waveform, or you may chose to filter a segment of the waveform by placing the anchors as boundaries on the left and right of the segment.

Invert
The Invert command lets you invert the entire waveforms, or marked segments of waveforms. The waveform is inverted about the 0-point axis.

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

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

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

Undo
The Undo command undoes the last editing operation.

View Commands

The View commands have commands that let you view various sections of the waveform area. The View commands include: Zoom In, Zoom Out, Hide/Show Toolbars and Channel 1 to 4 waveforms. Description of the view commands is given in the following.

Zoom In
The zoom in command operates between anchors. Anchors are marked as left and right hand triangles. The default position of the anchors is the start and the end of the waveform. To move an anchor to a new location, click and hold on the triangle and drag the anchor to left or right as required. If you move the left anchor to the right and the right anchor to the left, the area between the anchors will zoom in as you select this command.

Looking at the Waveform Map, as shown in Figure 3-28, you'll see that the white portion is the zoomed area. Click and hold on the white area and move your cursor around and the waveform screen will be updated accordingly.

While zoomed in you can perform Autoline and sketch editing, or zoom-in further by clicking and holding the mouse at one corner and releasing the mouse button at the other corner.

Zoom Out
The zoom out restores the screen to display the complete waveform.

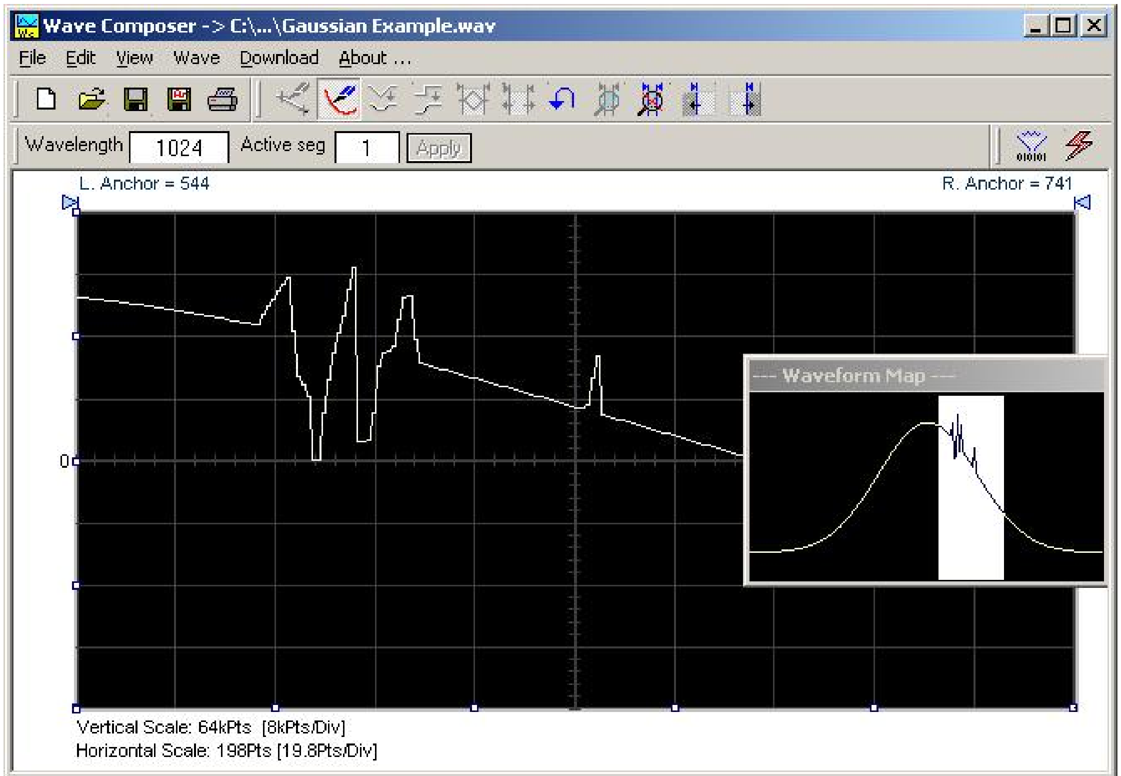

Figure 3-28, Zooming In on Waveform Segments

Wave Commands

The Wave commands let you create waveforms on the screen. The Wave command has a library of 8 waveforms: Sine, Triangle, Square, Sinc, Gaussian, Exponent, Pulse, Noise and dc. Also, from the Wave command, you can create Cardiac waveforms and pulse width modulation. Finaly, custom waveforms are created using the Equation Editor. Information how to create waveforms using the Wave commands is given below.

Creating Waveforms From the Built-in Library

You can create any waveform from the built-in library using the Wave command. Clicking on one of the Wave options will open a dialog box. An example of the Sine waveform dialog box is shown in Figure 3-29. This dialog box is representative of the rest of the waveforms, so other waveforms will not be described.

Creating Sine Waveforms

Use the following procedure to create sine waveforms from the built-in library. Click on Wave, then sine… the dialog box as shown in Figure 3-29 will appear. You can now start programming parameters that are available in this box.

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

End Point – Defines where the created waveform will end. Note that as you change the end point the right anchor will automatically adjust itself to the selected end point, 499 shown in the example.

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

Amplitude – 16-bit of vertical define 32,768 incremental steps. The Amplitude parameter defines how many of these steps are used for generating the sine. The example is showing sine waveform with maximum peak-to-peak amplitude. Any number below the maximum will generate an attenuated sine.

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

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

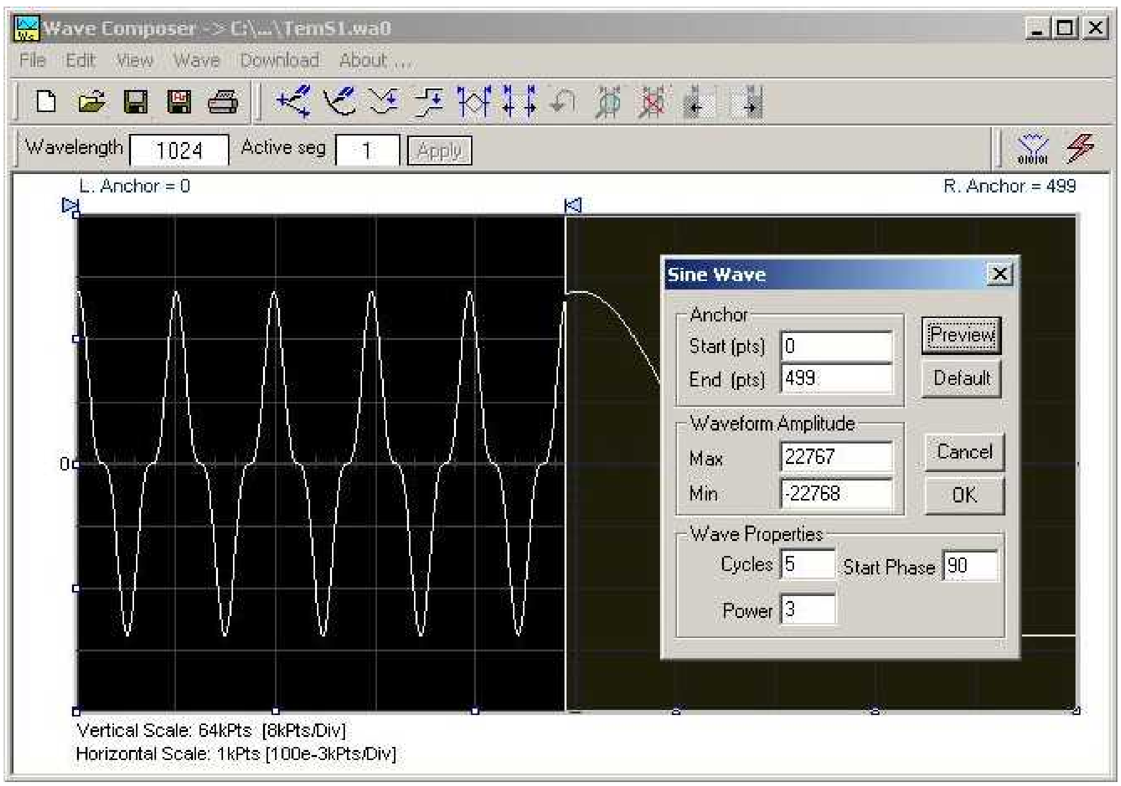

Figure 3-29, Generating Distorted Sine waves from the built-in Library

The Toolbar

The toolbar contains icons for editing the waveform screen, icons for saving and loading waveforms, fields for selecting an active channel and for adjusting segment length and more. The Toolbar is shown in Figure 3-30. For the individual icons, refer to the descriptions above of the Wave Composer Menus.

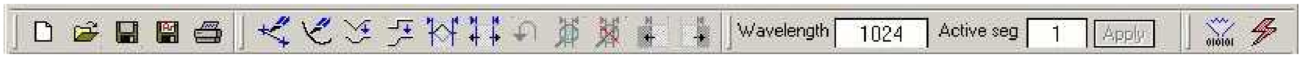

Figure 3-30, the Toolbar Icons

The Waveform Screen

Waveforms are created and edited on the waveform screen. Figure 3-35 shows an example of a waveform created using the equation editor and the anchors to limit generation of the waveform between points 100 and 900. The various elements of the waveform screen are described below.

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

The vertical axis is labeled from -32,767 through 32,768 for a total of 65,536 point (includes point "0"). This number represents 16 bits of vertical resolution and cannot be changed because it is critical to the range of which the 5251 operates.

The horizontal axis, by default has 1000 points (from point 0 to 999). This number can be changed using the Wave Length field in the Toolbar. The maximum length depends on the option installed in your instrument. The wave composer will let you define the horizontal axis to a maximum of 2M words).

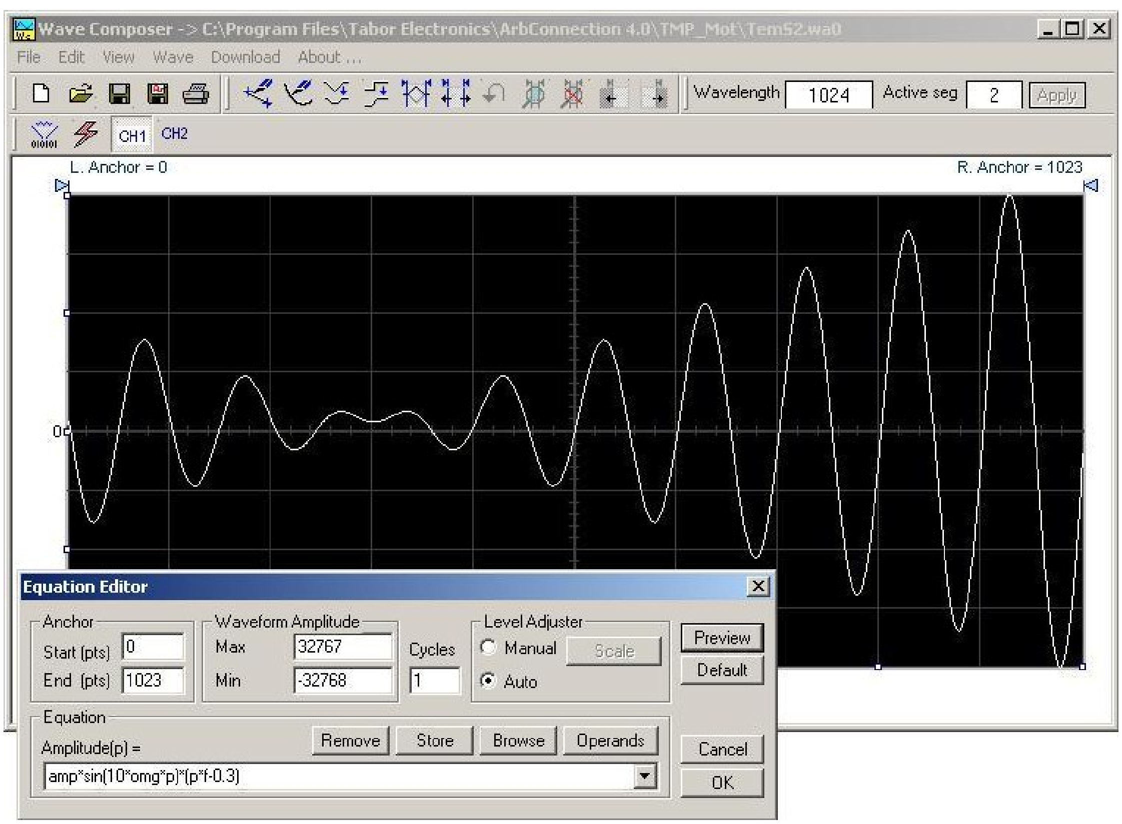

Figure 3-31, the Waveform Screen

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

There are two ways to control anchor placements.

1) Click and hold your mouse cursor on the left anchor triangle and then drag the curtain to the left position. Do the same for the right anchor. Notice the X and Y coordinates at the top of the waveform screen and how they change to correspond to your anchor placement.

2) You can also place your anchors in a more precise manner from the waveform library by programming the start and end points for the waveform. An example of anchor placement using the sine dialog box is shown in Figure 3-29.

Finally, when you are done creating and editing your waveform, you can save your work to a directory of your choice. The name at the title will show you the name you selected for storing your waveform and its path.

Generating Waveforms Using the Equation Editor

One of the most powerful feature within ArbConnection and probably the feature that will be used most is the Equation Editor. The Equation Editor let you write equations the same way as you would do on a blank piece of paper. The equations are then translated to sequential points that form waveforms and are displayed on the waveform screen. The Equation Editor will detect and inform you on syntax errors and, with its self adjusting feature, will automatically adjust your parameters so that none of the points on your waveform will exceed the maximum scale limits.

When you invoke the Equation Editor, the dialog box, as shown in Figure 3-32 will display. Use the following paragraphs to learn how to use this dialog box and how to write your equations.

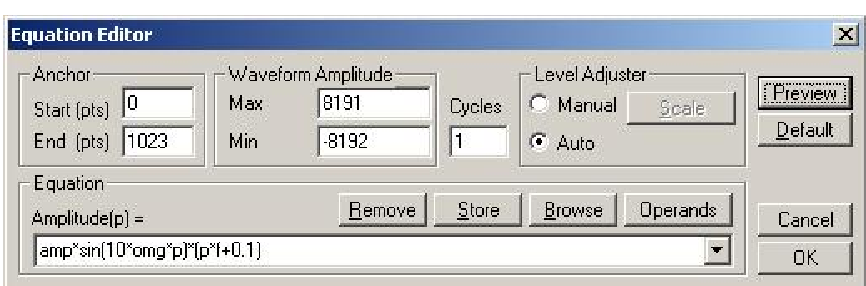

Figure 3-32, the Equation Editor Dialog Box

There are four sub-group parameters in the equation editor plus control buttons and equation field. These parts are described below.

Anchor
The anchors define start and end point of which the equation will be generated. By default the anchors are placed at the start and the end of the horizontal (time) scale however, the equation can be limited to a specific time scale by moving the anchor points from their default locations.

Start – defines the first point where the created wave will start. Note that if you change the start point the left anchor will automatically adjust itself to the selected start point.

End – defines where the created waveform will end. Note that as you change the end point the right anchor will automatically adjust itself to the selected end point.

Waveform Amplitude
The vertical axis of the Wave Composer represents 14-bits of vertical resolution. That means that the equation is computed, resolved and generated with 1/32,768 increments and accuracy. The Waveform Amplitude fields in the Equation Editor are used in two cases: 1) when the "amp" parameter is used in the equation or 2 if the Level Adjuster is set to Auto. Information on these two operations is given later.

Max – defines the positive peak of the vertical axis

Min – defines the negative peak of the vertical axis

Cycles
The Cycles parameter defines how many waveform cycles will be created within the specified start and end anchor points.

Level Adjuster
The Level Adjuster is a convenient tool that helps you adjust the amplitude and offset without modifying your equation. The Level Adjuster mode does not interfere with your calculations and displays the waveform as computed from your equation. The only difference is that your final calculations are stretched or shrunk or offset on the vertical scale to fit the new amplitude and offset boundaries.

If you change the Max and Min setting in the Waveform Amplitude fields and press the Adjust key, your waveform will offset immediately without changing the equation. The same way, you can also change amplitude only or both amplitude and offset. If you check the Manual option, you'll have to click on the Adjust button for the Waveform Amplitude parameters to take effect. The Adjust button name will change to Restore and back to Adjust if you click on it again. If you check the Auto option, your waveform will be created automatically with the new Amplitude setting.

Equation
The Equation group has four buttons and the equation field. You will be using the Equation field for writing your equations. Equation syntax and conventions are discussed in the following paragraphs. The *Remove* button clears the equation field so you can start typing a new equation. Click on the *Store* button to store your equation if you intend to use it again. The Browse button provides access to waveform pre-stored files in your computer for combining them in new equations. The *Operands* button expands the bottom of the dialog box to show the operands you can use with your equation.

While you type and store equations, they are collected in a history file and can be used again by expanding the history log from the equation field.

Control Buttons
There are four control buttons at the right corner of the dialog box. Use the *Preview* button to preview an image of your equation, or use the *OK* button to place your waveform on the waveform screen and to leave the dialog box on the screen. The *Default* button restores the parameters in the equation editor to their original factory default values. The *Cancel* button will remove the dialog box from the screen and will discard of any waveforms that you previewed with your Equation Editor.

Writing Equations

The Equation Editor lets you process mathematical expressions and convert them into waveform coordinates. As you probably already know, waveforms are made of vertical samples. The number of samples on your waveform is determined by the wavelength parameter. For example, if you have 1024 horizontal points, your equation will be computed along 1024 points as a function of the vertical scale. Each vertical sample is computed separately and placed along the horizontal axis. The points are graphically connected to form a uniform and continuous waveform shape however, if you zoom in on a waveform line, you'll see that the points are connected like a staircase. In reality, the 5251 generates its waveforms exactly as shown on the screen but, if the waveform has many horizontal points, the steps get smaller and harder to see without magnification.

Equations are always computed as a function of the vertical (Amplitude) axis therefore the left side of your equation will always look as Amplitude(p)=, where “p” is the equation variables in units of waveform points. You can write equations with up to 256 characters. If the equation is too long to fit in the visible field, parts to the left or right will scroll off the ends.

Equation Convention

The following paragraphs describe the conventions that are used for writing an equation. To avoid errors, it is extremely important that you make yourself familiar with these conventions before you plan your waveforms.

Equations are written in conventional mathematical notation. You may only enter the right part of the equation. The only limitation is that the equation must be of a single variable that is directly related to the current horizontal axis setting. Case is not important and spaces are ignored. Numbers are entered in scientific notation. All calculations are done with double-digit precision. For the trigonometric functions, all angles are expressed in radians.

A number of constants are provided: e, which is the base of the natural logarithm; pi, which is the circumference of a unit-diameter circle; per, which equals the programmed horizontal range; f, which equals 1 /per; omg, which equals 2 * pi / per, and numerals in the range of -1E^20 to 1E^20.

There are three classes of precedence: ^ (raise to power) has the highest precedence; (multiply) and / (divide) come second; + and - have the lowest precedence. Parentheses may be used to change the order of precedence. The following table summarize the mathematical expressions and their respective abbreviated commands that can be used with the Equation Editor.

Equation Editor Operands

^	Raise to the power
*	Multiply
/	Divide
+	Add
Ä	Subtract
( )	Parentheses
e	Base of natural Logarithm
pi (π)	Circumference of unit-diameter circle
per	Horizontal wavelength in points
f	I/per
omg (Ω)	2*π / per
amp	Amplitude in units of points or seconds
sin(x)	The sine of x(*)
cos(x)	The cosine of x
tan(x)	The tangent of x
ctn(x)	The cotangent of x
log(x)	The base IO logarithm of x
In(x)	The natural (base e) logarithm of x
abs(x)	The absolute value of x
-1E^20<>1E^20	Numerals, equation constants

(*)x = argument mathematical expression

After you get familiar with the operands and conventions, you can commence with a few simple equations and see what they do to your waveform screen. Once you'll get the feel, you'll be able to explore your own creativity to generate much more complicated and complex waveforms.

Typing Equations

If you remember from your old high school studies, the simplest curve of Y as a function of X is defined by the equation Y=aX+b. You can use the same “technique” to generate straight lines with the Equation Editor. Assuming first that p=0, try this:

Amplitude(p)=1000

Press [Preview] and see what you get. Of course, you get an uninteresting line that runs parallel to the X-axis. Now, lets give the line some angle by typing:

Amplitude(p)=-2*p+2000

Press [Preview] and see that the line slopes down. It may still be not very interesting however, pay close attention to the convention that is used in this equation. You cannot type: Amplitude(p)=-2p+1000, like you would normally do in your notebook; You must use the * (multiply) sign, otherwise you'll get a syntax error. Now we'll try to generate a simple sine waveform. Try this:

Amplitude(p)=sin(10)

Press [Preview] and… sorry, you still get nothing on the screen. The Wave Composer did not make a mistake! The sine of 10 in radians is exactly what it shows. You are unable to see the result because the line on your screen running across the 0 vertical point.

REMEMBER

The equation must be a function of a single variable and that variable must be directly related to the Horizontal axis Scale setting.

Now try this:

Amplitude(p)=sin(omg*p)

Still no good, but now press the [Adjust] button and here is your sinewave. So what's wrong? Well, if you'll give it a little amplitude it might help so, do it now exactly as follows:

Amplitude(p)=8000*sin(omg*p)

There you go. You should now see a perfect sine waveform with a period of 1000 points. This is because you have asked the Equation Editor to compute the sine along p points (“p” is the equation variable, remember?). If you want to create 10 sine waveforms, you should multiply p by 10. Try this:

Amplitude(p)=8000*sin(omg*p*10)

Equation Samples

So far, you have learned how to create two simple waveforms: straight lines and trigonometric functions. Let’s see if we can combine these waveforms to something more interesting. Take the straight line equation and add it to the sinewave equation:

Amplitude(p)=12000*sin(omg*p*l0)-8*p+4000

Press [Preview]. Your screen should look like Figure 3-33.

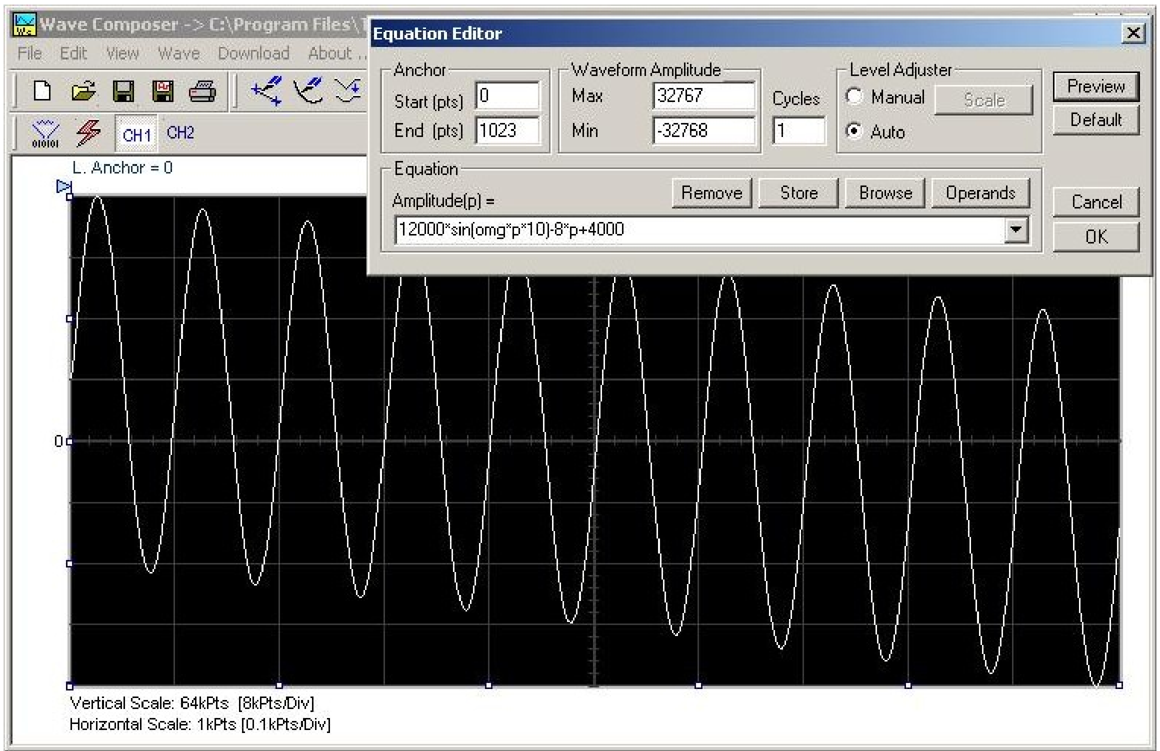

Figure 3-33, an Equation Editor Example

Now let’s try to modulate two sine waves with different periods and different start phase. Type this:

Amplitude(p)= 12000*sin(omg*p)*cos(omg*p*30)

Press [Preview]. Your screen should look like Figure 3-34.

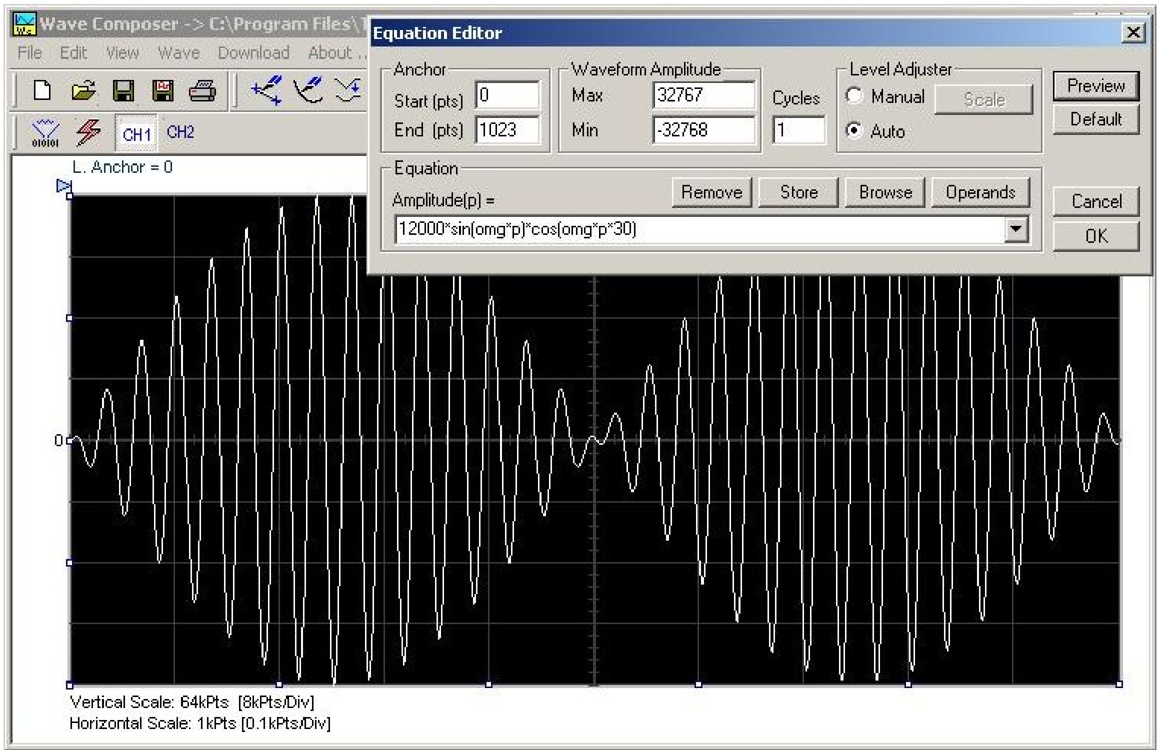

Figure 3-34, Using the Equation Editor to Modulate Sine Waveforms.

In the following example, as shown in Figure 3-40, 20% second harmonic distortion has been added to a standard sinewave. The original waveform had a peak-to-peak value of 24000 points so 19% second harmonic is equivalent to 4500 points. The frequency of the second harmonic is obviously double that of the fundamental, so term +4500*sin(2*omg*p) is added to the original sine wave equation. Use the following equation:

Amplitude(p)=24000*sin(omg*p)+4500*sine(2*omg*p)

Press [Preview]. Your screen should look like Figure 3-35.

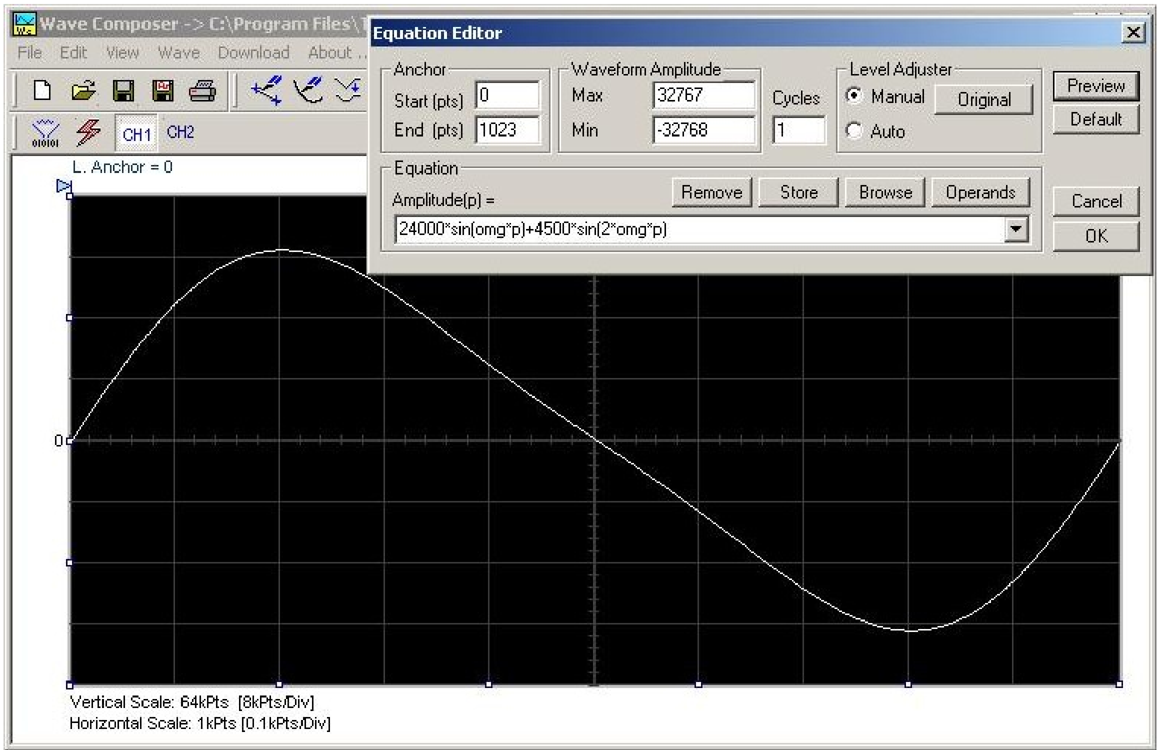

Figure 3-35, Using the Equation Editor to Add Second Harmonic Distortion.

In Figure 3-41 we created 10 cycles of sinewave made to decay exponentially. The original expression for a standard sinewave is multiplied by the term e^(p/-250). Increasing the value of the divisor (200 in this case) will slow down the rate of decay.

Use the following equation:

Amplitude(p)=12000*sin(omg*p*10)*e^(p/-250)

Press [Preview]. Your screen should look like Figure 3-36.

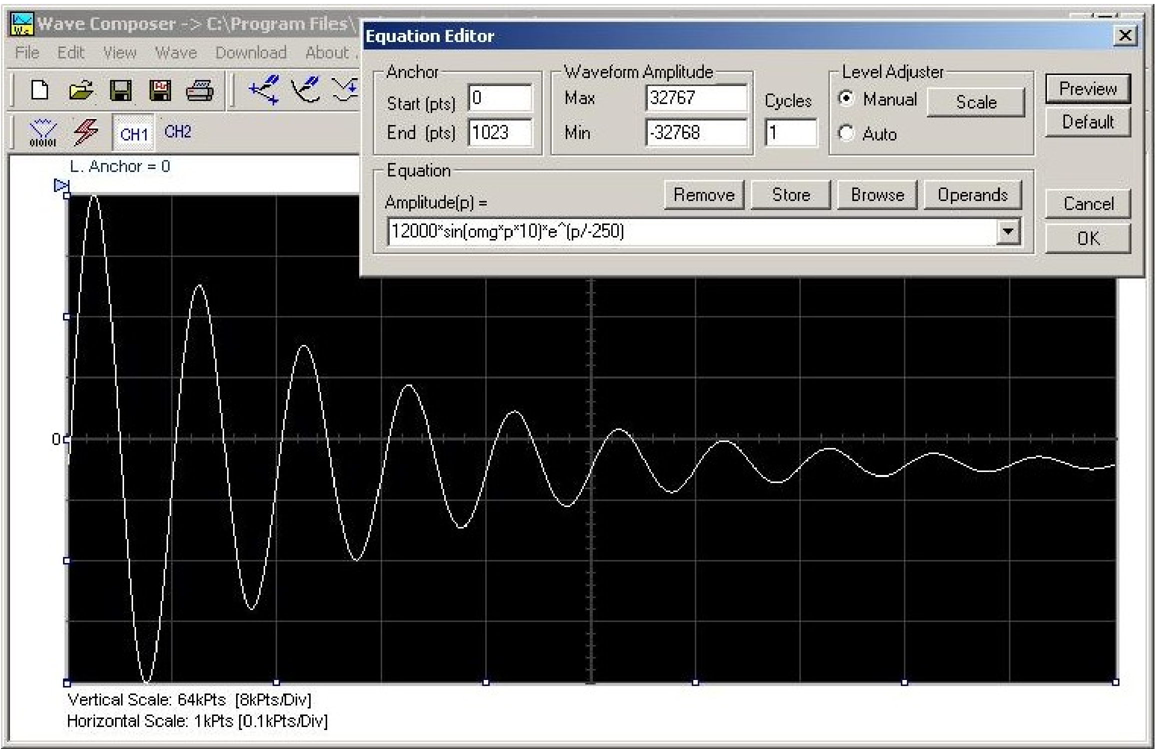

Figure 3-36, Using the Equation Editor to Generate Exponentially Decaying Sinewave

The last example as shown in Figure 3-37 is the most complex to be discussed here. Here, 100 cycles of sinewave are amplitude modulated with 10 cycles of sine wave with a modulation depth of 20%. To achieve this, the upper and lower sidebands are defined separately and added to the fundamental or carrier. The upper sideband is produced by the expression 100*cos(110*omg*p) and the lower sideband by the term 100*cos(90*omg*p).

Use the following equation:

Ampl(p)=6000*sin(100*omg*p)+1200*cos(110*omg*p)-1200*cos(90*omg*p)

Press [Preview]. Your screen should look like Figure 3-37.

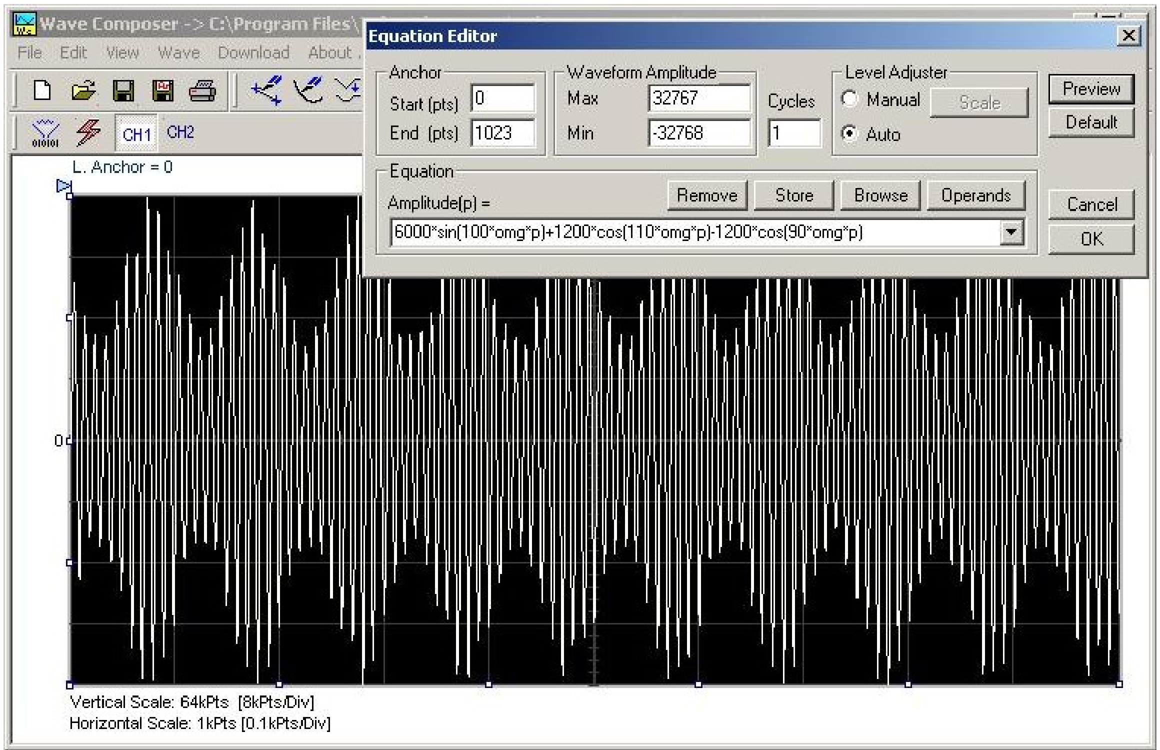

Figure 3-37, Using the Editor to Build Amplitude Modulated Signal with Upper and Lower Sidebands

Combining Waveforms

The last but not least powerful feature allows you to combine waveforms which you previously stored on your hard disc. You can write mathematical expressions that contain waveforms, simple operands and trigonometric functions similar to the example given below. If you want to use waveforms in your equations, you must first generate these waves and store them on your hard disk. You identify waveforms by adding the *.wav extension as shown in the example below.

Amplitude(p)= Sine.wav*sin(omg*p*10)*Noise.wav/1000

The above equation will generate amplitude-modulated waveform with added noise. The following steps demonstrate how to create, store and combine waveforms using this equation.

Step 1 – Create and store sine.wav. Invoke the Wave command and generate a sine waveform. Press OK and then select the Save Waveform As… from the File command. Save this file using the name Sine.wav. Note where you store this waveform as you would have to know the path for the next step.

Step 2 – Create and store Noise.wav. From the Wave command select Noise. Click OK and watch your waveform screen draw noisy signal. From the File menu select Save Waveform As… and save this waveform using the name Noise.wav.

Step 3 – Write and compute the original equation:

Amplitude(p)= c:/Sine.wav*sin(omg*p*5)*c:/Noise.wav/10

If you did not make any mistakes, your waveform screen should look as shown in Figure 3-38

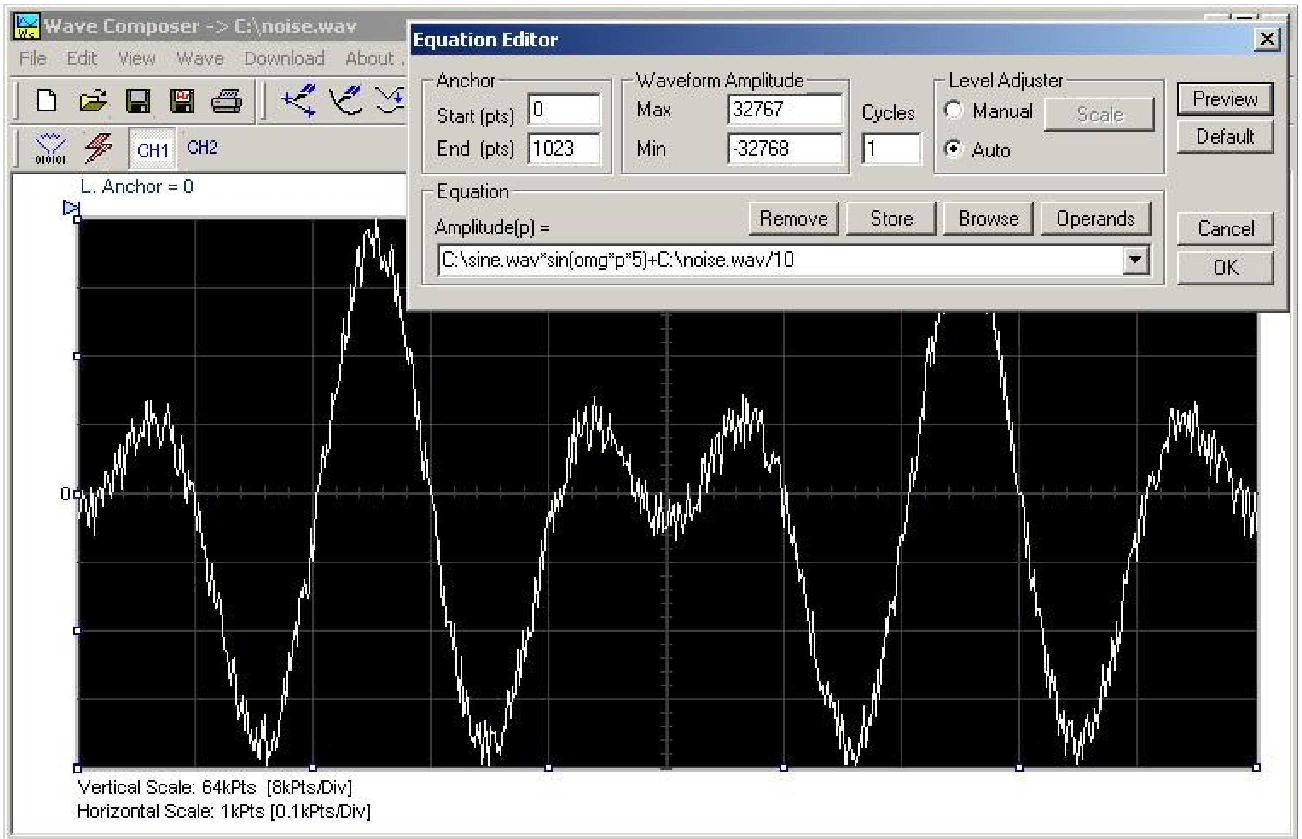

Figure 3-38, Combining Waveforms into Equations

The Pulse Composer

The Pulse Composer is a great tool for creating and editing pulses without the need to think about sample clock, number of points and complex equations. Pulses are created on the screen, simply and efficiently in a special dialog box by typing in the width and level, or by using the "rubber band" method to place straight line segments with the exact amplitude and time duration. The pulse composer can also multiply pulse sections to create pulse duplication along lengthy time intervals.

When you finally have your pulse design on the screen the program determines if the pulse design will fit in one memory segment or use multiple segments and employ the sequence generator for repeatable segments. In either case, bear in mind that if you already have some waveforms stored in memory segments, these will be erased to make room for the new pulse design. If you insist on keeping arbitrary waveforms and still download complex pulses, you can check the “Force pulse to one segment” option and the 5251 will do some extra “muscle flexing” to fit the pulse as required.

To launch the pulse composer point and click on the Pulse tab in the Panels bar. Figure 3-39 shows an example of the pulse composer. The Pulse Composer has three main sections: Commands bar, Toolbar and Waveform screen. Refer to Figure 3-39 throughout the description of these sections.

The Pulse Composer Commands bar

The commands bar provides access to standard Windows commands such as File and View. In addition, there are ArbExplorer-specific commands such as Edit, Wave and System.

In general, clicking on one of the commands opens a dialog box with an additional list of commands. Then, clicking on an additional command, may open a dialog box, or generate an immediate action. For example, Clicking on File and then Exit will cause an immediate termination of the Pulse Composer. The various commands in the Commands bar are listed and described below.

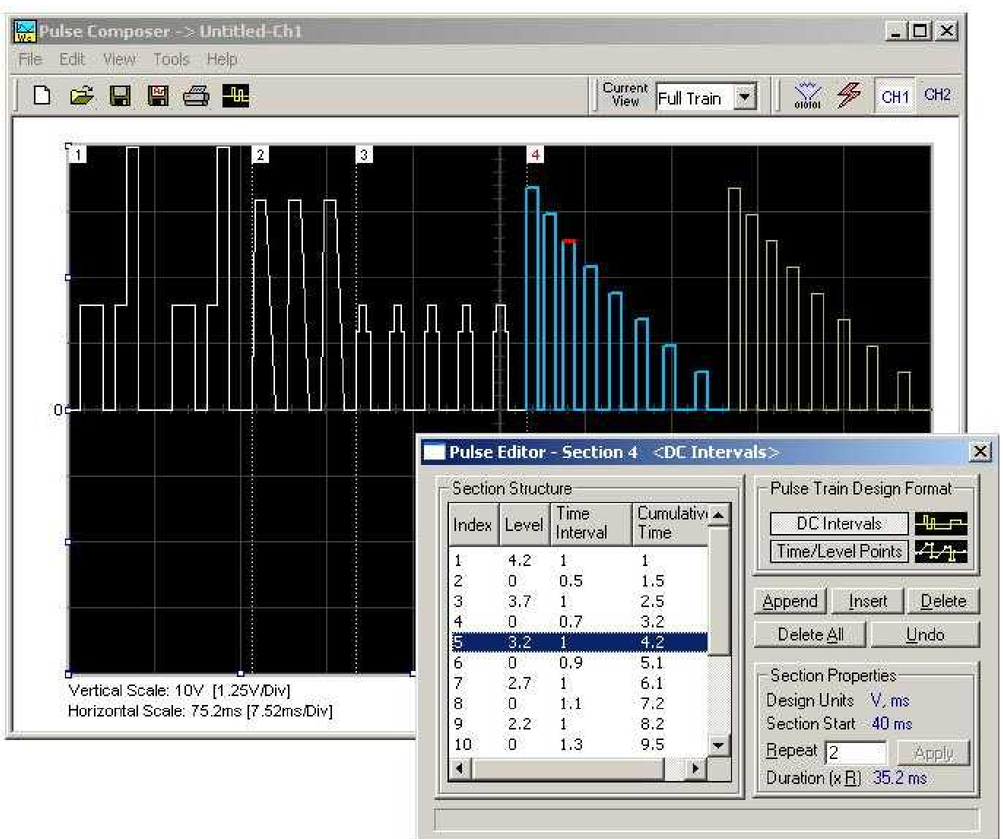

Figure 3-39, the Pulse Composer Screen

File Commands

The File command has 4 command lines that control pulse waveform files. Also use this command to print the active waveform, or exit the pulse composer program. Description of the various commands under File is given below.

New
The New (Ctrl+N) command will remove the waveform from the screen. If you made changes to the waveform area and use the New command, you should save your work before clearing the screen. The New command is destructive to the displayed waveform.

Open…
The Open… (Ctrl+O) command will let you browse through your disk space for previously saved pulse waveform files and load them to the pulse screen area. File extension that can be read to the pulse composer is *.pls.

Save
The Save (Ctrl+S) command will store the active waveform in your 5251 directory with a *.pls extension. If this is the first time you save your waveform, the Save As… command will be invoked automatically, letting you select name, location and format for your waveform file.

Save As…
Use the Save As… command the first time you save your waveform. It will let you select name, location and format for your waveform file.

Print
With this command you may print the active Pulse Window. The standard printer dialog box will appear and will let you select printer setup, or print the waveform page.

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

Edit Commands

The Edit commands are used for adding or removing pulse train sections. Use these commands to Append, Delete, Insert, or Undo last operation. The editing commands are explained in the following paragraphs.

Append Section
The Append Section command lets you append a new section at the end of the pulse train. Only one new section can be appended at the end of the train. If an empty section already exists, the append command will alert for an error. New sections are always appended at the end of the pulse train.

Insert Section
The insert Section command lets you insert a new section in between sections that were already designed. Only one new section can be inserted at the middle of the train. If an empty section already exists, the insert command will alert for an error.

Delete Section
The Delete Section command lets you remove sections from the pulse train without affecting the rest of the train. If you use this command from the Edit menu, make sure that the section you want to remove is currently the active section.

Remove all Sections
The Remove all Sections command lets you remove the entire pulse design from the pulse screen and start from a fresh page.

Undo
The Undo command undoes the last editing operation. This command is extremely useful in cases where you unintentionally delete a section from the pulse train and want to restore it to the screen.

View Commands

The View commands have commands that let you view various sections of the pulse area. The View commands include: Pulse Editor, Full Train or individual Sections and Options. Description of the view commands is given in the following.

Pulse Editor
The view Pulse Editor command invokes a dialog box as shown in Figure 3-40. In general, the pulse editor is used for placing straight line segments on the screen in intervals that define pulse width, rise/fall times and amplitude. Information how to use the pulse editor to create pulse trains is given later in this chapter.

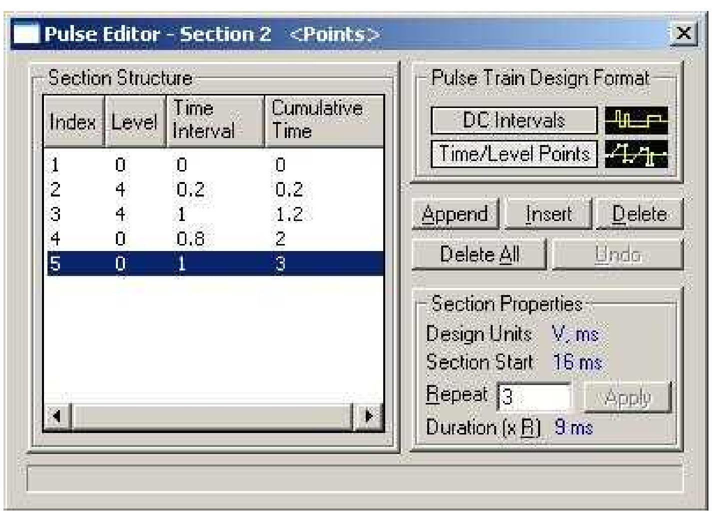

Figure 3-40, the Pulse Editor

Full Train
The view Full Train shows on the pulse screen all sections of the pulse train. Eventually, when all pulse sections have been designed, the entire pulse train as shown when the Full Train option has been selected will be downloaded to the instrument as a single waveform.

Single Section
The view Single Section shows on the pulse screen one section at a time. Eventually, when all pulse sections have been designed, the entire pulse train as shown when the Full Train option has been selected will be downloaded to the instrument as a single waveform.

Options
The view options command opens the dialog box as shown in Figure 3-41. Use this dialog box to fine-tune the pulse composer to the way it should deal with operational modes and the waveform memory. Information on options is given later in this chapter.

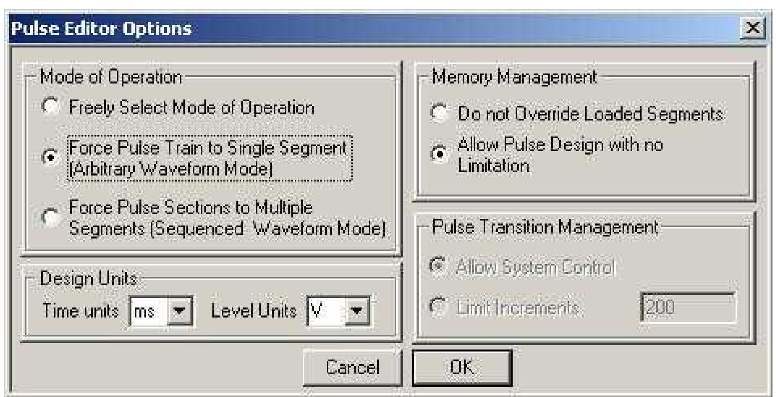

Figure 3-41, the Pulse Editor Options

Tools Commands

The Tools commands let you download pulse trains to the instrument. You can also clear the entire waveform memory using the Clear memory command.

Note

The Clear Memory command affects the entire waveform memory of the 5251 and therefore, be careful not to erase memory segments that you'll need to use with the arbitrary function.

The Pulse Composer Toolbar

The toolbar contains icons for editing the waveform screen, icons for saving and loading waveforms, fields for selecting an active channel and more. The Toolbar is shown in Figure 3-42. The icons, from left to right operate the following functions: New waveform, Open an existing waveform file, Save pulse train, Save pulse train As, Print the screen and open the pulse editor dialog box. Other icons select the current view on the screen, clear the memory and download the displayed pulse train to the active channel.

Figure 3-42, the Pulse Composer Toolbar Icons

Creating Pulses

As was mentioned above, creating pulses with the pulse editor is simple and intuitive, just as you would draw the pulse on a piece of paper. The pulse editor then processes the information, determines the appropriate mode and converts to waveform coordinates for downloading to the instrument for it to generate the required pulse shape.

There are a number of terms that will be used throughout the following description; Make yourself familiar with these terms before you proceed with actual design of your pulse.

Pulse Editor
The Pulse Editor is the prime tool for creating pulses. To invoke the pulse editor, point and click on the pulse editor icon on the pulse composer toolbar. You can also invoke the editor by clicking on the Section Number icon as will be shown later in this description. The pulse editor dialog box is shown in Figure 3-40.

Pulse Train
The Pulse Train identifies the entire pulse design. When downloading the waveform to the instrument, the entire pulse train will be downloaded, regardless if part of the pulse train is displayed on the pulse composer screen.

Pulse Section
Pulse train is constructed from 1 or more sections. If the pulse is simple, it can be created using one section only. For more complex pulse train, the train can be divided to smaller sections and each section designed separately for simplicity. Figure 3-43 shows a complex pulse train which was made from five simpler sections and Figure 3-44 shows the design of the fifth section only of the pulse train.

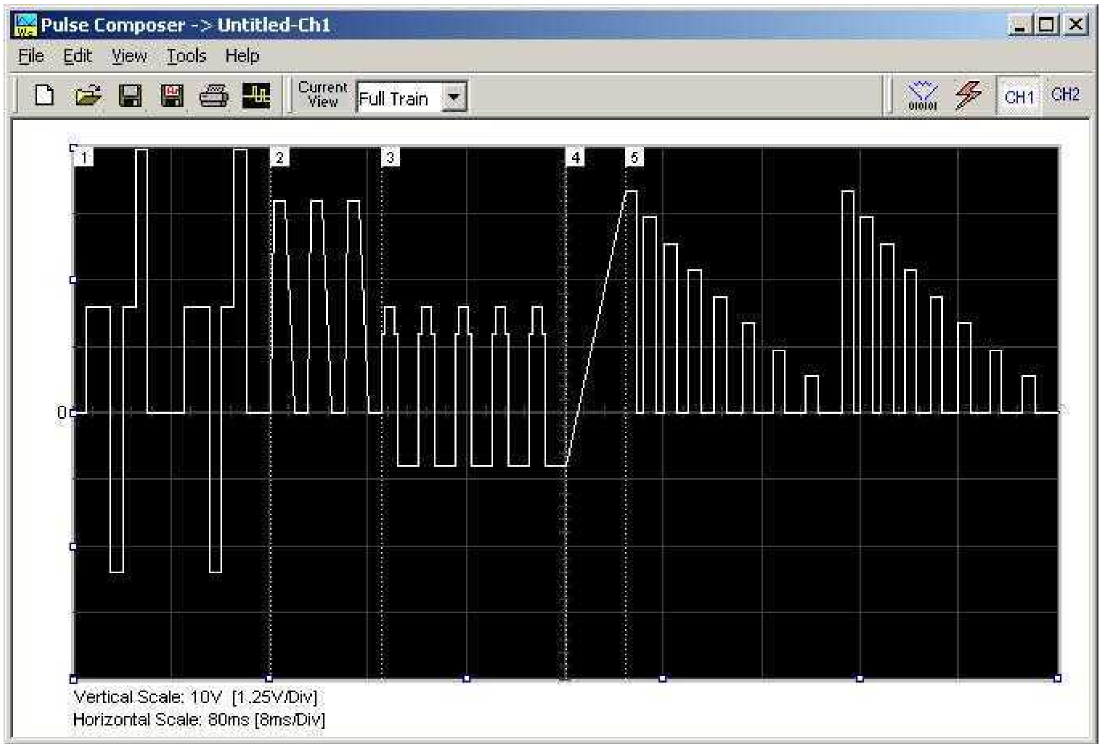

Figure 3-43, Complete Pulse Train Design

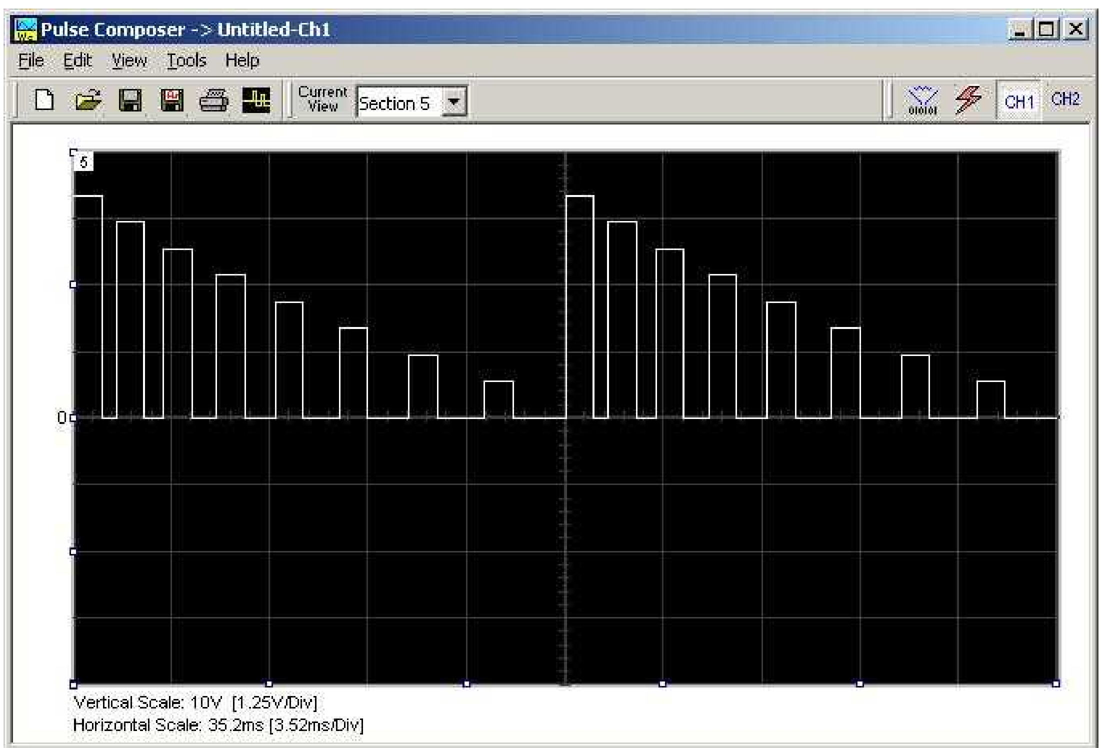

Figure 3-44, Section 5 of the Pulse Train Design

Now that we somewhat understand the terms we use for the pulse design, we start with an example how to design the pulse train as shown in Figure 3-43. If you already have some pulses shown on your pulse composer screen, click on New to start from a fresh page. Another step before you design your pulse train is to set the design parameters in the options menu that will determine the way that the pulse will be distributed in your waveform memory. Click on View→Options and refer to Figure 3-45 throughout the following description.

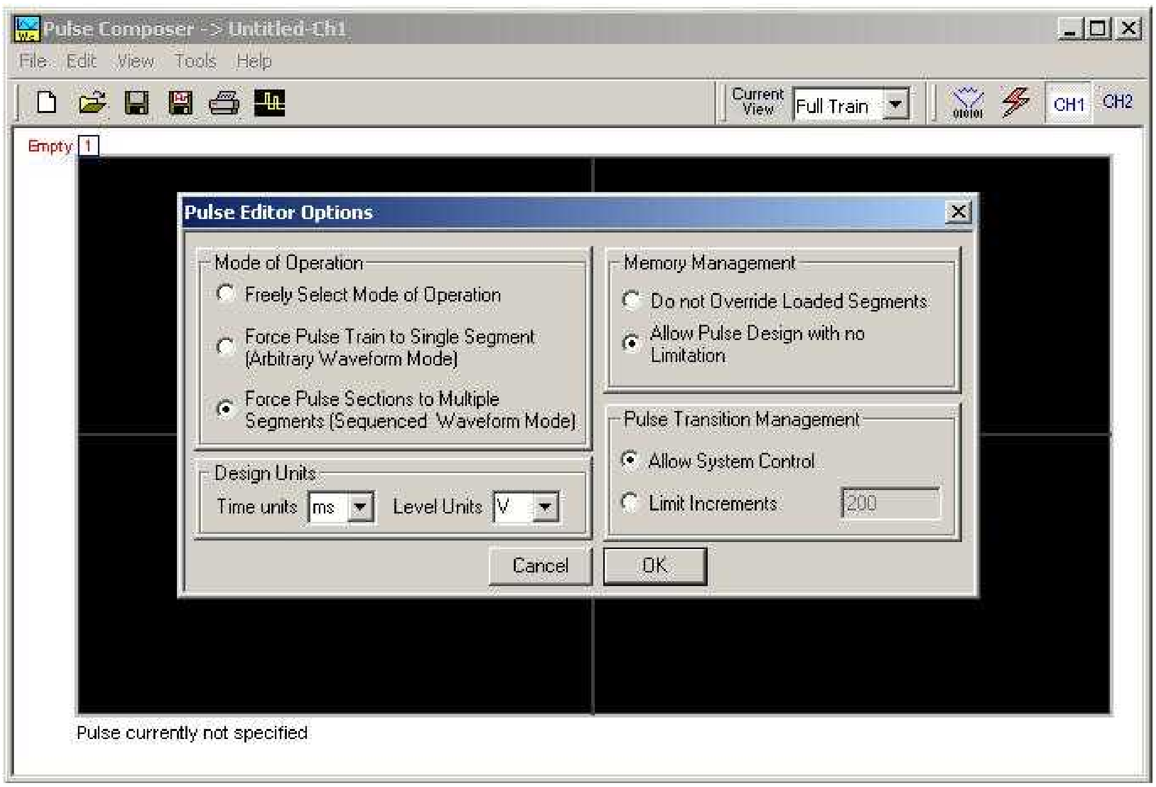

Figure 3-45, Selecting Pulse Editor Options

Setting the Pulse Editor Options

As shown in Figure 3-45, the pulse editor option dialog box is divided to functional groups: Mode of operation, Design Units, Memory Management and Pulse Transition Management. These groups are described below.

Mode of Operation

There are three options in the mode of operation group.

The force pulse train to single segment option is recommended if you are using one pulse section only. In this case, the pulse waveform will occupy one segment only and the generator will automatically be set to operate in arbitrary mode.

The force pulse sections to multiple segments option will place each section of the pulse train into a different memory segment and the generator will automatically be set to operate in sequenced mode. Select this option for the example we are going to build later.

If you are not sure what to do, select the freely select mode of operation and the generator will do the work for you.

Design Units
As you design your pulse pattern, it will be easier if you design it using the exact units as you would want to output to your load. Select between μs, ms and s for the pulse intervals and mV or V for the amplitude level. Select ms and V for the example we are going to build later.

Memory management
There are two options in the memory management group.

The do not override loaded segments option will make sure that whatever waveforms you already stored for the arbitrary function will stay intact after you save your pulse waveform.

The allow pulse design with no limitations option may overwrite memory segments that you already used previously for the arbitrary function however, this is the recommended option for the program and for the example we are going to build later.

Pulse Transition management
The pulse transition management parameter defines for the program how many waveform points will be used to step from one amplitude level to another amplitude level. The longer the transition time, the program will need more steps to smooth the transition. If you select the limit increments and set a pre-defined number of increments, you manually control how many waveform points will be dedicated for transitions however, if you are not sure what is the optimum number of increments, select the allow system control option for the program to make the transitions efficient in terms of memory usage and slope smoothness.

After you complete setting the pulse editor options, point and click on OK.

Using the Pulse Editor

The prime tool for building pulse patterns on the pulse composer screen is the pulse editor. To invoke the pulse editor, point and click on the pulse editor icon on the tools bar. The editor as shown in Figure 3-46 will show. Refer to this figure for the following descriptions.

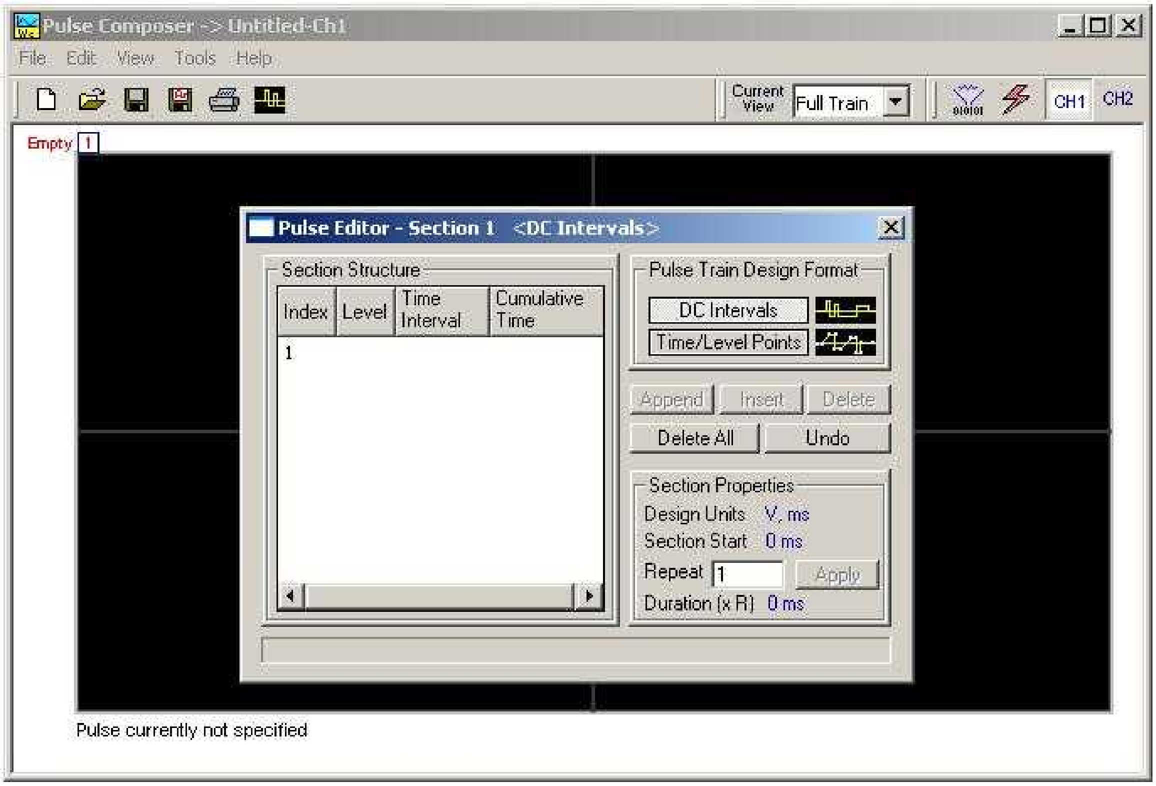

Figure 3-46, Using the Pulse Editor

The Pulse Editor as shown in Figure 3-46 has four groups: Section Structure, Pulse Train Design Format, Section Properties and control buttons. These groups are described below.

Pulse Train Design Format

There are two methods (or formats) that can be use for designing the pulse shape: DC Intervals and Time/Level Points. The design format is unique for the current section and cannot be switched during the section design.

DC Intervals – programs pulse duration using DC levels only. Transition times for this format are at the maximum rate that the generator can produce. For example, if you want to draw a simple square waveform that has 0V to 3.3V amplitude, 50% duty cycle and 1ms period, you enter the following parameters:

Index = 1, Level = 3.3, Time interval = 0.5 (Cumulative Time = 0.5)
Index = 2, Level = 0, Time Interval = 0.5 (Cumulative Time = 1.0)

Note as you build the segments that the pulse is being drawn on the screen as you type in the parameters. Also note that the Cumulative Time column is updated automatically with the cumulative time lapse from the start of the pulse.

Time/Level Points – programs pulse turning points using level and time markers. This format is a bit more complex to use however, it allows pulse design that require linear transition times. For example, if you want to draw a simple square waveform that has 0V to 3.3V amplitude, 50% duty cycle, 1ms period and 100ns transition times, you enter the following parameters:

Index = 1, Level = 0, Time interval = 0, (Cumulative Time = 0)
Index = 2, Level = 3.3, Time Interval = 0.1, (Cumulative Time = 0.1)
Index = 3, Level = 3.3, Time interval = 0.4, (Cumulative Time = 0.5)
Index = 4, Level = 0, Time interval = 0.1, (Cumulative Time = 0.6)
Index = 5, Level = 0, Time interval = 0.4, (Cumulative Time = 1.0)

Note as you build the segments that the pulse is being drawn on the screen as you type in the parameters and the specified point is marked with a red dot. Also note that the Cumulative Time column is updated automatically with the cumulative time lapse from the start of the pulse.

Section Structure
The term Section Structure is used to define part of the pulse train that share common properties. There are four parameters that can be programmed in this group: Index, Level, Time Interval and Cumulative Time.

Index – Is added automatically as you program pulse segments. The index line is highlighted as you point and click on pulse segments on the pulse editor screen.

Level – Specifies that peak level of the programmed segment. As you build the pulse, the level window is expended automatically to fit the required amplitude range. Note however, there is a limit to the level, which is being determined by the generator’s peak to peak specification.

Time Interval – Specifies the time that will lapse for the current index level. You can program the time interval and the cumulative time will be adjusted accordingly.

Cumulative Time – Specifies the time that will lapse from the start of the current pulse section. You can program the cumulative time and the time interval will be adjusted accordingly.

Section Properties
The Section Properties contains a summary of properties that are unique for the current section.

Design Units – Provide information on the units that are used when you draw the pulse segments. These units can be changed in the pulse editor options.

Section Start – Provides timing information for the start of the current section. If this is the first pulse section the value will always be 0. Subsequent sections will show the start mark equal to the end mark of the previous section.

Repeat – Allows multiplication of pulse segments without the need to re-design repetitive parts. After you enter a repeat value, press the Apply button to lock in the repeat multiplier.

Duration – Displays the time that will lapse from the start of the pulse section to the end. The duration shows the total time lapse, including the repeated sections.

Control Buttons

The control buttons allow appending, inserting, and deleting one or all index lines. The Undo button is useful in cases where an error was made and restoration of the last operation is critical.

Pulse Example, Section 1

Now that we are better familiar with the pulse editor and its options, we are ready to start building the first section of the pulse as shown in Figure 3-47. Point and click on the New icon and open the pulse editor. Type in the level and time intervals as shown in Figure 3-47. Note that the pulse segments are being created on the screen as you type the values.

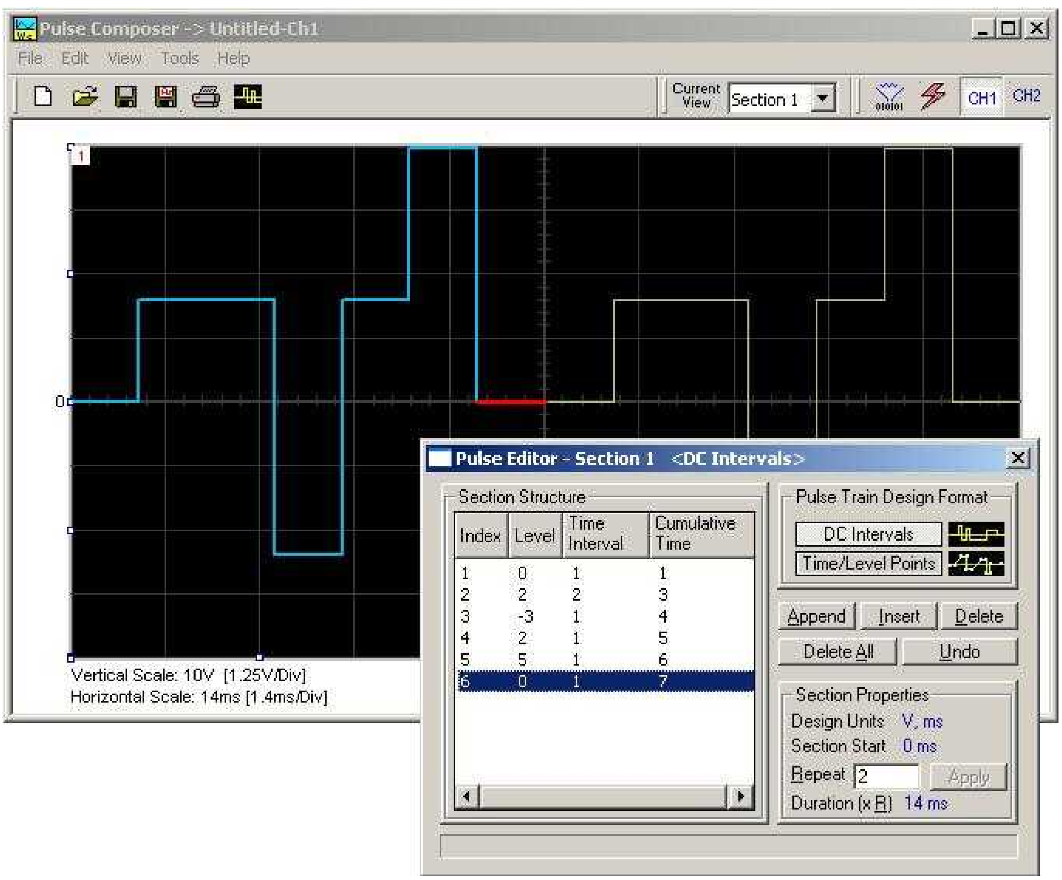

Figure 3-47, Building Section 1 of the Pulse Example

Tips

1. Use the tab button to edit the Section Structure fields.
2. Use Append to add an index line at the end of the list.
3. Use insert to add a segment above a focused line.

Before we proceed with the design of the next section, pay attention to some values that are now available on the composer screen. On the left bottom corner of the composer, Vertical Scale is showing 10 V (1.25 V/Div) and Horizontal Scale is showing 14 ms (1.4 ms/Div). These two values are critical for the integrity of the design because they are later being interpreted by the program and converted to waveform coordinates that the generator can process and output as a pulse shape. These values, may change as you add more sections to the pulse train.

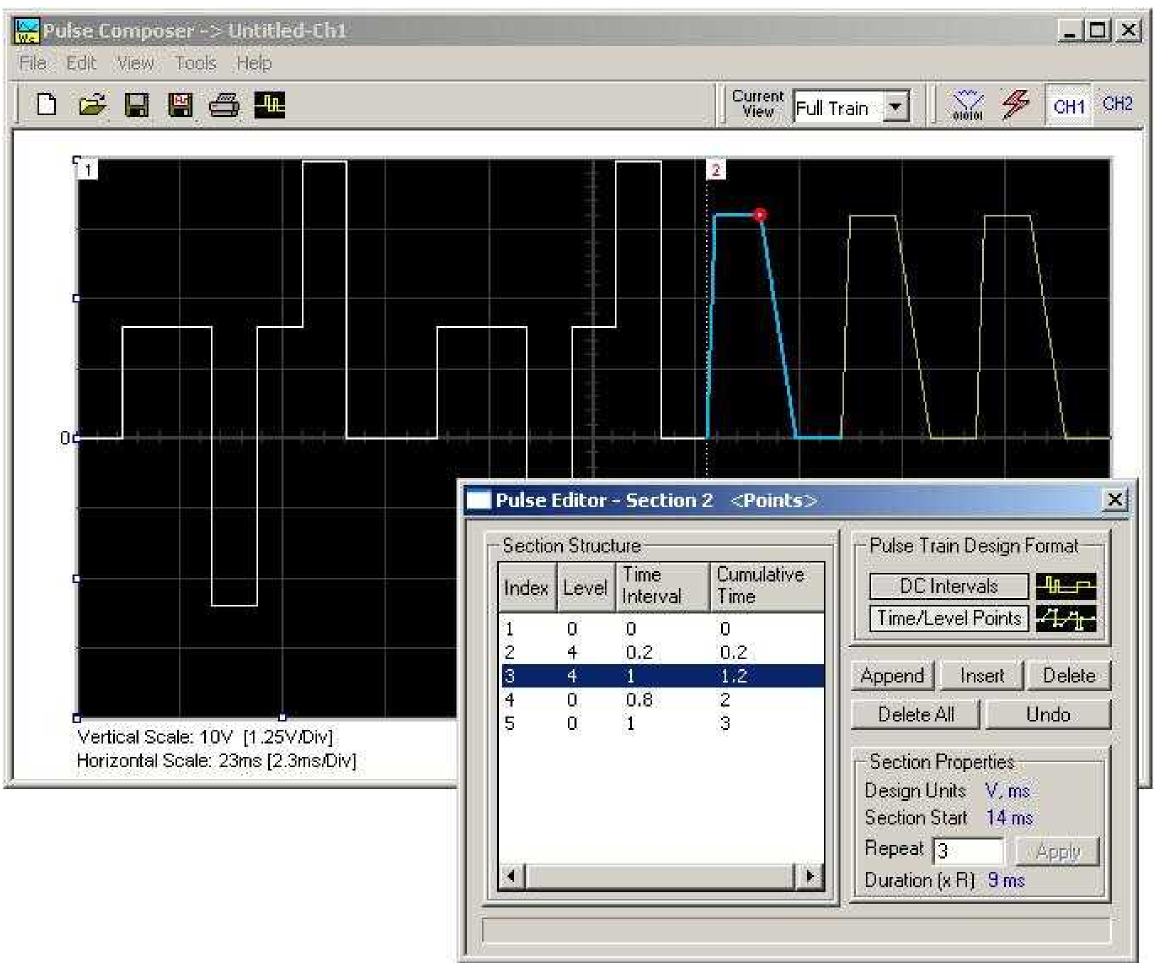

Figure 3-48, Building Section 2 of the Pulse Example

Pulse Example, Section 2

The first pulse section is complete. We are ready now to start building the second section of the pulse as shown in Figure 3-48. Point and click on the Edit command and select the Append Section option. A new section number will appear but it will show empty next to the section identifier.

Before you start entering values to this section, note that there are linear transitions required for this section. Therefore, select the Time/Level Points option in the Pulse Train Design Format. You are now ready to start programming values. In case you made a mistake and want to switch design formats after you have already typed in some values, the Pulse Editor will show an error alerting you that design format can only be changed for empty section. In this case, the only way to recover is to delete all entries and start from an empty index list. Type the section entries as shown in Figure 3-44.

Pulse Example, Section 3

The second pulse section is complete. We are ready now to start building the third section of the pulse as shown in Figure 3-44. Point and click on the Edit command and select the Append Section option. A new section number will appear but it will show empty next to the section identifier.

Before you start entering values to this section, note that there are fast transitions required for this section. Therefore, select the DC Intervals option in the Pulse Train Design Format. You are now ready to start programming values. In case you made a mistake and want to switch design formats after you have already typed in some values, the Pulse Editor will show an error alerting you that design format can only be changed for empty section. In this case, the only way to recover is to delete all entries and start from an empty index list. Type the section entries as shown in Figure 3-49.

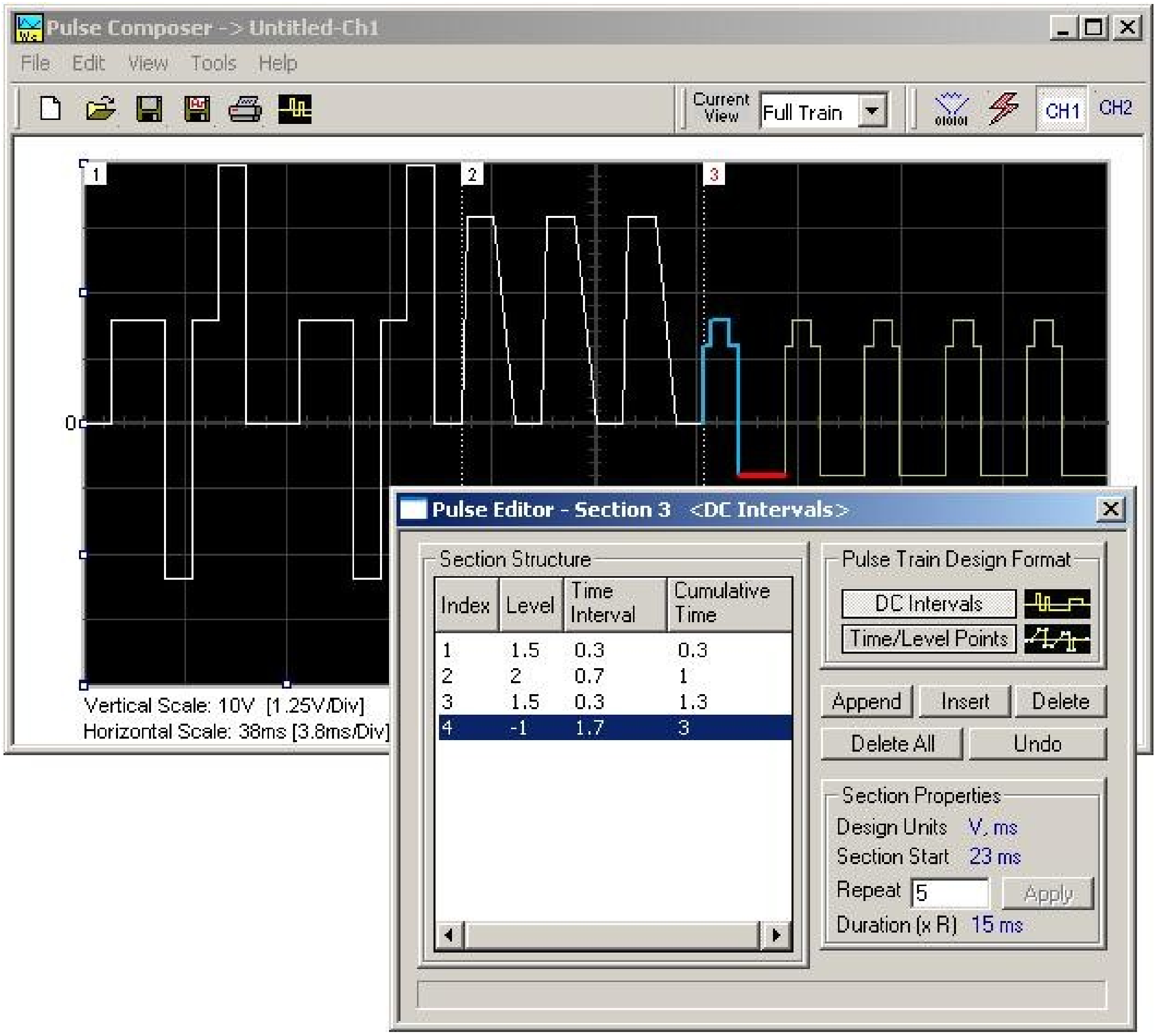

Figure 3-49, Building Section 3 of the Pulse Example

Pulse Example, Section 4

The third pulse section is complete. We are ready now to start building the forth section of the pulse as shown in Figure 3-44. Point and click on the Edit command and select the Append Section option. A new section number will appear and will show empty next to the section identifier.

Before you start entering values to this section, note that there is only one linear transition required for this section that will start from the last point of the previous section and will connect to the start point of the next section. Therefore, select the Time/Level Points option in the Pulse Train Design Format. You are now ready to start programming values. Type the section entries as shown in Figure 3-50.

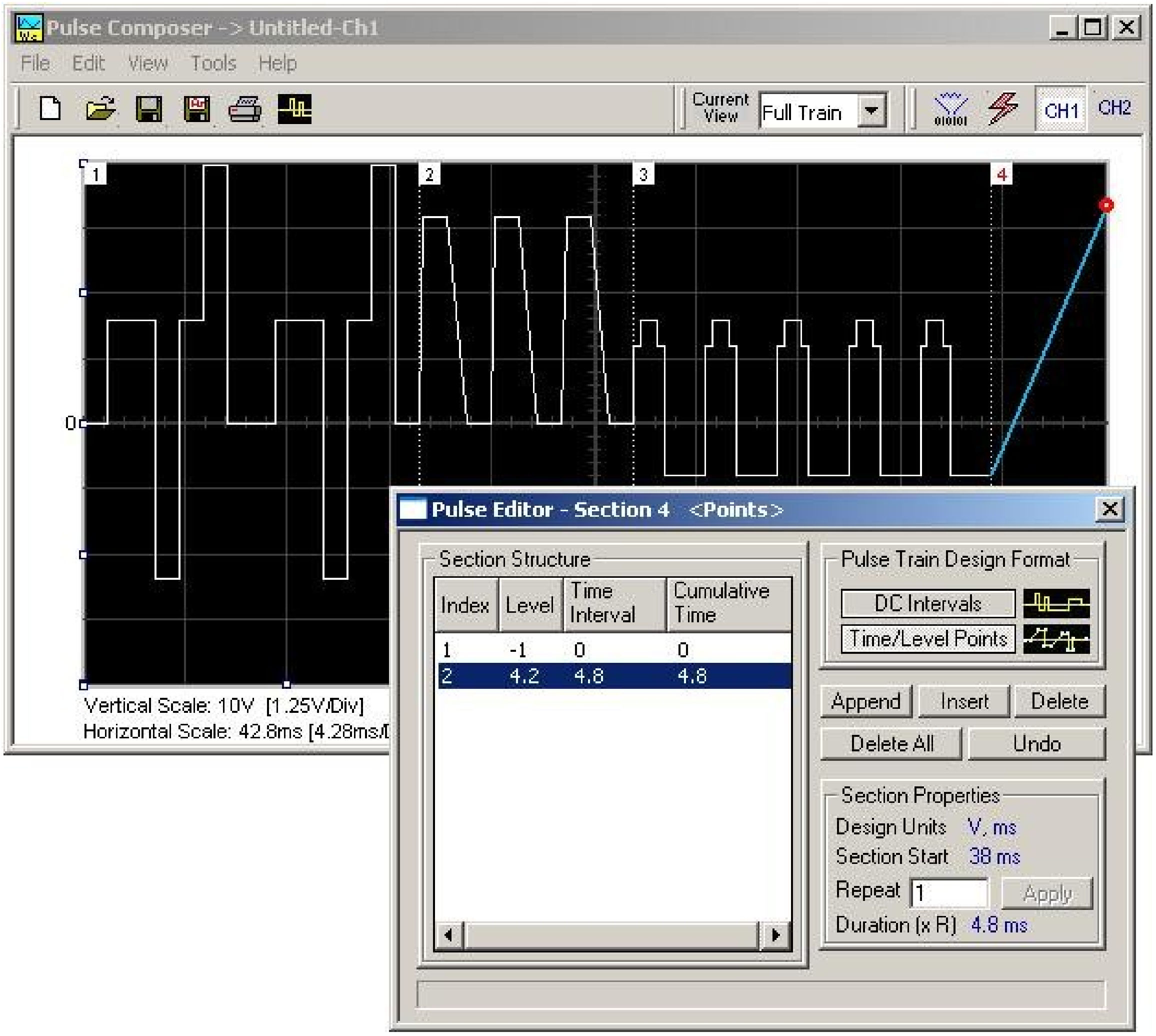

Figure 3-50, Building Section 4 of the Pulse Example

Pulse Example, Section 5

The fourth pulse section is complete. We are ready now to start building the fifth and final section of the pulse as shown in Figure 3-44. Point and click on the Edit command and select the Append Section option. A new section number will appear and will show empty next to the section identifier.

Note that there are fast transitions required for this section that will start from the last point of the previous section and will connect to the start point of the next section. Therefore, select the Time/Level Points option in the Pulse Train Design Format. You are now ready to start programming values. Type the section entries as shown in Figure 3-51.

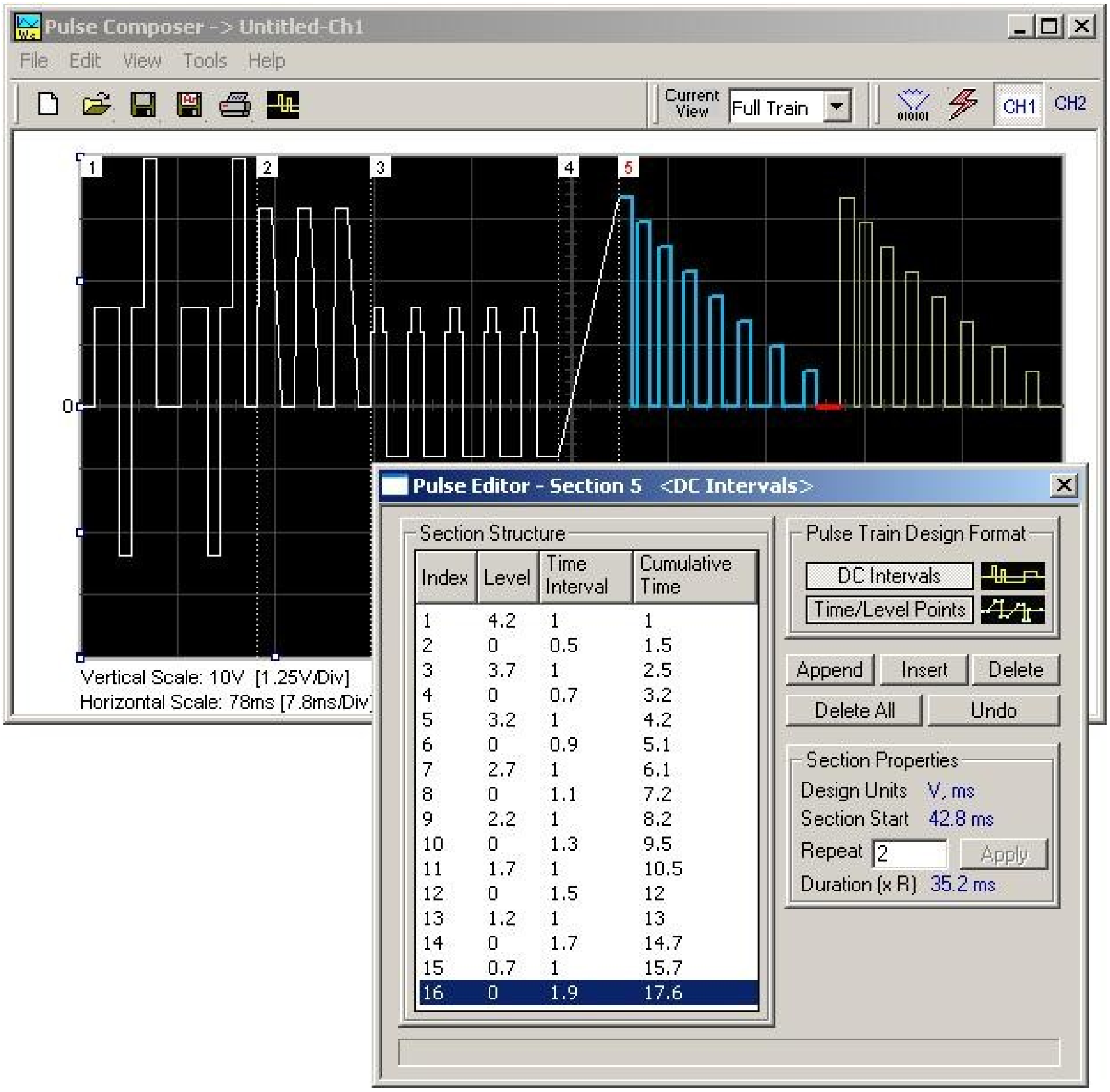

Figure 3-51, Building Section 5 of the Pulse Example

Downloading the Pulse Train

Congratulations for coming that far. If you followed the above description how to build this pulse example, the screen should look exactly as shown in Figures 4-43 and 4-51. If you are happy with the results, the next step is to download what you see on the pulse composer screen to the generator.

One more step before you download the waveform to the instrument is to check the Pulse Train Download Summary as appears after you press the Download icon. You can also view the same information if you select it from the View menu. Refer to Figure 3-52 for information how to interpret your download summary.

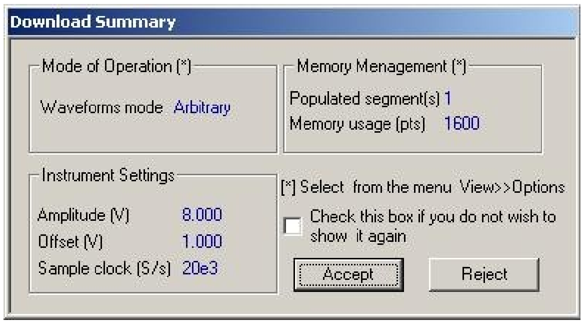

Figure 3-52, the Pulse Editor Download Summary

Interpreting the Download Summary

It is very important for you to understand that when you download a pulse waveform from the pulse composer, parameters and mode of operation may change settings on your generator. The download summary shows what will change and will let you reject the new settings if you do not agree to the changes. Once you press the Accept button, the waveform will be downloaded to the generator and the modes and parameters updated as shown in the dialog box. If you are already familiar with the changes and do not care to see the download summary every time you download a pulse waveform, you can check the box and it will not be shown on your next download. You can restore this summary from the View>>Download Summary command.

Mode of Operation – This describes the new setting of the operating mode. This field could display one of two options: Arbitrary or sequenced. Pay attention to the note (*) that says “Select from the menu View>>Options” Since we checked the Force Pulse Train to Single Segment (see Figure 3-46), the generator determines that the waveform mode be arbitrary and only one segment can be loaded with the pulse train.

Memory management – By selecting the arbitrary mode of operation, the pulse train is forced to a single segment. This summary shows which segment has been populated and how much memory was used to build the required pulse train.

Instrument Settings – Show the amplitude, offset and sample clock settings that will be changed on the generator. The settings in this summary cannot be affected from the pulse editor options settings. These are being computed and modified specifically for the current pulse train pattern and will change from pattern to pattern.

Accept/Reject – These buttons are the final step before you download the pulse train to the instrument. If you are unhappy with the instrument setting and want to change some of the options, there is still time Point and click on the Reject button and go do your changes. Point and click on the Accept button to complete the download process.

The FM Composer

The FM Composer looks and feels almost like the waveform composer except there is a major difference in what it does. If you look at the opening screen as shown in Figure 4-53, you'll see that the vertical axis is marked with frequencies. You'll see later that as you draw waveforms on the FM composer screen, these waveforms represent frequency changes and not amplitude changes as are generated by the waveform composer.

The FM composer is a great tool for controlling frequency agility by generating the agility curve as an arbitrary waveform. For example, if you create a sine waveform, the 5251 will generate frequency-modulated signal that will follow the sine pattern. The resolution and accuracy of the modulated waveform is unsurpassed and can only be duplicated by mathematical simulation. The FM composer is loaded with many features and options so use the following paragraphs to learn how to create and download modulating waveforms to the 5251 using the FM Composer.

Invoke the FM Composer from Panels bar. The Wave Composer has three sections: Commands bar, Toolbar and Waveform screen. Refer to Figure 3-53 throughout the description of these parts.

The Commands bar

The commands bar is exact duplication of the commands bar in the Wave composer. It provides access to standard Windows commands such as File and View.

In general, clicking on one of the commands opens a dialog box with an additional list of commands. Then, clicking on an additional command, may open a dialog box, or generate an immediate action. For example, Clicking on File and then Exit will cause an immediate termination of the FM Composer. On the other hand, clicking on Wave and then on Square, will open a Square Wave dialog box that lets you program and edit square wave parameters. The various commands in the Commands bar are listed and described below.

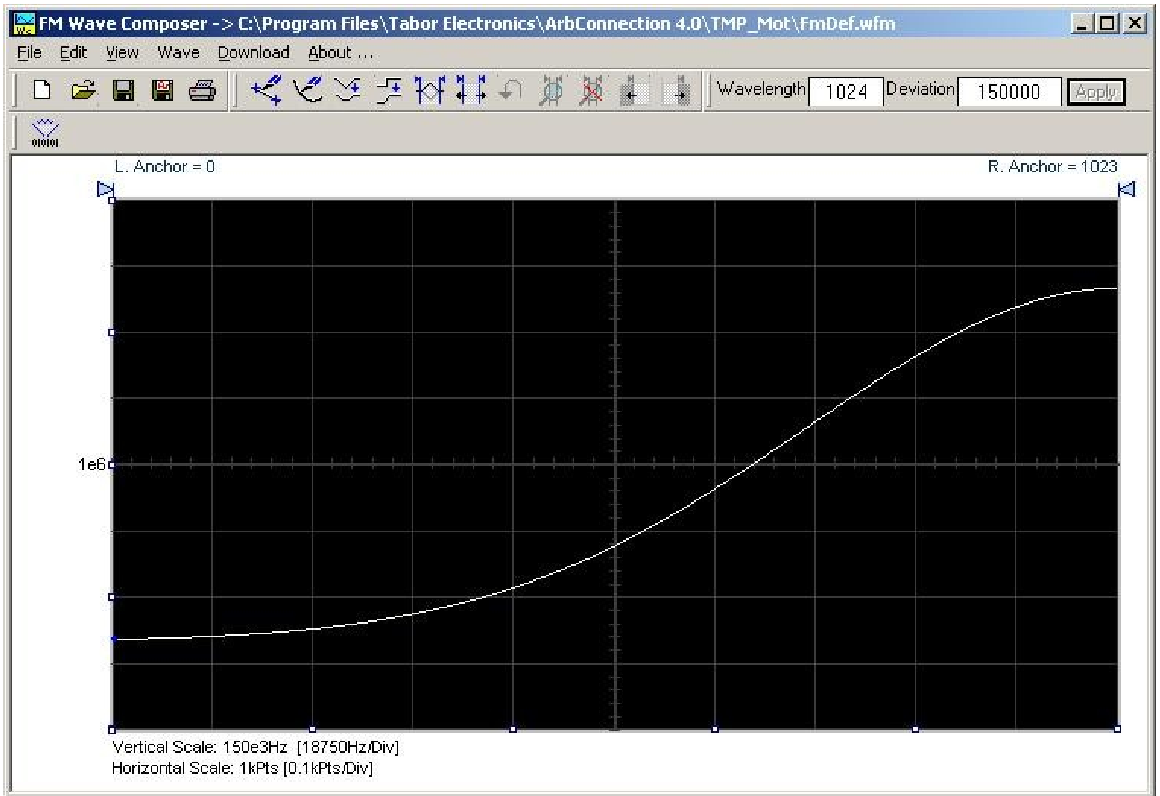

Figure 3-53, The FM Composer opening Screen

File Commands

The File command has 4 command lines that control waveform files. Also use this command to exit the FM composer program. Description of the various commands under File is given below.

New Waveform

The New Waveform command will remove the waveform from the screen. If you made changes to the waveform area and use this command, you should save your work before clearing the screen. The New Waveform command is destructive to the displayed waveform.

Open Waveform…

The Open Waveform… command will let you browse your disk for previously saved waveform files and load these waveforms to the waveform area. This command is also very useful for converting waveform files to format that is acceptable by the Wave Composer.

Save Waveform

The Save Waveform command will store your active waveform in your 5251 directory, as a binary file with a *.wvf extension. If this is the first time you save your waveform, the Save Waveform As… command will be invoked automatically, letting you select name, location and format for your waveform file.

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

Print
With this command you may print the active Waveform Window. The standard printer dialog box will appear and will let you select printer setup, or print the waveform page.

Exit
The Exit command ends the current FM Composer session and takes you back to the Panels screen. If you made changes to your waveform since it was last saved, make sure to Save your work before you use this command.

Wave Commands

The Wave commands let you create waveforms on the screen. The Wave command has a library of 6 waveforms: Sine, Triangle, Square, Exponent, Pulse, and Noise. It also lets you create waveforms using an Equation editor. Information how to create waveforms using the Wave commands is given below.

Creating Waveforms From the Built-in Library
You can create any waveform from the built-in library using the Wave command. Clicking on one of the Wave options will open a dialog box. An example of the Sine waveform dialog box is shown in Figure 3-54. This dialog box is representative of the rest of the waveforms, so other waveforms will not be described.

Creating Sine Waveforms
Use the following procedure to create sine waveforms from the built-in library. Click on Wave, then sine… the dialog box as shown in Figure 3-54 will appear. You can now start programming parameters that are available in this box.

Start Point Anchor – Defines the first point where the created wave will start. Note that if you change the start point the left anchor will automatically adjust itself to the selected start point. The example shows start point set at point 200.

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

Max. Peak Deviation – This parameter defines the forward peak deviation. Note that the forward peak deviation cannot exceed the pre-defined Deviation parameter as shown on the Toolbar. In case you need to exceed the pre-defined peak value you must quit this box and modify the Deviation parameter to provide sufficient range for the forward peak deviation range.

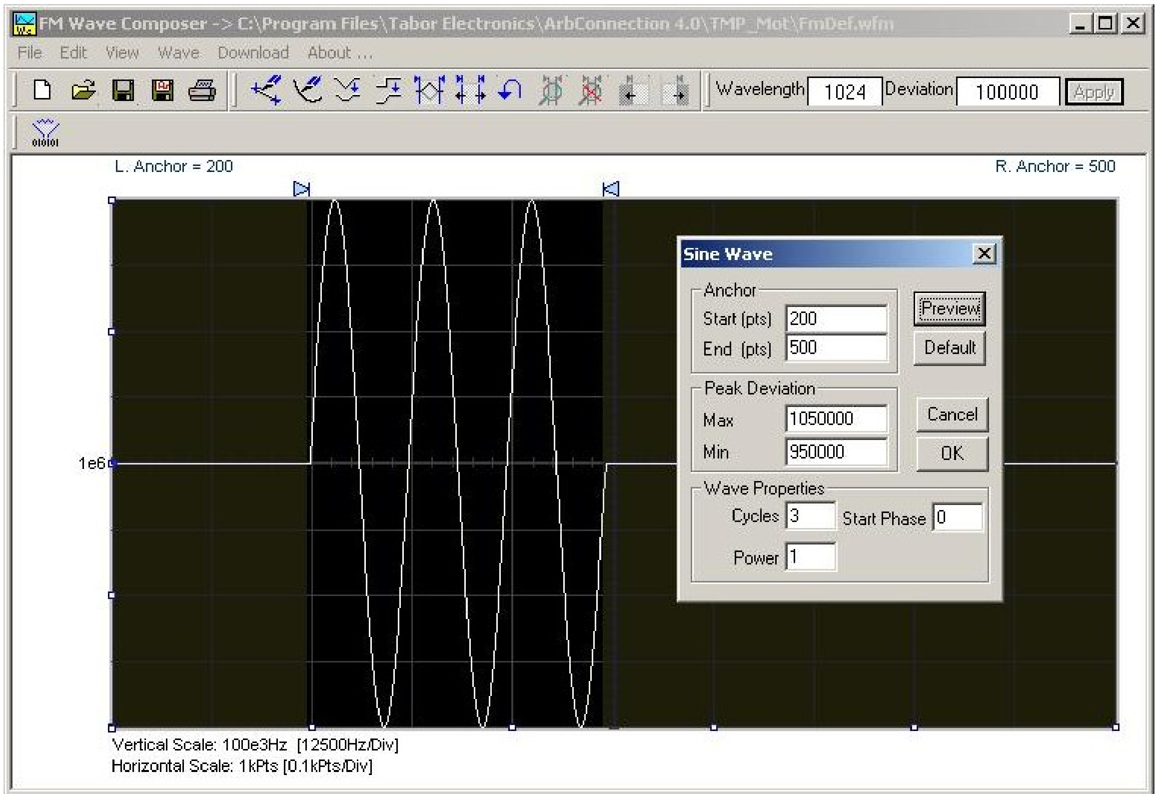

Figure 3-54, Generating Sine Modulation Using the FM Composer

Min. Peak Deviation – This parameter defines the backwards peak deviation. Note that the backwards peak deviation cannot exceed the pre-defined Deviation parameter as shown on the Toolbar. In case you need to exceed the pre-defined peak value you must quit this box and modify the Deviation parameter to provide sufficient range for the backwards peak deviation range.

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

Start Phase – The start phase parameter defines the angle of which the sine will start. The example shows 0° start phase.

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

Tip

The functionality of the FM composer is similar to the Wave composer. If you need more information on the FM composer functions, features and it equation editor, refer to the Wave composer section in this manual information.

The 3D Composer

The 3D Composer was specifically designed for simultaneous profiling of amplitude, frequency and phase. Amplitude profiles can be designed separately for channels 1 and 2, but frequency and phase profiles are shared by both channels. The following paragraphs will describe the various sections of the 3D composer and will guide you through some 3D programming examples.

The opening screen of the 3D composer is shown in Figure 3-55. As you can see it does not at all look like any of the other composers that were described previously discussed however, generating waveforms and programming profiles is very similar to other composer so you will be up and running in no time.

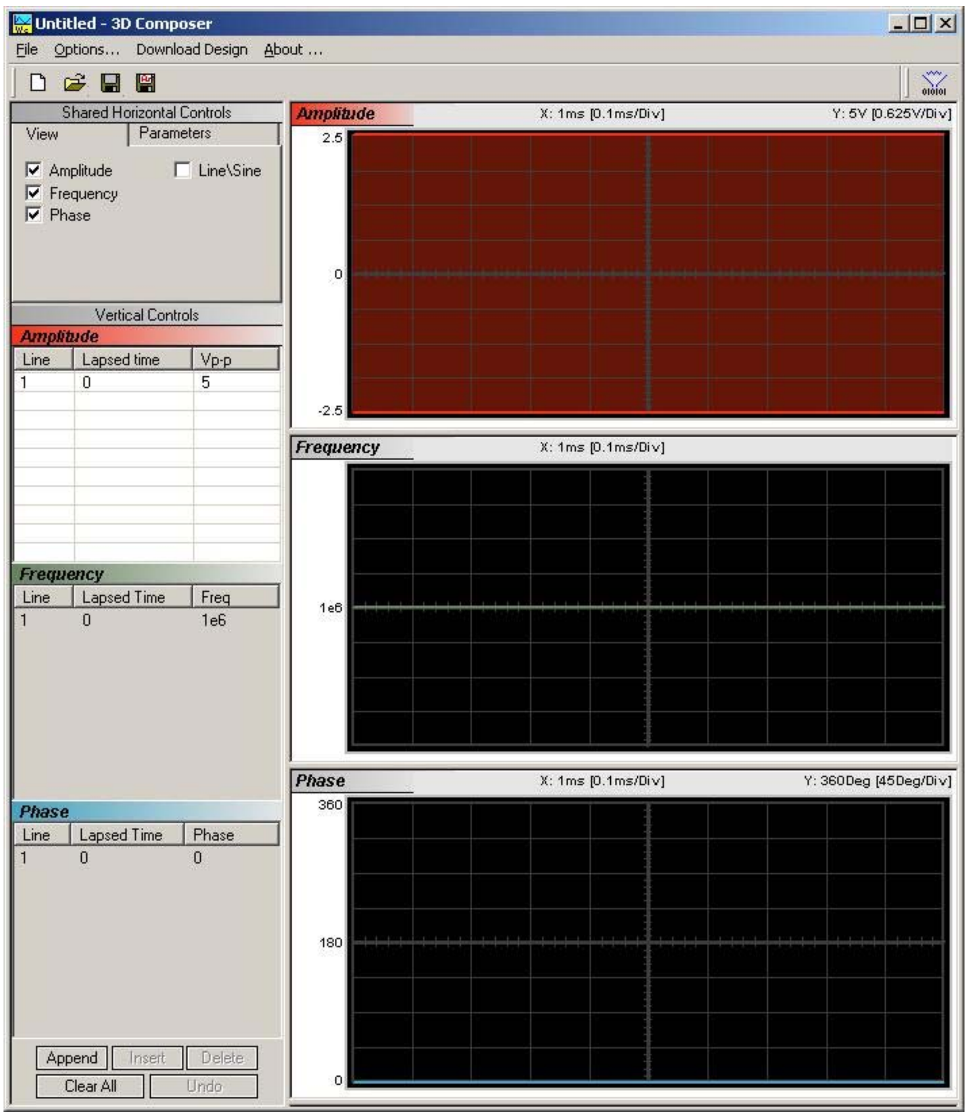

Figure 3-55, the 3D Composer Screen

The 3D composer has three main sections: Shared horizontal Controls, Vertical Controls and Graphical Screens. The panels on the left are used for designing the waveform parameters and the screens on the right side depict the shape of the profile. Below find a detailed description of all of these sections. Refer to Figure 3-55 throughout the description.

Shared Vertical Parameters

The *Shared Horizontal Control* has two tabs: *View* and *Parameters*.

View
The *View* tab is useful if you are interested in programming 1 or two profiles only and do not care to see other screens. Check the boxes for the profiles you wish to program only and these will be shown on the screen. For example, if you check the Amplitude and the Frequency options, the Phase screen will not be visible.

Parameters
The *Parameters* tab is used for setting up the duration of the signal, the position of the marker (if required) and the amount of memory that is allocated for this purpose. Setting up correctly the parameters in this group is the basic and the most important task before you start designing 3D waveforms. The duration can be set in units of ns, us, ms and seconds and can be programmed within the range of 800 ns to 30,000 s.

The 3D profiler behaves just like an arbitrary waveform. The shape of the profiler is generated using waveform points and a dedicated 3D sample clock. So, just as the basics for an arbitrary waveform design, the duration is derived from the following relationship:

Duration = SCLK / # of waveform points

where SCLK is the 3D sample clock and the # of waveform points can be programmed from 2 to 30,000.

Figure 3-56, the Parameters Tab

The best idea is to let the 3D composer set up the sample clock and the number of points automatically for you however, in some cases you may fine tune your requirement by pressing the Expand button. Figure 3-57 shows the Expanded Parameters options dialog box.

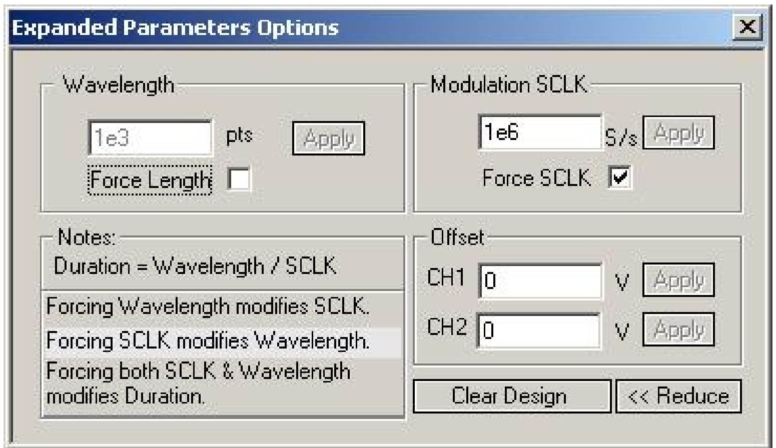

Figure 3-57, the Expanded Parameters Options Dialog Box

The Expanded Parameters options dialog box has three sections: Wavelength, Modulation SCLK and Offset. The wavelength and the modulation SCLK control the duration of the entire wave through the following relationship:

Duration = Modulation SCLK / Wavelength

Each of the parameters has a finite length and therefore, the duration has maximum and minimum intervals. The modulation SCLK has a range of 1 Hz to 2.5 MHz and the Wavelength is limited from 2 points to 30,000 points. As a result, the duration can be programmed from 800 ns to 30,000 s.

If you do not care to control the wavelength and the SCLK, then you can leave the task for the 3D composer. In that case you must leave the Force Length and Force SCLK check boxes – unmarked. If you check the Force SCLK box, the wavelength will be modified automatically to match the selected duration, as shown in Figure 4-62. If you check the Force Length box, the modulation SCLK will be modified automatically to match the selected duration. Finally, if you check both the Force Length and the Force Modulation SCLK boxes, the duration of the 3D profile will be affected.

To modify wavelength or modulation SCLK, check the appropriate box, modify the value and click on the Apply button to force the selected value. Any successive changes that you make to the edit fields require that you click on the Apply button to accept the new value.

The Offset group controls DC offsets of the modulated waveform. Changing offset does not affect other parameters except the location of the waveform along the vertical axis.

The Clear Design button resets the 3D composer and the Reduce button closes the dialog box.

Vertical Controls

The *Vertical Controls* are used for profiling amplitude, frequency and phase. When you modify the fields in any of the controls, the associated graphical screen are automatically updated with the assigned values and display the profile as designed in the vertical control fields. The Vertical Controls are shown in Figure 4-58. You can start designing profiles only when one of the control fields is active. Control fields become active when you click on a control field.

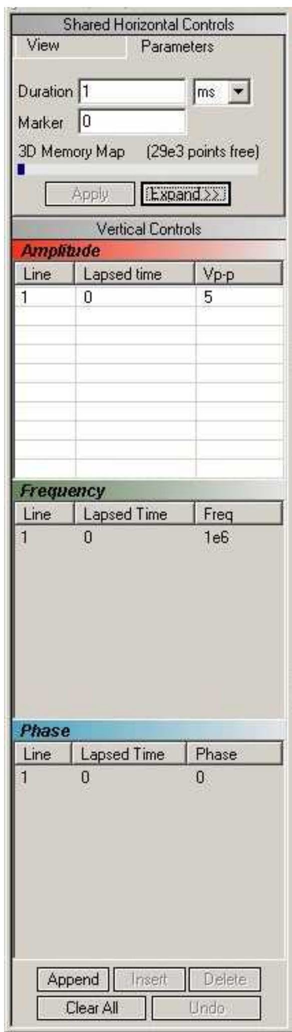

Figure 3-58, the 3D Vertical Controls

Graphical Screens

The *Graphical Screens* are shown in Figure 3-59. You can not change anything on the screens however, anything that you design in the Vertical Controls fields will automatically be updated and displayed on the graphical screens.

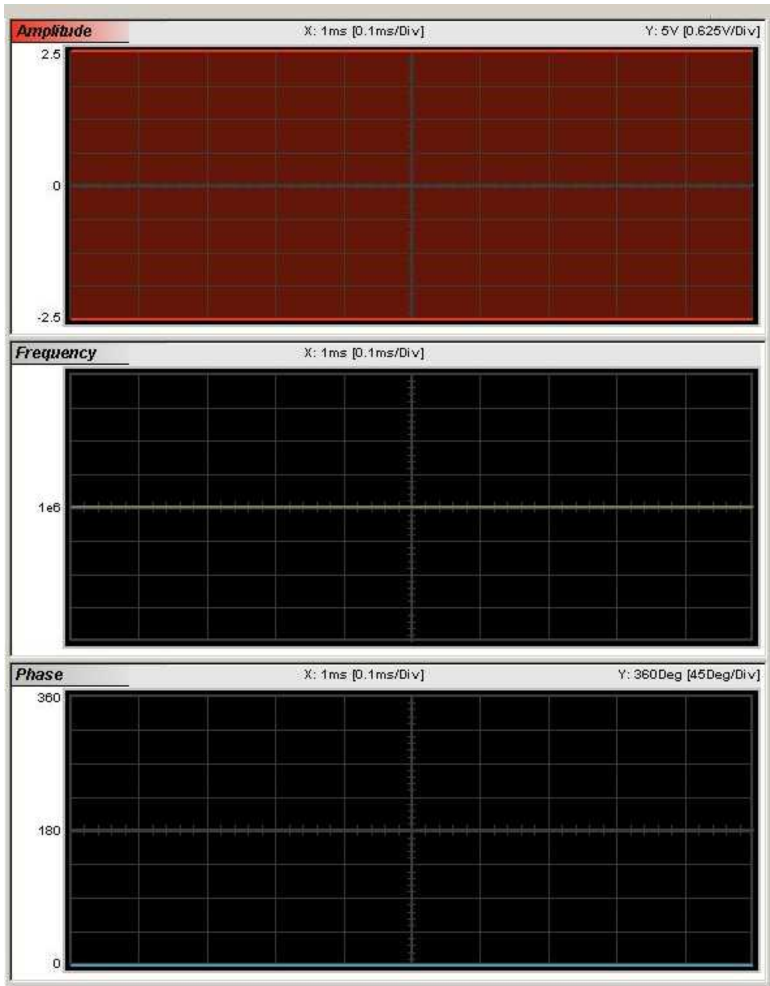

Figure 3-59, the 3D Graphical Screens

Designing 3D profiles

3D profiles are designed in the Vertical Controls fields. Notice that there are four separate control fields: Amplitude, Frequency and Phase.

Always start the design from the Shared Horizontal Controls group. In the View group, remove profiles that you do not care to design. Click on the Parameters tab and set up the duration of the waveform. An example of a 3D profile (chirp, in this example) is shown in Figure 3-60. As you can see the duration of the waveform was selected to be 100 ms.

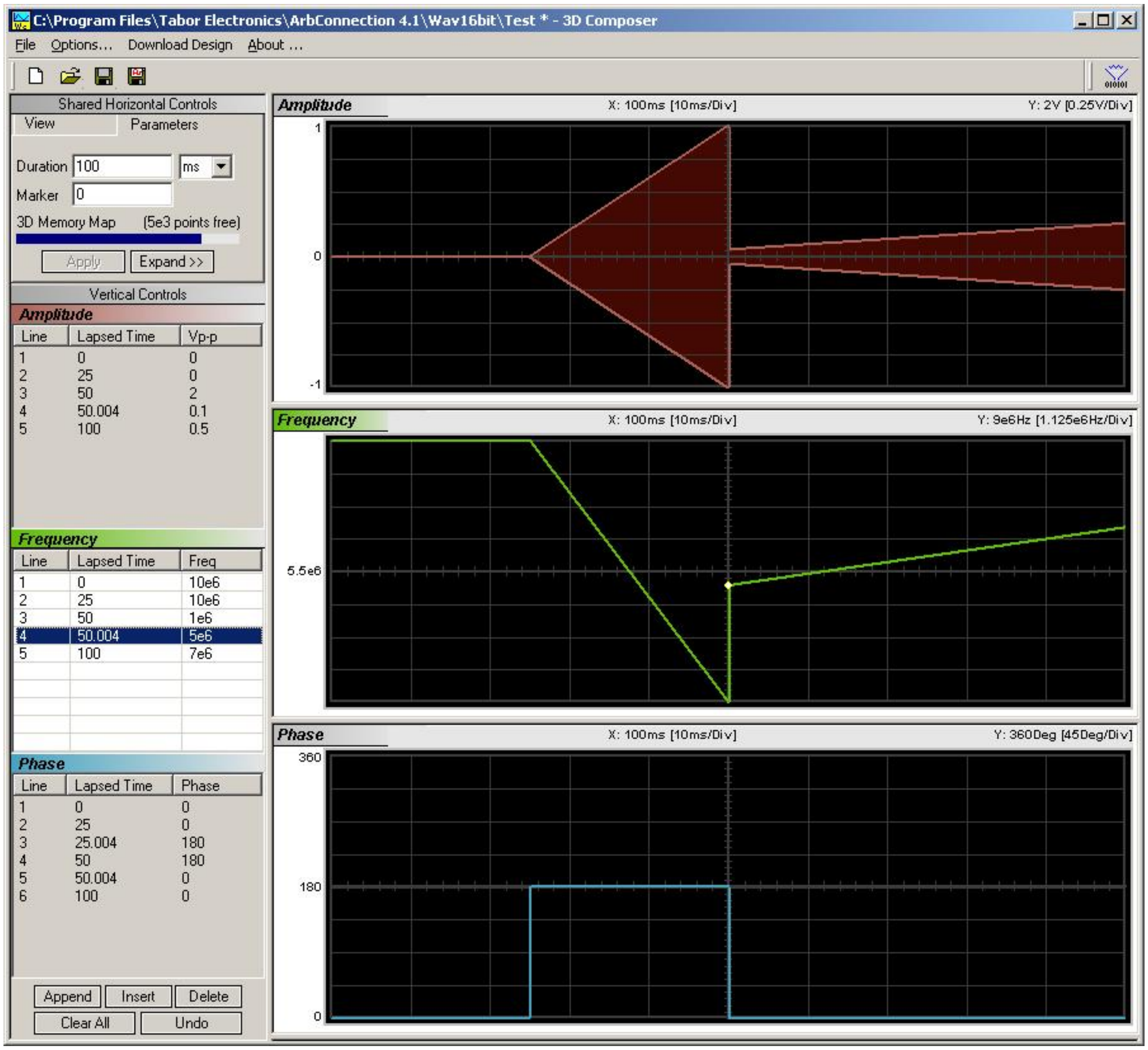

Figure 3-60, 3D Chirp Design Example

The Command Editor

The Command Editor is an excellent tool for learning low level programming of the 5251. Invoke the Command Editor from the System menu at the top of the screen. Dialog box, as shown in Figure 3-61 will pop up. If you press the Download button, the function call in the Command field will be sent to the instrument.

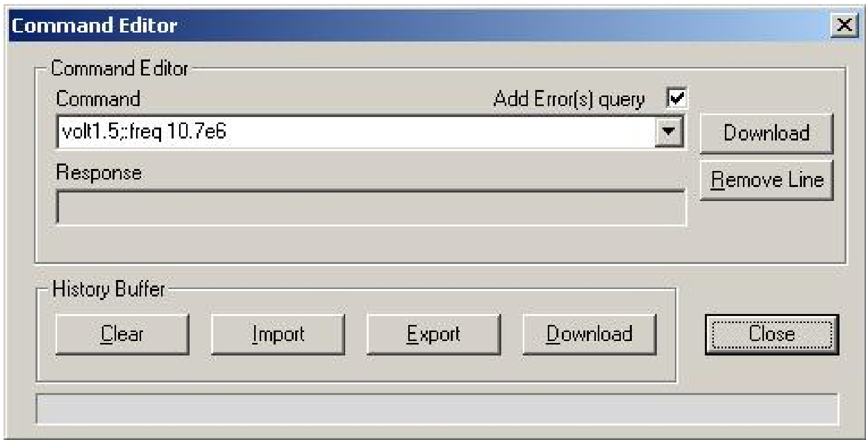

Figure 3-61, the Command Editor

Low-level SCPI commands and queries can be directly sent to the 5251 from the **Command** field and the instrument will respond to queries in the **Response** field. The command editor is very useful while developing your own application. Build your confidence or test various commands using the command editor. This way you can assure that commands or syntax that you use in your application will behave exactly the same way as it responds to the editor commands. A complete list of SCPI commands is available in the programming chapter of this manual.

Logging SCPI Commands

The Log File is very useful for programmers that do not wish to spend a lot of time on manuals. When you use ArbConnection, every time you click on a button or change parameter, the command is logged in the same format as should be used in external applications. Figure 3-62 shows an example of a log file and a set of SCPI commands as resulted from some changes made on ArbConnection panels. You can set up the 5251 from ArbConnection to the desired configuration, log the commands in the log file and then copy and paste to your application without any modifications. Of course, this is true for simple commands that do not involve file download but, on the other hand, this is a great tool to get you started with SCPI programming.

Figure 3-62, Log File Example

Chapter 4
Remote Programming Reference

Title	Page

What's in This Chapter

This Chapter lists and describes the set of SCPI-compatible (Standard Commands for Programmable Instruments) remote commands used to operate the 5251. To provide familiar formatting for users who have previously used the SCPI reference documentation, the command descriptions are dealt with in a similar manner. In particular, each sub-system's documentation starts with a short description, followed by a table showing the complete set of commands in the sub-system; finally the effects of individual keywords and parameters are described. Complete listing of all commands used for programming the 5251 is given in Table 4-1.

What is Required

To successfully use this instrument, the following conditions must be met:

1. The instrument is installed (and detected) in the PXI mainframe.
2. Visa 4.0 or later is installed.
3. IVI driver is installed.
4. ArbConnection 4.3 or later is installed.

Installation of one of the IVI driver or ArbConnection is mandatory and critical to the operation of the instrument as it places the control dll in the appropriate directory. Installation procedure of the 5251 and its controlling software can be found in the installation chapter of this manual. Even if you do not intend to use the IVI driver, nor will you use ArbConnection, it is suggested that you install both anyway and first operate the instrument through one of these utilities to make sure the 5251 responds correctly to commands and queries.

Both the IVI driver and ArbConnection are using built-in functions that convert standard SCPI commands to machine code. Knowledge of basic SCPI programming and concepts is required to operate the instrument and hence the short introduction to SCPI programming that is given below. If you are not sure what SCPI programming is use the log file in ArbConnection and select the show commands only; This will give you an overview on how commands control various operations of the instrument.

Introduction to SCPI

Commands to program the instrument over the GPIB are defined by the SCPI 1993.0 standard. The SCPI standard defines a common language protocol. It goes one step further than IEEE-STD-488.2 and defines a standard set of commands to control every programmable aspect of the instrument. It also defines the format of command parameters and the format of values returned by the instrument.

SCPI is an ASCII-based instrument command language designed for test and measurement instruments. SCPI commands are based on a hierarchical structure known as a tree system. In this system, associated commands are grouped together under a common node or root, thus forming subsystems.

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

```
:OUTPut
  :FILTer
     [:LPASs] {NONE|25M|50M|ALL}
        [:STATe] OFF | ON
```

OUTPut is the root keyword of the command; FILTer and STATe are second level keywords. LPASs is third level keyword. A colon (:) separates a command keyword from a lower level keyword.

Command Format

The format used to show commands in this manual is shown below:

```
FREQuency {<frequency>|MINimum|MAXimum}
```

The command syntax shows most commands (and some parameters) as a mixture of upper and lowercase letters. The uppercase letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, use the long form.

For example, in the above syntax statement, FREQ and FREQUENCY are both acceptable forms. Use upper or lowercase letters. Therefore, FREQ, FREQUENCY, freq, and Freq are all acceptable. Other forms such as FRE and FREQUEN will generate an error.

The above syntax statement shows the frequency parameter enclosed in triangular brackets. The brackets are not sent with the command string. A value for the frequency parameter (such as "FREQ 50e+6") must be specified.

Some parameters are enclosed in square brackets ([]). The brackets indicate that the parameter is optional and can be omitted. The brackets are not sent with the command string.

Command Separator

A colon (:) is used to separate a command keyword from a lower level keyword as shown below:

```
SOUR:FUNC:SHAP SIN
```

A semicolon (;) is used to separate commands within the same subsystem, and can also minimize typing. For example, sending the following command string:

```
TRIG:SLOP NEG;COUN 10;LEV -1
```

is the same as sending the following three commands:

```
:TRIG:SLOP NEG
:TRIG:COUN 10
:TRIG:LEV -1
```

Use the colon and semicolon to link commands from different subsystems. For example, in the following command string, an error is generated if both the colon and the semicolon are not used.

```
OUTP:STATE ON;:TRIG:BURS ON
```

The MIN and MAX 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.

Querying Parameter Setting

Query the current value of most parameters by adding a question mark (?) to the command. For example, the following command sets the output function to square:

```
SOUR:FUNC:SHAP SQR
```

Query the output function by executing:

```
SOUR:FUNC:SHAP?
```

Query Response Format

The response to a query depends on the format of the command. In general, a response to a query contains current values or settings of the generator. Commands that set values can be queried for their current value. Commands that set modes of operation can be queried for their current mode. IEEE-STD-488.2 common queries generate responses, which are common to all IEEE-STD-488.2 compatible instruments.

SCPI Command Terminator

A command string sent to the function generator must terminate with a <new line> character. The IEEE-STD-488 EOI message is a <new line> character. Command string termination always resets the current SCPI command path to the root level.

IEEE-STD-488.2 Common

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

Commands

command keyword is separated from the first parameter by a blank space. Use a semicolon (;) to separate multiple commands as shown below:

```
*RST; *STB?; *IDN?
```

SCPI Parameter Type

The SCPI language defines four different data formats to be used in program messages and response messages: numeric, discrete, boolean, and arbitrary block.

Numeric Parameters

Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation. Special values for numeric parameters like MINimum and MAXimum are also accepted.

Engineering unit suffices with numeric parameters (e.g., MHz or kHz) can also be sent. If only specific numeric values are accepted, the function generator will ignore values, which are not allowed and will generate an error message. The following command is an example of a command that uses a numeric parameter:

```
VOLT:AMPL <amplitude>
```

Discrete Parameters

Discrete parameters are used to program settings that have a limited number of values (i.e., FIXed, USER and SEQuence). They have short and long form command keywords. Upper and lowercase letters can be mixed. Query responses always return the short form in all uppercase letters. The following command uses discrete parameters:

```
SOUR:FUNC:MODE {FIXed | USER | SEQuence}
```

Boolean Parameters

Boolean parameters represent a single binary condition that is either true or false. The generator accepts "OFF" or "0" for a false condition. The generator accepts "ON" or "1" for a true condition. The instrument always returns "0" or "1" when a boolean setting is queried. The following command uses a boolean parameter:

```
OUTP:FILT { OFF | ON }
```

The same command can also be written as follows:

```
OUTP:FILT {0 | 1 }
```

Arbitrary Block Parameters

Arbitrary block parameters are used for loading waveforms into the generator's memory. Depending on which option is installed, the Model 5251 can accept binary blocks up to 1M bytes. The following command uses an arbitrary block parameter that is loaded as binary data:

```
TRAC:DATA#564000<binary_block>
```

Binary Block Parameters

Binary block parameters are used for loading segment and sequence tables into the generator's memory. Information on the binary block parameters is given later in this manual.

SCPI Syntax and Styles

Where possible the syntax and styles used in this section follow those defined by the SCPI consortium. The commands on the following pages are broken into three columns; the KEYWORD, the PARAMETER FORM, and any NOTES.

The KEYWORD column provides the name of the command. The actual command consists of one or more keywords since SCPI commands are based on a hierarchical structure, also known as the tree system. Square brackets ([ ]) are used to enclose a **keyword** that is optional when programming the command; that is, the 5251 will process the command to have the same effect whether the optional node is omitted by the programmer or not. Letter case in tables is used to differentiate between the accepted short form (upper case) and the long form (upper and lower case).

The PARAMETER FORM column indicates the number and order of parameter in a command and their legal value. Parameter types are distinguished by enclosing the type in angle brackets (< >). If **parameter** form is enclosed by square brackets ([ ]) these are then optional (care must be taken to ensure that optional parameters are consistent with the intention of the associated keywords). The vertical bar (|) can be read as "or" and is used to separate alternative parameter options.

Table 4-1, Model 5251 SCPI Commands List Summary

Keyword	Parameter Form	Default
Instrument Control Commands		
:OUTPut		
:LOAD	50 to 1e6	50
[:STATe]	OFF | ON | 0 | 1	0
:SYNC		
[:STATe]	OFF | ON | 0 | 1	0
:POSition	0 to 1999999	0
:FILTer		
[:LPASs]	NONE | 25M | 50M | 60M | 120M	NONE
[:SOURce]		
:ROSCillator		
:SOURce	INTernal | EXTernal	INT
:FREQuency		
[:CW]	10e-3 to 100e6 | MINimum | MAXimum	1e6
:RASTer	1.5 to 250e6 | MINimum | MAXimum	1e7
:SOURce	INTernal | EXTernal	INT
:VOLTage		
[:LEVel]		
[:AMPLitude]	100e-3 to 10 | MINimum | MAXimum	5
:OFFSet	-4.950 to 4.950	0
:FUNCtion		
:MODE	FIXed | USER | SEQuence | MODulation | COUNter | PULSe | HALFcycle	FIX
Standard Waveforms Commands		
:SHAPe	SINusoid | TRIangle | SQUare | PULSe | RAMP | SINC | GAUSsian | EXPonential | NOISe | DC	SIN
:SINusoid		
:PHASe	0 to 360.0	0
:TRIangle		
:PHASe	0 to 360.0	0
:SQUare		
:DCYCle	0 to 99.99	50
:PULSe		
:DELay	0 to 99.999	10
:WIDth	0 to 99.999	10
:TRANsition		
[:LEADing]	0 to 99.999	10
:TRAiling	0 to 99.999	10

Table 4-1, Model 5251 SCPI Commands List Summary (continued)

Keyword	Parameter Form	Default
:RAMP		
:DELay	0 to 99.99	0
:TRANsition		
[:LEADing]	0 to 99.99	60
:TRAiling	0 to 99.99	30
:SINC		
:NCYCle	4 to 100	10
:GAUSsian		
:EXPonent	10 to 200	20
:EXPonential		
:EXPonent	-100 to 100	1
:DC		
[:AMPLitude]	-5 to 5	5
Arbitrary Waveforms Commands		
:TRACe		
[:DATA]	<data_array>	
:DEFine	<1 to 10k>,<16 to 2e6> (<segment_#>,<size>)	1, 16
:DELete		
[:NAME]	1 to 10k	
:ALL		
:SELect	1 to 10k	1
:SEGMent		
[:DATA]	<data_array>	
Sequence Commands		
[:SOURce]		
:SEQuence		
[:DATA]	<data_array>	
:ADVance	AUTOmatic | STEP | SINGle | MIX	AUTO
:SELect	1 to 10	1
:DEFine	<step>,<seg_number>,<repeat>,<adv_mode>,<sync_bit>	
:DELete		
:NAME	1 to 4096	
:ALL		
:SYNC		
[:TYPe]	BIT | LCOMplete	LCOM

Table 4-1, Model 5251 SCPI Commands List Summary (continued)

Keyword	Parameter Form	Default
Modulated Waveforms Commands		
[:SOURce]		
:MODulation		
:TYPE	OFF | FM | AM | SWE | FSK | ASK | PSK | FHOPping | 3D	OFF
:CARRier		
[:FREQuency]	10 to 100e6	1e6
:BASeline	CARRier | DC	CARR
:LOAD		
:DEMO		
:FM		
:DEViation	10.0e-3 to 100e6	100e3
:FUNCtion		
:SHAPe	SINusoid | TRIangle | SQUare | RAMP | ARB	SIN
:FREQuency	10e-3 to 100e3	10e3
:RASTer	1 to 2.5e6	1e6
:MARKer		
[:FREQuency]	10e-3 to 100e6	1e6
:DATA	<data_array>	
:AM		
:FUNCtion		
:SHAPe	SINusoid | TRIangle | SQUare | RAMP	SIN
:MODulation		
:FREQuency	10e-3 to 1e6	10e3
:DEPTh	0 to 100	50
:SWEep		
[:FREQuency]		
:STARt	10 to 100.0e6	10e3
:STOP	10 to 100e6	1e6
:TIME	1.4e-6 to 40.0	1e-3
:DIRection	UP | DOWN	UP
:SPACing	LINear | LOGarithmic	LIN
:MARKer		
[:FREQuency]	10 to 100e6	10e3

Table 4-1, Model 5251 SCPI Commands List Summary (continued)

Keyword	Parameter Form	Default
Modulated Waveforms Commands (continued)		
:FSK		
:FREQuency		
:SHIFted	10 to 100e6	100e3
:BAUD	1 to 10e6	10e3
:MARKer	1 to 4000	1
:DATA	<data_array>	
:ASK		
[:AMPLitude]		
[:STARt]	0 to 10	5
:SHIFted	0 to 10	1
:BAUD	1 to 2.5e6	10e3
:MARKer	1 to 1000	1
:DATA	<data_array>	
:FHOPping		
:DWELl		
:MODe	FIXed | VARiable	FIX
[:TIMe]	200e-9 to 20	200e-9
:FIXed		
:DATA	<data_array>	
:VARiable		
:DATA	<data_array>	
:MARKer	1 to 1000	1
:3D		
:DATA	<data_array>	
:MARKer	1 to 30000	
:RASTer	1 to 2.5e6	1e6
:PSK		
:PHASe		
[:STARt]	0 to 360	0
:SHIFted	0 to 360	180
:DATA	<data_array>	
:MARKer	1 to 4000	1
:BAUD	1 to 10e6	10e3

Table 4-1, Model 5251 SCPI Commands List Summary (continued)

Keyword	Parameter Form	Default
Run Mode Commands		
:INITiate		
[:IMMediately]		
:CONTinuous	OFF | ON | 0 | 1	1
:TRIGger		
[:IMMediate]		
:BURSt		
[:STATe]	OFF | ON | 0 | 1	0
:COUNt	1 to 1000000	1
:DELay		
[:STATe]	OFF | ON | 0 | 1	0
:TIMe	200e-9 to 20	200e-9
:GATE		
[:STATe]	OFF | ON | 0 | 1	0
:LEVel	-5 to 5	1.6
:SOURce		
[:ADVance]	BUS | EXTernal | MIXed | TTLTrig 0-7 | STAR	EXT
:SLOPe	POSitive | NEGative	POS
:RETRigger		
[:STATe]	OFF | ON | 0 | 1	0
:TIMe	200e-9 to 20	200e-9
:STAR		
[:STATe]	OFF | ON	OFF
Auxiliary Functions Commands		
:AUXiliary		
:COUNter		
:FUNCtion	FREQuency | PERiod | APERiod | PULSe | GTOTalize | ITOTalize	FREQ
:DISPlay		
:MODE	NORMal | HOLD	NORM
:GATE		
:TIME	100e-6 to 1	1
:RESet		
:READ		
:HALFcycle		
:DELay	200e-9 to 20	1e-6
:DCYCle	0 to 99.99	50
:FREQuency	10e-3 to 1e6	1e6
:PHASe	0 to 360	0
:SHAPe	SINusoid | TRIangle | SQUare	SIN

Table 4-1, Model 5251 SCPI Commands List Summary (continued)

Keyword	Parameter Form	Default
Auxiliary Functions Commands (continued)		
:AUXiliary		
:PULSe		
:DELay	0 to 1e3	0
:DOUBle		
[:STATe]	OFF | ON | 0 | 1	0
:DELay	0 to 1e3	1e-3
:LEVel		
:HIGH	-4.950 to 5	5
:LOW	-5 to 4.950	0
:HIGH	0 to 1e3	1e-3
:POLarity	NORMal | COMPlement | INVerted	NORM
:PERiod	80e-9 to 2e6	10e-3
:STATe	OFF | ON | 0 | 1	1
:TRANsition		
[:LEADing]	0 to 1e3	1e-3
:TRAiling	0 to 1e3	1e-3
System Commands		
:RESet		
:SYSTem		
:ERRor?		
:INFOrmation		
:CALibration?		
:MODel?		
:SERial?		
*CLS		
*OPC		
*RST		
*TRG		
*IDN?		

Instrument Control Commands

This group is used to control output channels and their respective state, amplitude and offset settings, as well as the waveform mode. You can also set the phase offset between channels and select filters to re-structure the shape of your waveform. Multiple instruments can be synchronized with these commands, as well. The output frequency and the reference source are also selected using commands from this group. Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Table 4-2, Instrument Control Commands Summary

Keyword	Parameter Range	Default
:OUTPut		
:LOAD	50 to 1e6	50
[:STATe]	OFF | ON | 0 | 1	0
:SYNC		
[:STATe]	OFF | ON | 0 | 1	0
:POSition	0 to 1999999	0
:FILTer		
[:LPASs]	NONE | 25M | 50M | 60M | 120M	NONE
[:SOURce]		
:ROSCillator		
:SOURce	INTernal | EXTernal	INT
:FREQuency		
[:CW]	10e-3 to 100e6 | MINimum | MAXimum	1e6
:RASTer	1.5 to 250e6 | MINimum | MAXimum	1e7
:SOURce	INTernal | EXTernal	INT
:VOLTage		
[:LEVel]		
[:AMPLitude]	100e-3 to 10 | MINimum | MAXimum	5
:OFFSet	-4.950 to 4.950	0
:FUNCtion		
:MODE	FIXed | USER | SEQuence | MODulation | COUNter | PULSe | HALFcycle	FIX

OUTPut:LOAD<load>

Description
This command will specify the load impedance that will be applied to the 5251 output.

Parameters

Name	Type	Default	Description
<load>	Numeric (integer only)	50	Will specify the load impedance that will be applied to the 5251 outputs in units of Ω. The default setting is 50 Ω. The range of load impedance is 50 Ω to 1 MΩ..Accurate setting of the load impedance is crucial for correct display readout of the amplitude level on the load.

OUTPut{OFF|ON|0|1}(?)

Description
This command will turn the 5251 output on and off. Note that for safety, the outputs always default to off, even if the last instrument setting before power down was on

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Sets the output on and off

Response
The 5251 will return 1 if the output is on, or 0 if the output is off.

OUTPut:SYNC{OFF|ON|0|1}(?)

Description
This command will turn the 5251 SYNC output on and off. Note that for safety, the SYNC output always defaults to off, even if the last instrument setting before power down was on

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Will set the SYNC output on and off

Response
The 5251 will return 1 if the SYNC output is on, or 0 if the SYNC output is off.

OUTPut:SYNC:POSition<position>(?)

Description

This command will program the 5251 SYNC position. This command is active in arbitrary (USER) mode only.

Parameters

Name	Range	Type	Default	Description
<position>	0 to 2e6-1	Numeric (Integer only)	0	Will set the SYNC position in waveform points. The sync position can be programmed in increments of 4 points minimum.

Response

The 5251 will return the present SYNC position value

OUTPut:FILTer{NONE|25M|50MH|60M|120M}(?)

Description

This command will select which filter is connected to the 5251 output. Observe the following restrictions when you try to use this command:

1) Filter selection is not available when the instrument is set to output the standard sine waveform. In fact, the default waveform shape is sine. Therefore, filter selection will be available for use only after you select a different waveform, or change the output mode to use.
2) Filters are placed before the output amplifier. Therefore, do not expect the filters to remove in-band amplifier harmonics and spurious.

Parameters

Name	Type	Default	Description
None	Discrete	None	Disables all filters at the output path. This option cannot be selected when standard waveform is generated
25M	Discrete		Connects a 25MHz, Bessel type filter, to the output path
50M	Discrete		Connects a 50MHz, Bessel type filter, to the output path
65M	Discrete		Connects a 25MHz, Elliptic type filter, to the output path
120M	Discrete		Connects a 120MHz, Elliptic type filter, to the output path

Response

The 5251 will return NONE, 25M, 50M, 60M, or 120M depending on the type of filter presently connected to the output.

ROSCillator:SOURce{INTernal|EXTernal}(?)

Description

This command will select the reference source for the sample clock generator.

Parameters

Name	Type	Default	Description
INTernal	Discrete	INT	Selects an internal source. The internal source could be either the standard 100ppm oscillator, or the optional 1ppm TCXO
EXTernal	Discrete		Activates the external reference input. An external reference must be connected to the 5251 for it to continue normal operation

Response

The 5251 will return INT, or EXT depending on the present 5251 setting.

FREQuency{<freq>|MINimum|MAXimum}(?)

Description

This command modifies the frequency of the standard waveforms in units of hertz (Hz). It has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 100e6	Numeric	1e6	Will set the frequency of the standard waveform in units of Hz. Although the display resolution for the frequency setting is 9 digits only, the frequency command can be used with resolutions up to 14 digits. The accuracy of the instrument however, can only be tested to this accuracy using an external reference that provides the necessary accuracy and stability
<MINimum>		Discrete		Will set the frequency of the standard waveform to the lowest possible frequency (10e-3).
<MAXimum>		Discrete		Will set the frequency of the standard waveform to the highest possible frequency (100e6).

Response

The 5251 will return the present frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FREQuency:RASTer{<sclk>|MINimum|MAXimum}(?)

Description
This command modifies the sample clock frequency of the arbitrary waveform in units of samples per second (S/s). It has no affect on standard waveforms.

Parameters

Name	Range	Type	Default	Description
<sclk>	1.5 to 250e6	Numeric	1e7	Will set the sample clock frequency of the arbitrary and sequenced waveform in units of S/s. Although the display resolution for the frequency setting is 9 digits only, the frequency command can be used with resolutions up to 14 digits. The accuracy of the instrument however, can only be tested to this accuracy using an external reference that provides the necessary accuracy and stability
<MINimum>		Discrete		Will set the sample clock frequency to the lowest possible frequency (1.5).
<MAXimum>		Discrete		Will set the frequency of the standard waveform to the highest possible frequency (300e6).

Response
The 5251 will return the present sample clock frequency value. The returned value will be in standard scientific format (for example: 100MHz would be returned as 100e6 – positive numbers are unsigned).

FREQuency:RASTer:SOURce{EXTernal|INTernal}(?)

Description
This command selects the source of the sample clock generator. This command affects both the standard and the arbitrary waveforms.

Parameters

Name	Type	Default	Description
INTernal	Discrete	INT	Selects an internal source.
EXTernal	Discrete		Activates the external sample clock reference input. An external reference must be connected to the 5251, in the range of the internal source, for it to continue normal operation. Observe the input level and limitations before connecting an external signal.

Response
The 5251 will return EXT if an external source is selected, or INT if the internal source is selected.

VOLTage{<ampl>|MINimum|MAXimum}(?)

Description
This command programs the peak to peak amplitude of the output waveform. The amplitude is calibrated when the source impedance is 50Ω.

Parameters

Name	Range	Type	Default	Description
<ampl>	100e-3 to 10e0	Numeric	5	Will set the amplitude of the output waveform in units of volts. Amplitude setting is always peak to peak. Offset and amplitude settings are independent providing that the offset + amplitude does not exceed the specified window.
<MINimum>		Discrete		Will set the amplitude to the lowest possible level (100mV).
MAXimum>		Discrete		Will set the amplitude to the highest possible level (10V).

Response
The 5251 will return the present amplitude value. The returned value will be in standard scientific format (for example: 100mV would be returned as 100e-3 – positive numbers are unsigned).

VOLTage:OFFSet<offs>(?)

Description
This command programs the amplitude offset of the output waveform. The offset is calibrated when the source impedance is 50Ω.

Parameters

Name	Range	Type	Default	Description
<offs>	-4.950 to 4.950	Numeric	0	Will set the offset of the output waveform in units of volts. Offset and amplitude settings are independent providing that the offset + amplitude does not exceed the specified window.

Response
The 5251 will return the present offset value. The returned value will be in standard scientific format (for example: 100mV would be returned as 100e-3 – positive numbers are unsigned).

FUNCTion:MODE{FIXed|USER|SEQuence|MODulatedCOUNter|PULSe|HALFcycle}(?)

Description
This command defines the type of waveform that will be available at the output connector. It also selects one fo the auxiliary functions from: counter/timer, digital pulse generator and half cycle waveforms

Parameters

Name	Type	Default	Description
FIXed	Discrete	FIX	Selects the standard waveform shapes. There is an array of waveforms that is built into the program. You can find these waveform shapes in the standard waveforms section.
USER	Discrete		Selects the arbitrary waveform shapes. Arbitrary waveforms must be loaded to the 5251 memory before they can be replayed. You can find information on arbitrary waveforms in the appropriate sections in this manual.
SEQuenced	Discrete		Selects the sequenced waveform output. To generate a sequence, you must first download waveform coordinates to different segments and then build a sequence table to generate a complex waveform that is using these segments.
MODulated	Discrete		Selects the modulated waveforms. There is an array of built-in modulation schemes. However, you can also build custom modulation using the arbitrary function.
COUNter	Discrete		Selects the counter/timer auxiliary function. Note that when you select this function, all waveform generation of the 5251 are purged and the 5251 is transformed to behave as if it was a stand-alone counter/timer. The counter/timer functions and parameters can be programmed using the auxiliary commands.
PULSe	Discrete		Selects the digital pulse generator auxiliary function. Note that when you select this function, all waveform generation of the 5251 are purged and the 5251 is transformed to behave as if it was a stand-alone pulse generator. The digital pulse generator functions and parameters can be programmed using the auxiliary commands.
HALFcycle	Discrete		Selects the half cycle auxiliary function. Note that when you select this function, all waveform generation of the 5251 are purged and the 5251 is transformed to behave as if it was a stand-alone half cycle generator. The half cycle generator functions and parameters can be programmed using the auxiliary commands.

Response

The 5251 will return FIX, USER, SEQ, MOD, COUN, PULS or HALF depending on the present 5251 setting.

Standard Waveforms Control Commands

This group is used to control the standard waveforms and their respective parameters. There is an array of standard waveforms that could be used without the need to download waveform coordinates to the instrument. You can also modify the parameters for each waveform to a shape suitable for your application.

Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Table 4-3, Instrument Control Commands Summary

Keyword	Parameter Range	Default
:FUNCtion		
:SHAPe	**SINusoid** | TRIangle | SQUare | PULSe | RAMP | SINC | GAUSsian | EXPonential | NOISe | DC	SIN
:SINusoid		
:PHASe	0 to 360.0	0
:TRIangle		
:PHASe	0 to 360.0	0
:SQUare		
:DCYCle	0 to 99.99	50
:PULSe		
:DELay	0 to 99.999	10
:WIDth	0 to 99.999	10
:TRANsition		
[:LEADing]	0 to 99.999	10
:TRAiling	0 to 99.999	10
:RAMP		
:DELay	0 to 99.99	0
:TRANsition		
[:LEADing]	0 to 99.99	60
:TRAiling	0 to 99.99	30
:SINC		
:NCYCle	4 to 100	10
:GAUSsian		
:EXPonent	10 to 200	20
:EXPonential		
:EXPonent	-100 to 100	1
:DC		
[:AMPLitude]	-5 to 5	5

FUNCtion:SHAPe{SINusoid|TRIangle|SQUare|PULSe|RAMP|SINC|EXPonential| GAUSsian|NOISe|DC}(?)

Description
This command defines the type of waveform that will be available at the output connector.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects the sine waveform from the built in library.
TRIangle	Discrete		Selects the triangular waveform from the built in library.
SQUare	Discrete		Selects the square waveform from the built in library.
PULSe	Discrete		Selects the pulse waveform from the built in library.
RAMP	Discrete		Selects the ramp waveform from the built in library.
SINC	Discrete		Selects the sinc waveform from the built in library.
EXPonential	Discrete		Selects the exponential waveform from the built in library.
GAUSsian	Discrete		Selects the gaussian waveform from the built in library.
DC	Discrete		Selects the DC waveform from the built in library.
NOISe	Discrete		Selects the noise waveform from the built in library.

Response
The 5251 will return SIN, TRI, SQU, PULS, RAMP, SINC, EXP, GAUS, NOIS, or DC depending on the present 5251 setting

SINusoid:PHASe<phase>(?)

Description
This command programs start phase of the standard sine waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<phase>	0 to 360	Numeric	0	Programs the start phase parameter in units of degrees. Sine phase can be programmable with resolution of 0.1° throughout the entire frequency range of the sine waveform.

Response
The 5251 will return the present start phase value.

TRIangle:PHASe<phase>(?)

Description
This command programs start phase of the standard triangular waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<phase>	0 to 360	Numeric	0	Programs the start phase parameter in units of degrees. Triangle phase can be programmable with resolution of 0.1° throughout the entire frequency range of the triangular waveform.

Response
The 5251 will return the present start phase value.

SQUare:DCYCle<duty_cycle>(?)

Description
This command programs duty cycle of the standard square waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<duty_cycle>	0 to 99.99	Numeric	50	Programs the square wave duty cycle parameter in units of percent

Response
The 5251 will return the present duty cycle value.

PULSe:DELay<delay>(?)

Description
This command programs delay of the standard pulse waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<delay>	0 to 99.999	Numeric	10	Programs the pulse delay parameter in units of percent

Response
The 5251 will return the present pulse delay value.

PULSe:WIDth<pulse_width>(?)

Description
This command programs pulse high portion of the standard pulse waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<pulse_width>	0 to 99.999	Numeric	10	Programs the pulse width parameter in units of percent

Response
The 5251 will return the present width value.

PULSe:TRANsition<rise>(?)

Description
This command programs pulse transition from low to high of the standard pulse waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<rise>	0 to 99.999	Numeric	10	Programs the pulse rise time parameter in units of percent

Response
The 5251 will return the present rise time value

PULSe:TRANsition:TRAiling<fall>(?)

Description
This command programs pulse transition from high to low of the standard pulse waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<fall>	0 to 99.999	Numeric	10	Programs the pulse fall time parameter in units of percent

Response
The 5251 will return the present fall time value.

RAMP:DELay<delay>(?)

Description
This command programs delay of the standard ramp waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<delay>	0 to 99.99	Numeric	10	Programs the ramp delay parameter in units of percent

Response
The 5251 will return the present ramp delay value.

Ramp:TRANsition<rise>(?)

Description
This command programs ramp transition from low to high of the standard ramp waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<rise>	0 to 99.99	Numeric	60	Programs the pulse rise time parameter in units of percent

Response
The 5251 will return the present rise time value

RAMP:TRANsition:TRAiling<fall>(?)

Description
This command programs ramp transition from high to low of the standard ramp waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<fall>	0 to 99.99	Numeric	30	Programs the ramp fall time parameter in units of percent

Response
The 5251 will return the present fall time value.

SINC:NCYCleN_cycles>(?)

Description
This command programs the number of “0-crossings” of the standard SINC pulse waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<N_cycle>	4 to 100	Numeric (Integer only)	10	Programs the number of zero-crossings parameter

Response
The 5251 will return the present number of zero-crossing value.

GAUSsian:EXPonent<exp>(?)

Description
This command programs the exponent for the standard gaussian pulse waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<exp>	4 to 100	Numeric	20	Programs the exponent parameter

Response
The 5251 will return the present exponent value.

EXPonential:EXPonent<exp>(?)

Description
This command programs the exponent for the standard exponential waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<exp>	-100 to 100	Numeric	1	Programs the exponent parameter

Response
The 5251 will return the present exponent value.

DC<amplitude>(?)

Description
This command programs the exponent for the standard exponential waveform. This command has no affect on arbitrary waveforms.

Parameters

Name	Range	Type	Default	Description
<amplitude>	-5 to 5	Numeric	5	Programs the DC amplitude parameter

Response
The 5251 will return the present DC amplitude value.

Arbitrary Waveforms Control Commands

This group is used to control the arbitrary waveforms and their respective parameters. This will allow you to create segments and download waveforms. Using these commands you can also define segment size and delete some or all unwanted waveforms from your memory. Use the commands in this group to turn the digital output on and off and to download data to the digital pattern buffer.

Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Generating Arbitrary Waveforms
Arbitrary waveforms are generated from digital data points, which are stored in a dedicated waveform memory. Each data point has a vertical resolution of 16 bits (65536 points), i.e., each sample is placed on the vertical axis with a precision of 1/65536. The Model 5251 has 2 M waveform memory capacity as standard.

Each horizontal point has a unique address - the first being 00000 and the last depends on the memory option. In cases where smaller waveform lengths are required, the waveform memory can be divided into smaller segments.

When the instrument is programmed to output arbitrary waveforms, the clock samples the data points (one at a time) from address 0 to the last address. The rate at which each sample is replayed is defined by the sample clock rate parameter.

Unlike the built-in standard waveforms, arbitrary waveforms must first be loaded into the instrument's memory. Correct memory management is required for best utilization of the arbitrary memory. An explanation of how to manage the arbitrary waveform memory is given in the following paragraphs.

Arbitrary memory Management
The arbitrary memory in comprised of a finite length of words. The maximum size arbitrary waveform that can be loaded into memory depends on the option that is installed in your instrument. The various options are listed in Chapter 1 of this manual. If you purchased the 5251 with in its basic configuration, you should expect to have 1 Meg words to load waveforms.

Waveforms are created using small sections of the arbitrary memory. The memory can be partitioned into smaller segments (up to 16k) and different waveforms can be loaded into each segment, each having a unique length. Minimum segment size is 16 points. Information on how to partition the memory, define segment length and download waveform data to the 5251 is given in the following paragraphs.

Table 4-4, Arbitrary Waveforms Commands Summary

Keyword	Parameter Range	Default
:TRACe		
[:DATA]	<data_array>	
:DEFine	<1 to 10k>,<16 to 2e6> (<segment_#>,<size>)	1,16
:DELete		
[:NAME]	1 to 10k	
:ALL		
:SELect	1 to 10k	1
:SEGMent		
[:DATA]	<data_array>	

TRACe#<header><binary_block>

Description

This command will download waveform data to the 5251 memory. Waveform data is loaded to the 5251 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. As an example, the next command will download to the generator an arbitrary block of data of 1024 points

```
TRACe#42048<binary_block>
```

This command causes the transfer of 2048 bytes of data (1024 waveform points) into the active memory segment. The <header> is interpreted this way:

- The ASCII "#" ($23) designates the start of the binary data block.
- "4" designates the number of digits that follow.
- "2048" is the even number of bytes to follow.

The generator accepts binary data as 16-bit integers, which are sent in two-byte words. Therefore, the total number of bytes is always twice the number of data points in the waveform. For example, 20000 bytes are required to download a waveform with 10000 points. The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data format is demonstrated in Figure 4-1.

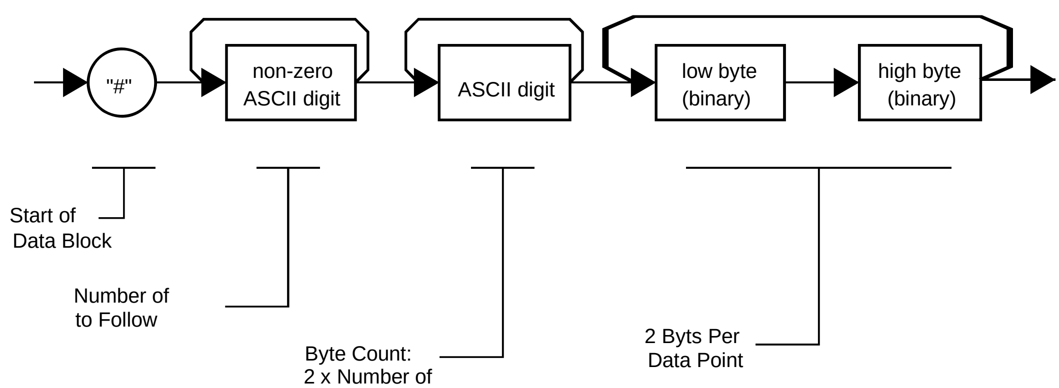

Figure Chapter 4-1, Definite Length Arbitrary Block Data Format

Transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0dH) and line feed (LF – 0aH) characters can be used as waveform data points and will not cause unexpected termination of the arbitrary block data.

- <binary_block> Represents waveform data.

The waveform data is made of 16-bit words however, the GPIB link has 8 data bas lines and accepts 8-bit words only. Therefore, the data has to be prepared as 16-bit words and rearranged as two 8-bit words before it can be used by the 5251 as waveform data points. The following description shows you how to prepare the data for downloading to the 5251. There are a number of points you should be aware of before you start preparing the data:

1. Each channel has its own waveform memory. Therefore, make sure you selected the correct active channel before you download data to the generator
2. Waveform data points have 16-bit values
3. Data point range is 0 to 65,535 decimal
4. Data point 0 to data point 65,535 corresponds to full-scale amplitude setting.

Figure 4-2 shows how to initially prepare the 16-bit word for a waveform data point. Data has to be further manipulated to a final format that the instrument can accept and process as waveform point.

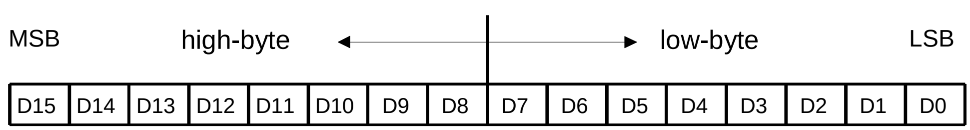

Figure 4-2, 16-bit Initial Waveform Data Point Representation

Figure 4-3 shows the same 16-bit word as in Figure 4-2, except the high and low bytes are swapped. This is the correct format that the 5251 expects as waveform point data. The first byte to be sent to the generator is the low-byte and then high-byte.

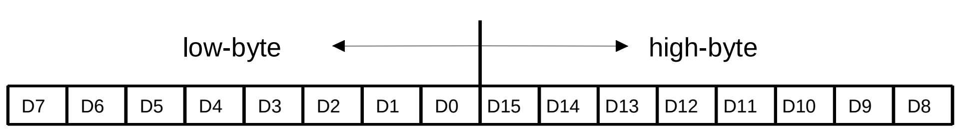

Figure 4-3, 16-bit Waveform Data Point Representation

Parameters

Name	Type	Description
<header>	Discrete	Contains information on the size of the binary block that contains waveform coordinates.
<binary_block>	Binary	Block of binary data that contains information on the waveform coordinates.

TRACe:DEFine<segment_number>,<length>

Description

Use this command to attach size to a specific memory segment. The final size of the arbitrary memory is 1M points (2M optional). The memory can be partitioned to smaller segments, up to 10k segments. This function allows definition of segment size. Total length of memory segments cannot exceed the size of the waveform memory.

NOTE

The 5251 operates in interlaced mode where four memory cells generate one byte of data. Therefore, segment size can be programmed in numbers evenly divisible by four only. For example, 2096 bytes is an acceptable length for a binary block. 2002 is not a multiple of 4, therefore the generator will generate an error message if this segment length is used.

Parameters

Name	Range	Type	Default	Description
<segment_ number>	1 to 10k	Numeric (integer only)	1	Selects the segment number of which will be programmed using this command
<length>	16 to 2M	Numeric (integer only)		Programs the size of the selected segment. Minimum segment length is 16 points

TRACe:DELete<segment_number>

Description

This command will delete a segment. The memory space that is being freed will be available for new waveforms as long as the new waveform will be equal or smaller in size to the deleted segment. If the deleted segment is the last segment, then the size of another waveform written to the same segment is not limited. For example, let consider two segments, the first being a 1000-point waveform and the second with 100 points. If you delete segment 1, you can reprogram another waveform to segment 1 with size to 1000 points. If you reprogram segment 1 with 1004 points, the instrument will generate an error and will not accept this waveform. On the other hand, if you delete segment 2, which was the last segment you programmed, then you can reprogram this segment with waveforms having length limited only by the size of the entire memory space.

Parameters

Name	Range	Type	Default	Description

<segment_ number>	1 to 10k	Numeric (integer only)	1	Selects the segment number of which will be deleted

TRACe:DELete:ALL

Description

This command will delete all segments and will clear the entire waveform memory. This command is particularly important in case you want to de-fragment the entire waveform memory and start building your waveform segments from scratch.

TIP

The TRAC:DEL:ALL command does not re-write the memory so, whatever waveforms were downloaded to the memory are still there for recovery. The TRAC:DEL:ALL command removes all stop bits and clears the segment table. You can recover memory segments by using the TRAC:DEF command. You can also use this technique to resize, or combine waveform segments.

TRACe:SELect<segment_number>

Description

This command will select the active waveform segment for the output. By selecting the active segment you are performing two function:

1. Successive :TRAC commands will affect the selected segment
2. The SYNC output will be assigned to the selected segment. This behavior is especially important for sequence operation, where multiple segments form a large sequence. In this case, you can synchronize external devices exactly to the segment of interest

Parameters

Name	**Range**	**Type**	**Default**	**Description**
<segment_ number>	1 to 10k	Numeric (integer only)	1	Selects the active segment number

Response

The 5251 will return the active segment number.

SEGment#<header><binary_block>

Description

This command will partition the waveform memory to smaller segments and will speed up memory segmentation. The idea is that waveform segments can be built as one long waveform and then just use this command to split the waveform to the appropriate memory segments. In this way, there is no need to define and download waveforms to individual segments.

Using this command, segment table data is loaded to the 5251 using high-speed binary transfer in a similar way to downloading waveform data with the trace command. 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 large number of segment. As an example, the next command will generate three segments with 12 bytes of data that contains segment size information.

```
SEGment#212<binary_block>
```

This command causes the transfer of 12 bytes of data (3 segments) into the segment table buffer. The <header> is interpreted this way:

- The ASCII "#" ($23) designates the start of the binary data block.
- "2" designates the number of digits that follow.
- "12" is the number of bytes to follow. This number must divide by 4.

The generator accepts binary data as 32-bit integers, which are sent in two-byte words. Therefore, the total number of bytes is always 4 times the number of segments. For example, 36 bytes are required to download 9 segments to the segment table. The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data format is demonstrated in Figure 5-1. The transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0dH) and line feed (LF – 0aH) characters can be used as segment table data points and will not cause unexpected termination of the arbitrary block data.

The segment table data is made of 32-bit words however, the GPIB link has 8 data bas lines and accepts 8-bit words only. Therefore, the data has to be prepared as 32-bit words and rearranged as six 8-bit words before it can be used by the 5251 as segment table data. Figure 5-4 shows how to prepare the 32-bit work for the segment start address and size. There are a number of points you should be aware of before you start preparing the data:

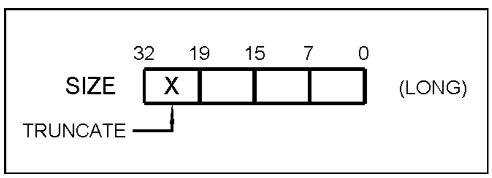

Figure 4-4, Segment Address and Size Example

1. Each channel has its own segment table buffer. Therefore, make sure you selected the correct active channel (with the INST:SEL command) before you download segment table data to the generator
2. Minimum number of segments is 1; maximum number of segments is 16k
3. Maximum segment size depends on your installed option. With the basic 5251 you can program maximum 1M in one segment. With the 2M option, you can use the full size of 2 Meg
4. Segment table data has 32-bit values of which are used for segment size. Therefore, Data for each segment must have 4 bytes
5. The number of bytes in a complete segment table must divide by 6. The Model 5251 has no control over data sent to its segment table during data transfer. Therefore, wrong data and/or incorrect number of bytes will cause erroneous memory partition

Parameters

Name	Type	Description
<binary_block>	Binary	Block of binary data that contains information on the segment table.

Sequenced Waveforms Control Commands

This group is used to control the sequenced waveforms and their respective parameters. This will allow you to create multiple sequence table and modify segment loops and links. Also use these commands to add or delete sequences from your instrument.

Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Generating Sequenced Waveforms
Sequenced waveforms are made of a number of arbitrary waveforms, which can be linked and looped in user-programmable order. Sequenced waveforms are generated from waveforms stored in the 5251 as memory segments. Therefore, before a sequence can be used, download waveform segments to the arbitrary memory using TRAC# or DMA methods. Information on how to partition the memory and how to download waveforms is given in the section entitled **Generating Arbitrary Waveforms**.

An example of how sequenced waveforms work is demonstrated in figure 1-13 through 1-15. The sequence generator lets you link and loop segments in user-defined order. Figure 1-16 shows a sequence of waveforms that were stored in three different memory segments.

There are a number of tools that you can use to build a sequence table. The easiest way is of course to use the ArbConnection program. Information how to use the ArbConnection program is given in a later chapter. In other cases, SCPI programming allows low-level programming of sequence tables.

In general, sequences can be build one step at a time using the SEQ:DEF command. The one step method is slow and tedious however, it allows better control for one who just begins his first sequence programming. Advanced users can download a complete sequence table using the binary sequence download option. The later being much faster for applications requiring large sequence tables. Use the information below to understand sequence commands and how to implement them in your application.

Table 4-5, Sequence Control Commands

Keyword	Parameter Form (Default in Bold)	Notes
[:SOURce]		
:SEQuence		
[:DATA]	<data_array>	
:ADVance	AUTOmatic | STEP | SINGle | MIX	AUTO
:SELect	1 to 10	1
:DEFine	<step>,<seg_number>,<repeat>,<adv_mode>,<sync_bit>	
:DELete		
:NAME	1 to 4096	
:ALL		
:SYNC		
[:TYPe]	BIT | LCOMplete	LCOM

SEQuence#<header><binary_block>

Description

This command will build a complete sequence table in one binary download. In this way, there is no need to define and download individual sequencer steps. Using this command, sequence table data is loaded to the 5251 using high-speed binary transfer in a similar way to downloading waveform data with the trace command. 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 long sequences that use a large number of segment and sequence steps. As an example, the next command will generate three-step sequence with 16 bytes of data that contains segment number, repeats (loops) and mixed mode flag option.

```
SEQuence#216<binary_block>
```

This command causes the transfer of 16 bytes of data (2-step sequence) to the sequence table buffer. The <header> is interpreted this way:

- The ASCII "#" ($23) designates the start of the binary data block.
- "2" designates the number of digits that follow.
- "16" is the number of bytes to follow. This number must divide by 8.

The generator accepts binary data as 64-bit integers, which are sent in two-byte words. Therefore, the total number of bytes is always eight times the number of sequence steps. For example, 16 bytes are required to download 2 sequence steps to the sequence table. The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data format is demonstrated in Figure 4-1. The transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0dH) and line feed (LF – 0aH) characters can be used as sequence data and will not cause unexpected termination of the arbitrary block data. Figure 4-5 shows how to prepare the 64-bit word for the sequence step, repeat, mixed mode and sync bit.

The sequence table data is made of 64-bit words however, the GPIB link has 8 data bas lines and accepts 8-bit words only. Therefore, the data has to be prepared as 64-bit words and rearranged as six 8-bit words before it can be used by the 5251 as sequence table data. Figure 5-6 shows how to prepare the 64-bit word for the sequence step, repeat and mixed mode flag.

There are a number of points you should be aware of before you start preparing the data:

1. Each channel has its own sequence table buffer. Therefore, make sure you selected the correct active channel (with the INST:SEL command) before you download sequence table data to the generator
2. Minimum number of sequencer steps is 1; maximum number is 4096
3. The number of bytes in a complete sequence table must divide by 8. The Model 5251 has no control over data sent to its sequence table during data transfer. Therefore, wrong data and/or incorrect number of bytes will cause erroneous sequence partition
4. The LSB bit is the only bit used in the mode byte. This bit has an affect on the operation of the sequence only when Mixed Step Advance mode is active. With the LSB bit set to “0”, the sequence generator will advance to the next step automatically. With the LSB bit set to “1”, the sequence generator will advance to the next step only when a valid trigger signal will be sensed at the trigger input.
5. SYNC state bit is valid only when the sequence sync type is BIT

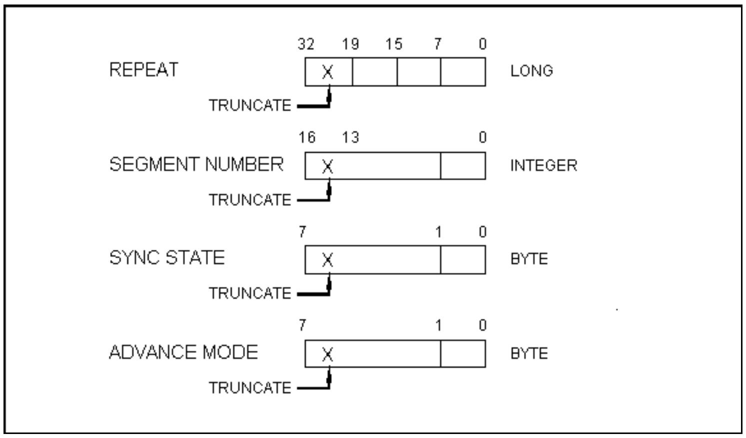

Figure 4-5, 64-bit Sequence Table Download Format

Parameters

Name	**Type**	**Description**
<binary_block >	Binary	Block of binary data that contains information on the sequence table.

SEQuence:ADVance{AUTOmatic|STEP|SINGle|MIXed}(?)

Description

This command will select the sequence advance mode. The way the instrument advances through the sequence links can be specified by the user.

Parameters

Name	**Type**	**Default**	**Description**
AUTOmatic	Discrete	AUTO	Specifies continuous advance where the generator steps continuously to the end of the sequence table and repeats the sequence from the start. For example, if a sequence is made of three segments 1, 2 and 3, the sequence will generate an infinite number of 1,2,3,1,2,3,1,2,3…waveforms. Of course, each link (segment) can be programmed with its associated loop (repeat) number.
STEP	Discrete		In step advance mode, the sequence is advanced to the next waveform only when a valid trigger is received. The output of the 5251 generates the first segment continuously until a trigger signal advances the sequence to the next segment. If repeats were selected for a segment, the loop counter is executed automatically.
SINGle	Discrete		In single advance mode, the generator idles between steps until a valid trigger signal is sensed. This mode operates with trigger mode only. An attempt to select the SING advance mode when the 5251 is in continuous operating mode will generate an error. After trigger, the generator outputs one waveform cycle. Then, the output level idles at a DC level equal to the last point of the last generated waveform. If loops (repeats) were programmed, the output will repeat this segment every time a trigger is received. Only after executing all of the programmed loops will the sequence step to the next assigned segment.
MIXed	Discrete		Mixed mode is a special mode that combines continuous step advance with single step advance in a sequence. There are three conditions for the sequence generator to operate in this mode: 1) The 5251 must be set to operate in continuous mode 2) Select the MIX sequence advance mode 3) Assign the mixed mode bits for each sequence step in your SEQ:DEF command. “0” programs normal advance, “1” programs trigger advance. Step with a “0” bit assigned to it will advance automatically to the next step. If “1” is assigned to a step, the instrument will generate this step and its associated number of repeats continuously

and only a valid trigger signal will advance this step to the next step.

Response

The 5251 will return the AUTO, STEP, SING, or MIX depending on the present sequence advance mode setting.

SEQuence:SELect<sequence_number>(?)

Description

This command will select an active sequence to be generated at the output connector. By selecting the active sequence, successive :SEQ commands will affect the selected sequence only

Parameters

Name	Range	Type	Default	Description
<sequence_ number>	1 to 10	Numeric (integer only)	1	Selects the active sequence number

Response

The 5251 will return the active sequence number.

SEQuence:DEFine<step>,<seg_number>,<repeat>,<adv_mode>,<sync_bit>(?)

Description

This command builds a step in a sequence table. It defines all of the parameters that are associated with the sequence step such as segment number, link, loop, advance mode and sync mode.

Parameters

Name	Range	Type	Description
<step>	1 to 4096	Numeric (integer only)	Programs the step in the sequence table. Steps are indexed from 1 to 4096 and must be programmed in an ascending order; Empty step locations in a sequence table are not permitted.
<seg_number>	1 to 10k	Numeric (integer only)	Assigns a segment to a specific step number. When encountered in the sequence table, the segment number that is associated with the step will be generated.
<repeat>	1 to 1M	Numeric integer only)	Programs the repeat number of loops that a specific step will play before advancing to the next step in the sequence.
<adv_mode>	0-1	Boolean	"0" programs normal advance, "1" programs trigger advance. Step with a "0" bit assigned to it will advance automatically to the next step. If "1" is assigned to a step, the instrument will generate this step continuously and only a valid trigger signal will cause the sequence to advance to the next step. Note that the <adv_mode> parameter has no affect when the sequence advance mode is set to SING
<sync_bit>	0-1	Boolean	"1" programs bit present at a specific sequence step. This feature is required in applications where multiple sync bits are required in a single sequence. Note that normal sync output during sequence mode is LCOM.

NOTE

Although trigger signals are used to advance mixed mode, the mixed mode operates in continuous mode only. The <mode> parameter will be ignored if you will use SING as advance mode for the sequence table.

TIP

Every time you use the SEQ:DEF command while your 5251 is in sequenced operating mode, the instrument attempts to rebuild the sequence table and restart the sequence. Therefore, sending this command in sequenced mode will slow the programming process and the operation of the generator. Using the SEQ:DEF command in FIX or USER mode will greatly speed up programming time.

SEQuence:DELete<sequence_number>

Description
This command will delete a step in a specific sequence table. Before you use this step make sure your sequence number is setup correctly for this operation.

Parameters

Name	Range	Type	Default	Description
<sequence_ number>	1 to 4096	Numeric (integer only)	1	Selects the step number of which will be deleted

SEQuence:DELete:ALL

Description
This command will delete the enire sequence table. Before you use this step make sure your sequence number is setup correctly for this operation.

OUTPut:SYNC:TYPE{BIT|LCOMplete}(?)

Description
This command will program the 5251 SYNC mode.

Parameters

Name	Type	Default	Description
BIT	Discrete		The sync output will generate a pulse at the beginning of a specific segment regardless how many times the segment appears in a sequence. The width of the sync pulse is 16 waveform points.
LCOMplete	Discrete	LCOM	The sync output will transition high at the beginning of the sequence and will transition low at the end of the sequence, less 16 waveform points.

Response
The 5251 will return BIT or LCOM depending on the present SYNC mode

Modulated Waveforms Control Commands

This group is used to control the modulated waveforms and their respective parameters. Note that the modulation can be turned off to create continuous carrier waveform (CW). The following modulation schemes can be selected and controlled: FM, AM, FSK, ASK, Sweep, Frequency hops and 3D. The modulation commands are summarized in Table 4-6. Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Table 4-6, Modulated Waveforms Commands

Keyword	Parameter Form	Default
[:SOURce]		
:MODulation		
:TYPE	OFF |FM | AM | SWEep | FSK | ASK | PSK |FHOPping | 3D	OFF
:CARRier		
[:FREQuency]	10 to 100e6	1e6
:BASeline	CARRier | DC	CARR
:LOAD		
:DEMO		
	Frequency Modulation Commands	
:FM		
:DEViation	10.0e-3 to 100e6	100e3
:FUNCtion		
:SHAPe	SINusoid | TRIangle | SQUare | RAMP | ARB	SIN
:FREQuency	10e-3 to 100e3)	10e3
:RASTer	1 to 2.5e6)	1e6
:MARKer		
[:FREQuency]	10e-3 to 100e6)	1e6
:DATA	<data_array>	
	Amplitude Modulation Commands	
:AM		
:FUNCtion		
:SHAPe	SINusoid | TRIangle | SQUare | RAMP	SIN
:MODulation		
:FREQuency	10e-3 to 1e6	10e3
:DEPTh	0 to 100	50
	Sweep Modulation Commands	
:SWEep		
[:FREQuency]		
:STARt	10 to 100e6	10e3
:STOP	10 to 100e6	1e6
:TIME	1.4e-6 to 40.0	1e-3
:DIRection	UP | DOWN	UP
:SPACing	LINear | LOGarithmic	LIN
:MARKer		
[:FREQuency]	10 to 100e6	505e3

Table 44-6, Modulated Waveforms Commands (continued)

Keyword	Parameter Form	Default
[:SOURce]		
	Frequency Shift Keying Modulation Commands	
:FSK		
:FREQuency		
:SHIFted	10 to 100e6	100e3
:BAUD	1 to 10e6	10e3
:MARKer	1 to 4000	1
:DATA	<data_array>	
	Amplitude Shift Keying Modulation Commands	
:ASK		
[:AMPLitude]		
[:STARt]	0 to 10	5
:SHIFted	0 to 10	1
:BAUD	1 to 2.5e6	10e3
:MARKer	1 to 1000	1
:DATA	<data_array>	
	Frequency Hopping Modulation Commands	
:FHOPping		
:DWELl		
:MODe	FIXed | VARiable	FIX
[:TIMe]	200e-9 to 20	200e-9
:FIXed		
:DATA	<data_array>	
:VARiable		
:DATA	<data_array>	
:MARKer	1 to 1000	1
	3D Modulation Commands	
:3D		
:DATA	<data_array>	
:MARKer	1 to 30000	
:RASTer	1 to 2.5e6	1e6
:PHASe		
[:STARt]	0 to 360	0
:SHIFted	0 to 360	180
:DATA	<data_array>	
:MARKer	1 to 4000	1
:BAUD	1 to 10e6	10e3

MODulation:TYPE{OFF|FM|AM|SWEeep|FSK|ASK|FHOPping| |3D|PSK| }(?)

Description

This command will select the modulation type. All modulation types are internal, thus external signals are not required for producing modulation.

Parameters

Name	Type	Default	Description
OFF	Discrete	OFF	Modulation off is a special mode where the output generates continuous, non-modulated sinusoidal carrier waveform (CW).
FM	Discrete		This turns on the FM function. Program the FM parameters to fine tune the function for your application.
AM	Discrete		This turns on the AM function. Program the AM parameters to fine tune the function for your application.
SWEep	Discrete		This turns on the sweep function. Program the sweep parameters to fine tune the function for your application.
FSK	Discrete		This turns on the FSK function. Program the FSK parameters to fine tune the function for your application.
ASK	Discrete		This turns on the ASK function. Program the ASK parameters to fine tune the function for your application.
PSK	Discrete		This turns on the PSK function. Program the PSK parameters to fine tune the function for your application.
FHOPping	Discrete		This turns on the frequency hopping function. Program the hop parameters to fine tune the function for your application.
3D	Discrete		This turns on the 3D function. Program the 3D parameters to fine tune the function for your application.

Response

The 5251 will return OFF, FM, AM, SWE, FSK, ASK, PSK, FHOP or 3D depending on the present modulation type setting.

MODulation:CARRier<frequency>(?)

Description

This command programs the CW frequency. Note that the CW waveform is sine only and its frequency setting is separate to the standard sine waveform. The CW frequency setting is valid for all modulation types.

Parameters

Name	Range	Type	Default	Description
<frequency>	10 to 100e6	Numeric	1e6	Programs the frequency of the carrier waveform in units of Hz. Note that the CW waveform is sine only and its frequency setting is separate to the standard sine waveform.

Response

The 5251 will return the current carrier frequency value.

MODulation:CARRier:BASeline{CARRier|DC}(?)

Description

This command will program the carrier baseline when the modulation is used in triggered mode.

Parameters

Name	Type	Default	Description
CARRier	Discrete	CARR	This selects the carrier as the baseline for the modulation function, when operating in one of the interrupted run modes. The output will generate continuous, none modulated sinusoidal waveform (CW) until triggered, upon trigger will generate the modulated waveform and then resume generating continuous CW.
DC	Discrete		This selects DC level as the baseline for the modulation function, when operating in one of the interrupted run modes. The output will generate continuous DC until triggered, upon trigger will generate the modulated waveform and then resume generating continuous DC level.

Response

The 5251 will return CARR, or DC depending on the present carrier baseline setting.

MODulation:LOAD:DEMO

Description

This command will load demo table to the memory. The table type depends on the selected modulation function. Table will be loaded for the following functions: (n)PSK, User PSK, (n)QAM and User QAM.

FM Modulation Programming

Use the following command for programming the FM parameters. FM control is internal. There are two types of waveforms that can be used as the modulating waveforms: Standard and Arbitrary. The standard waveforms are built in a library of waveforms and could be used anytime without external control. The arbitrary waveforms must be loaded into a special FM arbitrary waveform memory and only then can be used as a modulating waveform.

FM:DEViation<deviation>(?)

Description
This programs the deviation range around the carrier frequency. The deviation range is always symmetrical about the carrier frequency. If you need non-symmetrical deviation range, you can use the arbitrary FM composer screen or an external utility to design such waveforms.

Parameters

Name	Range	Type	Default	Description
<deviation>	10e-3 to 100e6	Numeric	100e3	Programs the deviation range around the carrier frequency in units of Hz.

Response
The 5251 will return the present deviation frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FM:FUNCtion:SHAPe(SINusoid|TRIangle|SQUare|RAMP|ARB}(?)

Description
This command will select one of the waveform shapes as the active modulating waveform.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects the sine shape as the modulating waveform
TRIangle	Discrete		Select the triangular shape as the modulating waveform
SQUare	Discrete		Select the square shape as the modulating waveform
RAMP	Discrete		Selects the ramp shape as the modulating waveform
ARB	Discrete		Selects an arbitrary waveform as the modulating shape. The waveform must be designed and downloaded to the FM arbitrary modulating waveform memory before one can use this option. Information on how to create and download FM arbitrary waveforms is given later in this chapter.

Response
The 5251 will return SIN, TRI, SQU, RAMP, or ARB depending on the selected function shape setting.

FM:FREQuency<fm_freq>(?)

Description
This command will set the modulating wave frequency for the built-in standard modulating waveform library.

Parameters

Name	Range	Type	Default	Description
<fm_freq>	10e-3 to 100e3	Numeric	10e3	Programs the frequency of the modulating waveform in units of Hz. The frequency of the built-in standard modulating waveforms only is affected.

Response
The 5251 will return the present modulating waveform frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FM:FREQuency:RASTer<arb_fm_freq>(?)

Description
This command will set the sample clock frequency for the arbitrary modulating waveform. Arbitrary modulating waveforms must be created in an external utility and downloaded to the FM arbitrary waveform memory before this function can be used.

Parameters

Name	Range	Type	Default	Description
<arb_fm_freq>	1 to 2.5e6	Numeric	1e6	Programs the sample clock frequency of the arbitrary modulating waveform in units of S/s.

Response
The 5251 will return the present sample clock of the arbitrary modulating waveform value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FM:MARKer<frequency>(?)

Description

This function programs marker frequency position. FM marker can be placed inside the following range: (carrier frequency ± deviation frequency / 2). The marker pulse is output from the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<frequency>	10e-3 to 100e6	Numeric	1e6	Programs the marker frequency position in units of Hz.

Response

The 5251 will return the present marker frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FM:DATA#<header><binary_block>

Description

This command will download FM modulating waveform data to the arbitrary FM memory. Arbitrary modulating waveform table data is loaded to the 5251 using high-speed binary transfer in a similar way to downloading waveform data with the trace command. High-speed binary transfer allows any 8-bit bytes (including extended ASCII code) to be transmitted in a message. Remember, downloading data to the arbitrary FM waveform memory is very different than loading arbitrary waveform data. Waveform data programs amplitude domain therefore, every point programs an amplitude level. On the other hand, FM modulating waveform data programs frequency domain therefore, every point sets different sample clock frequency.

```
FM:DATA#3100<binary_block>
```

This command causes the transfer of 10 bytes of data to the arbitrary FM waveform memory. The <header> is interpreted this way:

- The ASCII "#" ($23) designates the start of the binary data block.
- "3" designates the number of digits that follow.
- "100" is the number of bytes to follow. This number must divide by 4.

The generator accepts binary data as 32-bit integers, which are sent in five-byte words. Therefore, the total number of bytes is always three times the number of arbitrary FM waveform points. For example, 100 bytes are required to download 20 arbitrary FM waveform points. The IEEE-STD-488.2 definition of Definite Length Arbitrary Block Data format is demonstrated in Figure 5-1 (refer to the TRACe subsystem). The transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0dH) and line feed (LF – 0aH) characters can be used as sequence data and will not cause unexpected termination of the arbitrary block data.

Downloading data to the arbitrary FM waveform memory is very different than loading arbitrary waveform data. Waveform data programs amplitude domain therefore, every point programs an amplitude level. On the other hand, FM modulating waveform data programs frequency domain therefore, every point sets different frequency. The FM modulating waveform data is made of 32-bit words. However, the GPIB link has 8 data bas lines and accepts 8-bit words only. Therefore, the data has to be prepared as 32-bit words and rearranged as five 8-bit words before it can be used by the 5251 as FM modulating waveform data. Figure

4-8 shows how to prepare the 32-bit word for the FM modulating waveform.

There are a number of points you should be aware of before you start preparing the data:

1. The FM function is shared by both channels
2. The number of bytes in a complete FM modulating waveform data must divide by 4. The Model 5251 has no control over data sent to its FM waveform during data transfer. Therefore, wrong data and/or incorrect number of bytes will cause errors
3. The LSBit on the last byte sets marker position. “0” = sets no marker and “1” sets marker. You can set as many markers as you want.
4. The SYNC output serves as marker output when you have the 5251 set to operate in FM mode. Normal SYNC level is TTL low. The SYNC output is set to TTL high at the position of the marker. This way you can use the SYNC output to mark frequency occurrences during FM operation.
5. Data download is terminated with the MSBit of the last byte set to 1.

The following sequence should be used for downloading arbitrary FM Waveforms:

1. Prepare your FM waveform data points using the following relationship:

   N = Frequency[Hz] x 14.31655765

2. Use an I/O routine such as ViMoveAsync (from the VISA I/O library) to transfer binary blocks of data to the generator.

Parameters

Name	**Type**	**Description**
<binary_block >	Binary	Block of binary data that contains information on the arbitrary modulating waveform.

AM modulation Programming

Use the following command for programming the AM parameters. AM control is internal. The commands for programming the amplitude modulation function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

AM:FUNCtion:SHAPe(SINusoid|TRIangle|SQUare|RAMP}(?)

Description
This command will select one of the waveform shapes as the active modulating waveform.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects the sine shape as the modulating waveform
TRIangle	Discrete		Select the triangular shape as the modulating waveform
SQUare	Discrete		Select the square shape as the modulating waveform
RAMP	Discrete		Selects the ramp shape as the modulating waveform

Response
The 5251 will return SIN, TRI, SQU, or RAMP depending on the selected function shape setting.

AM:FREQuency<am_freq>(?)

Description
This command will set the modulating wave frequency for the built-in standard modulating waveform library.

Parameters

Name	Range	Type	Default	Description
<am_freq>	10e-3 to 1e6	Numeric	10e3	Programs the frequency of the modulating waveform in units of Hz. The frequency of the built-in standard modulating waveforms only is affected.

Response
The 5251 will return the present modulating waveform frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

AM:DEPth<depth>(?)

Description
This command will set the modulating wave frequency for the built-in standard modulating waveform library.

Parameters

Name	Range	Type	Default	Description
<depth>	0 to 100	Numeric	50	Programs the depth of the modulating waveform in units of percent.

Response
The 5251 will return the present modulating depth value.

Sweep Modulation Programming

Use the following command for programming the sweep parameters. Sweep control is internal. The frequency will sweep from start to stop frequencies at an interval determined by the sweep time value and controlled by a step type determined by the sweep step parameter.

There are two sweep modes: Linear, where the step of which the generator increments from start to stop frequency is linear and Logarithmic, where the step of which the generator increments from start to stop frequency is logarithmic

The commands for programming the frequency sweep function are described below.

SWEep:STARt<start_freq>(?)

Description

This specifies the sweep start frequency. The 5251 will normally sweep from start to stop frequencies however, if the sweep direction is revered, the output will sweep from stop to start frequencies. The start and stop frequencies may be programmed freely throughout the frequency of the standard waveform frequency range.

Parameters

Name	Range	Type	Default	Description
<start_freq>	10 to 100e6	Numeric	10e3	Programs the sweep start frequency. Sweep start is programmed in units of Hz.

Response

The 5251 will return the present sweep start frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

SWEep:STOP<stop_freq>(?)

Description

This specifies the sweep stop frequency. The 5251 will normally sweep from start to stop frequencies however, if the sweep direction is revered, the output will sweep from stop to start frequencies. The start and stop frequencies may be programmed freely throughout the frequency of the standard waveform frequency range.

Parameters

Name	Range	Type	Default	Description
<stop_freq>	10 to 100e6	Numeric	1e6	Programs the sweep stop frequency. Sweep stop is programmed in units of Hz.

Response

The 5251 will return the present sweep stop frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

SWEep:TIMe<time>(?)

Description

This specifies the time that will take the 5251 to sweep from start to stop frequencies. The time does not depend on the sweep boundaries as it is automatically adjusted by the software to the required interval. At the end of the sweep cycle the output waveform maintains the sweep stop frequency setting except if the 5251 is in continuous run mode where the sweep repeats itself continuously.

Parameters

Name	Range	Type	Default	Description
<time>	1.4e-6 to 40	Numeric	1e-3	Programs the sweep time. Sweep time is programmed in units of s.

Response

The 5251 will return the present sweep time. The returned value will be in standard scientific format (for example: 100ms would be returned as 100e-3 – positive numbers are unsigned).

SWEep:DIRection(UP|DOWN}(?)

Description

This specifies if the 5251 output will sweep from start-to-stop (UP) or from stop-to-start (DOWN) frequencies. Sweep time does not affect the sweep direction and frequency limits. At the end of the sweep cycle the output waveform normally maintains the sweep stop frequency setting but will maintain the start frequency, if the DOWN option is selected except if the 5251 is in continuous run mode where the sweep repeats itself continuously.

Parameters

Name	Type	Default	Description
UP	Discrete	UP	Selects the sweep up direction
DOWN	Discrete		Select the sweep down direction

Response

The 5251 will return UP, or DOWN depending on the selected direction setting.

SWEep:SPACing(LINear|LOGarithmic}(?)

Description

This specifies the sweep step type. Two options are available: logarithmic or linear. In linear, the incremental steps between the frequencies are uniform throughout the sweep range. Logarithmic type defines logarithmic spacing throughout the sweep start and stop settings.

Parameters

Name	Type	Default	Description
LINear	Discrete	LIN	Selects the linear sweep spacing
LOGarithmic	Discrete		Select the logarithmic sweep spacing

Response

The 5251 will return LIN, or LOG depending on the selected spacing setting.

SWEep:MARKer<frequency>(?)

Description
This function programs marker frequency position. Sweep marker can be placed in between the start and the stop frequencies. The marker pulse is output from the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<frequency>	10 to 100e6	Numeric	10e3	Programs the marker frequency position in units of Hz.

Response
The 5251 will return the present marker frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FSK Modulation Programming

Use the following command for programming the FSK parameters. FSK control is internal. The frequency will shift from carrier to shifted frequency setting at a rate determined by the baud value and controlled by a sequence of bits in the FSK data table. The commands for programming the frequency shift keying function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

FSK:FREQuency:SHIFted<shift_freq>(?)

Description

This programs the shifted frequency. The frequency shifts when the pointer in the data array points to "1".

Parameters

Name	Range	Type	Default	Description
<shift_freq>	10 to 100e6	Numeric	100e3	Programs the shifted frequency value in units of Hz.

Response

The 5251 will return the present shifted frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FSK:FREQuency:BAUD<baud>(?)

Description

This allows the user to select FSK word rate. The word rate is the interval of which the bit streams in the FSK data array are clocked causing the output frequency to hop from carrier to shifted frequency values and visa versa.

Parameters

Name	Range	Type	Default	Description
<baud>	1 to 10e6	Numeric	10e3	Programs the rate of which the frequency shifts from carrier to shifted frequency in units of Hz.

Response

The 5251 will return the present baud value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FSK:FREQuency:MARKer<index>(?)

Description
Programs where on the data stream the 5251 will generate a pulse, designated as FSK marker, or index point. The marker pulse is generated at the SYNC output connector. Note that if you intend to program marker position, you must do it before you load the FSK data list.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 4000	Numeric (integer only)	1	Programs a marker pulse at an index bit position.

Response
The 5251 will return the present marker position.

FSK:DATA<fsk_data>

Description
Loads the data stream that will cause the 5251 to hop from carrier to shifted frequency and visa versa. Data format is a string of "0" and "1" which define when the output generates carrier frequency and when it shifts frequency to the FSK value. "0" defines carrier frequency,"1" defines shifted frequency. Note that if you intend to program marker position, you must do it before you load the FSK data list.

Below you can see how an FSK data table is constructed. The sample below shows a list of 10 shifts. The 5251 will step through this list, outputting either carrier or shifted frequencies, depending on the data list: Zero will generate carrier frequency and One will generate shifted frequency. Note that the waveform is always sinewave and that the last cycle is always completed.

Sample FSK Data Array

0 1 1 1 0 1 0 0 0 1

Parameters

Name	Type	Description
<fsk_data>	ASCII	Block of ASCII data that contains information for the generator when to shift from carrier to shifted frequency and visa versa.

ASK Modulation Programming

Use the following command for programming the ASK parameters. ASK control is internal. The amplitude will toggle between two amplitude settings at a rate determined by the baud value and controlled by a sequence of bits in the ASK data table. The commands for programming the amplitude shift keying function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

ASK<amplitude>(?)

Description
This programs the normal amplitude setting. The amplitude shifts when the pointer in the data array points to “1”.

Parameters

Name	Range	Type	Default	Description
<amplitude>	0 to 10	Numeric	5	Programs the amplitude setting in units of volt.

Response
The 5251 will return the present amplitude value. The returned value will be in standard scientific format (for example: 100mV would be returned as 100e-3 – positive numbers are unsigned).

ASK:SHIFted<shift_ampl>(?)

Description
This programs the shifted amplitude. The amplitude shifts when the pointer in the data array points to “1”.

Parameters

Name	Range	Type	Default	Description
<shift_ampl>	0 to 10	Numeric	1	Programs the shifted amplitude setting in units of volt.

Response
The 5251 will return the present shifted amplitude value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

ASK:BAUD<rate>(?)

Description
This allows the user to select ASK word rate. The word rate is the interval of which the bit streams in the ASK data array are clocked causing the output amplitude to hop from one level to shifted amplitude level values and visa versa.

Parameters

Name	Range	Type	Default	Description
<rate>	1 to 2.5e6	Numeric	10e3	Programs the rate of which the frequency shifts from carrier to shifted frequency in units of Hz.

Response

The 5251 will return the present baud value. The returned value will be in standard scientific format (for example: 100kHz would be returned as 100e3 – positive numbers are unsigned).

ASK:FREQuency:MARKer<index>(?)

Description
Programs where on the data stream the 5251 will generate a pulse, designated as ASK marker, or index point. The marker pulse is generated at the SYNC output connector. Note that if you intend to program marker position, you must do it before you load the ASK data list.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 1000	Numeric (integer only)	1	Programs a marker pulse at an index bit position.

Response
The 5251 will return the present marker position.

ASK:DATA<ask_data>

Description
Loads the data stream that will cause the 5251 to hop from one amplitude level to shifted amplitude level and visa versa. Data format is a string of "0" and "1" which define when the output generates base level and when it shifts amplitude to the ASK value. "0" defines base level amplitude,"1" defines shifted amplitude level. Note that if you intend to program marker position, you must do it before you load the ASK data list.

Below you can see how an ASK data table is constructed. The sample below shows a list of 10 shifts. The 5251 will step through this list, outputting either base or shifted amplitudes, depending on the data list: Zero will generate base level and One will generate shifted amplitude. Note that the waveform is always sinewave and that the last cycle is always completed.

Sample ASK Data Array

0 1 1 1 0 1 0 0 0 1

Parameters

Name	Type	Description
<ask_data>	ASCII	Block of ASCII data that contains information for the generator when to shift from base to shifted amplitude and visa versa.

Frequency

Use the following command for programming the frequency hop

Hopping Modulation Programming

parameters. Hop control is internal. The frequency will hop from frequency to frequency at a rate determined by the dwell time value and controlled by a sequence of frequencies in the HOP data table.

There are two hop modes: Fixed Dwell, where the rate of which the generator hops from frequency to frequency is constant and Variable Dwell, where the rate of which the generator hops from frequency to frequency is programmable for each hop.

The commands for programming the frequency hopping function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

FHOP:DWELl:MODe(FIXed|VARiable}(?)

Description
This selects between fixed or variable dwell-time for the frequency hops. Select the fixed option if you want each frequency to dwell equally on each step. The variable option lets you program different dwell times for each frequency hop. The 5251 output hops from one frequency to the next according to a sequence given in a hop table. The variable dwell time table contains dwell time data for each step however, the fixed dwell time table does not contain any dwell time information and therefore, if you select the fixed option, make sure your dwell time is programmed as required.

Parameters

Name	Type	Default	Description
FIXed	Discrete	FIX	Selects the fixed dwell time frequency hops mode
VARiable	Discrete		Select the variable dwell time frequency hops mode

Response
The 5251 will return FIX, or VAR depending on the selected dwell setting.

FHOP:DWELl<dwell_time>(?)

Description
This selects the dwell time for frequency hops when the selected mode is Fixed dwell time hops. The dwell time table in this case does not contain the dwell time per step parameters and therefore, the value which is programmed with this command remains constant for the entire hop sequence.

Parameters

Name	Range	Type	Default	Description
<dwell_time>	200e-9 to 20	Numeric	200e-9	Programs dwell time for the fixed dwell-time frequency hop function. The same dwell time will be valid for each frequency hop. Dwell time is programmed in units of s.

Response
The 5251 will return the present dwell time value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

FHOP:FIX:DATA<fix_hop_data>

Description

This command will download the data array that will cause the instrument to hop through the frequency list. The dwell time for each frequency list item is fixed and can be programmed using the HOP:DWEL command. Note that if you intend to program marker position, you must do it first and then load the frequency hops list.

Below you can see how a hop table is constructed. The file sample below shows a list of 10 frequencies. The 5251 will hop through this list, outputting the next frequency each time it hops. Note that the carrier waveform is always sinewave and that the last cycle is always completed even if the dwell time is shorter than the period of the waveform. For example, if you program dwell time of 1ms and the frequency step has frequency of 1Hz (1s period), the frequency step will last 1 second although the dwell time is 1ms.

Sample Frequency Hops Data Array

1e+6 2e+6 3e+3 4e+6 5e+5 6e+2 7e+1 8e+6 9e+3 10e+5

Parameters

Name	Type	Description
<fix_hop_data>	Double	Block of binary data that contains information of frequency values.

FHOP:FIX:DATA<var_hop_data>

Description

This command will download the data array that will cause the instrument to hop through the frequency list. The dwell time for each frequency list item is variable and is supplied in the variable hop table data array. Note that the HOP:DWEL command has no effect on this sequence. Also note that if you intend to program marker position, you must do it first and then load the frequency hops list.

Below you can see how a hop table is constructed. The file sample below shows a list of 10 frequencies and their associated dwell times. The 5251 will hop through this list, outputting the next frequency each time it hops. Note that the carrier waveform is always sinewave and that the last cycle is always completed even if the dwell time is shorter than the period of the waveform. For example, if you program dwell time of 1ms and the frequency step has frequency of 1Hz (1s period), the frequency step will last 1 second although the dwell time is 1ms.

Sample Frequency Hops Data Array

1e+6 100 2e+6 2000 3e+3 3e4 4e+6 40 5e+5 5e3 6e+2 6000 7e+1 0.7 8e+8e2 6 9e+3 90 10e+51000

In the above example, the first number is the frequency value and the second number is its dwell time. Therefore, only even number of sets can be located in this table.

Parameters

Name	Type	Description
<var_hop_data>	Double	Block of binary data that contains information of frequency hop values and their respective dwell time.

FHOP:MARKer<index>(?)

Description

Programs where on the frequency list the 5251 will generate a pulse, designated as Hop marker, or index point. The marker pulse is generated at the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 1000	Numeric (integer only)	1	Programs a marker pulse at an index frequency hop position.

Response

The 5251 will return the present marker position.

3D Modulation Programming

Use the following command for programming the 3D modulation parameters. 3D modulation requires an external utility to download the modulation coordinates into the 3D memory location. In case you intend to build your own 3D profiles, use the examples as given in the IVI drivers that are supplied with the 5251.

The commands for programming the 3D function are described below. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

3D:DATA<data_array>

Description

The 3D modulation allows simultaneous profiling of amplitude, frequency and phase. Amplitude profiles can be different for each channel however, frequency and phase are common to both channels. There are 30,000 waveform points that are allocated for the 3D modulation of which can be clocked using a 3D sample clock generator from 1 Hz to 2.5 MHz and thus generating up to 30,000 increments of simultaneous amplitude, frequency and phase profiles within the programmed period.

3D data must be downloaded to the 5251 before it can generate 3D profiles. The best way to generate such data would be by using the supplied ArbConnection program. Information how to use ArbConnection is given in a separate chapter of this manual. To generate the data, open the 3D Composer and create your profiles, then store the profiles with a known name. You can then use the stored files as data entry for the 3D data array input. Another way to create 3D data is by using the supplied IVI driver. The IVI driver has sample programs and software routines that show how to generate 3D data.

Regardless if you select to use ArbConnection or the IVI driver, you are always welcomed to contact the Tabor Electronics support center for information and help with this function.

Parameters

Name	Type	Description
<data_array>	Double	Block of binary data that contains information of the 3D profiles. Data contains amplitude sweeps for both channels as well as, frequency and phase sweep parameters for the 3D waveform.

3D:MARKer<index>(?)

Description

Programs where on the 3D profile the 5251 will generate a pulse, designated as 3Dop marker, or index point. The marker pulse is generated at the SYNC output connector.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 30000	Numeric (integer only)	1	Programs a marker pulse at an index 3D position.

Response

The 5251 will return the present marker position.

3D:RASTer<3D_freq>(?)

Description

This command will set the sample clock frequency for the 3D modulation profiler. The 3D waveforms must be created using an external utility and downloaded to the 3D memory before this function can be used.

Parameters

Name	Range	Type	Default	Description
<3D_freq>	1 to 2.5e6	Numeric	1e6	Programs the sample clock frequency of the 3D modulating waveform in units of S/s.

Response

The 5251 will return the present sample clock of the 3D modulating waveform value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

PSK Modulation Programming

Use the following command for programming the PSK parameters. The PSK function can shift from start to shifted phase setting, within the range of 0 to 360°, at a frequency determined by the rate value and controlled by a sequence of bits in the PSK data table. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

PSK:PHASe:<start_phase>(?)

Description

This programs the start phase of the carrier waveform. The start phase shifts when the pointer in the data array points to “0”.

Parameters

Name	Range	Type	Default	Description
<start_phase>	0 to 360	Numeric	0	Programs the start phase for the carrier waveform in units of degrees.

Response

The 5251 will return the present start phase value.

PSK:PHASe:SHIFted<shift_phase>(?)

Description

This programs the shifted phase. The phase shifts when the pointer in the data array points to “1”.

Parameters

Name	Range	Type	Default	Description
<shift_phase>	0 to 360	Numeric	180	Programs the shift phase for the carrier waveform in units of degrees.

Response

The 5251 will return the present shift phase value.

PSK:DATA<psk_data>

Description

Loads the data stream that will cause the 5251 to hop from phase to phase. Data format is a string of "0" and "1" which define when the output generates the various phases. The size of the data word depends on the PSK function. For PSK and BPSK there are only two bits - "0" defines start phase,"1" defines shifted phase. 16PSK has 4 bits of which 0000 defines the first phase vector 0001 defines the second, 0000 the third and 1111 defines the 16th phase vector. Note that if you intend to program marker position, you must do it before you load the PSK data list.

Below you can see how an PSK data table and a 16PSK data table are constructed. The PSK data table sample below shows a list of 10 shifts. The 5251 will step through this list, outputting either start or shifted phases, depending on the data list: Zero will generate start phase and One will generate shifted phase. Note that the output waveform is always sinewave and that the last cycle is always completed. The 16PSK data array has 10 shifts as well except this time the shifts are a bit more complex.

Sample PSK Data Array
0 1 1 1 0 1 0 0 0 1

Sample 16PSK Data Array
0000 0100 1010 0111 1111 0001 0010 0111 0101 1111

Parameters

Name	Type	Description
<psk_data>	ASCII	Block of ASCII data that contains information for the generator when to step from one phase setting to another.

PSK:MARKer<index>(?)

Description
Programs where on the data stream the 5251 will generate a pulse, designated as PSK marker, or index point. The marker pulse is generated at the SYNC output connector. Note that if you intend to program marker position, you must do it before you load the PSK data list. The PSK:MARK command is common to all PSK modulation functions.

Parameters

Name	Range	Type	Default	Description
<index>	1 to 4000	Numeric (integer only)	1	Programs a marker pulse at an index bit position.

Response
The 5251 will return the present marker position.

PSK:BAUD<baud>(?)

Description
This allows the user to select (n)PSK baud. The baud is the interval of which the symbols stream in the (n)PSK data array as they are clocked with the baud generator. Note that this command is dedicated for programming the (n)PSK modulation function only and will have no effect on the PSK function.

Parameters

Name	Range	Type	Default	Description
<baud>	1 to 10e6	Numeric	10e3	Programs the baud of which the symbols stream in the (n)PSK data table. Baud is programmed in units of Hz.

Response

The 5251 will return the present baud value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

Run Mode Commands

The Run Mode Commands group is used to synchronize device actions with external events. These commands control the trigger modes of the Model 5251. The generator can be placed in Triggered, Gated or Burst mode. Trigger source is selectable from an external source, an internal re-trigger generator or a software trigger. Optional nodes were omitted from these commands. The Run Mode settings affect all waveform shapes equally except when using the modulated waveforms. In the case of modulated waveform, the output idles on the carrier waveform until stimulated to output a modulation cycle or burst of cycles. Factory defaults after *RST are shown in bold typeface. Parameter low and high limits are given where applicable.

Table 4-7, Run Mode Commands

Keyword	Parameter Form	Default
:INITiate		
[:IMMediately]		
:CONTinuous	OFF | ON | 0 | 1	1
:TRIGger		
[:IMMediate]		
:BURSt		
[:STATe]	OFF | ON | 0 | 1	0
:COUNt	1 to 1000000	1
:DELay		
[:STATe]	OFF | ON | 0 | 1	0
:TIMe	200e-9 to 20	200e-9
:GATE		
[:STATe]	OFF | ON | 0 | 1	0
:LEVel	-5 to 5	1.6
:SOURce		
[:ADVance]	BUS | EXTernal | MIXed | TTLTrig 0-7 | STAR	EXT
:SLOPe	POSitive | NEGative	POS
:RETRigger		
[:STATe]	OFF | ON | 0 | 1	0
:TIMe	200e-9 to 20	200e-9
:STAR		
[:STATe]	OFF | ON	OFF

INITiate:CONTinuous{OFF|ON|0|1}(?)

Description
This command will set the output in continuous operation and interrupted operation. The run mode commands will affect the 5251 only after it will be set to interrupted operation.

Parameters

Name	Type	Default	Description
ON	Discrete	ON	Disables all interrupted modes and forces the continuous run mode
OFF	Discrete		Select the interrupted run mode. While in this switch option, you can program the 5251 to operate in triggered, gated, or counted burst run modes.

Response
The 5251 will return OFF, or ON depending on the selected option.

TRIGger:BURSt{OFF|ON|0|1}(?)

Description
This command will toggle the counted burst run mode on and off. This command will affect the 5251 only after it will be set to INIT:CONT OFF.

Parameters

Name	Type	Default	Description
OFF	Discrete	OFF	Turns the burst run mode off.
ON	Discrete		Enables the counted burst run mode. Burst count is programmable using the TRIG:BURS:COUN command.

Response
The 5251 will return OFF, or ON depending on the selected option.

TRIGger:BURSt:COUNt<burst>(?)

Description
This function sets the number of cycles when the Burst Mode is on. Use the init:cont off;:trig:burs on commands to select the Burst Mode.

Parameters

Name	Range	Type	Default	Description
<burst>	1 to 1M	Numeric (integer)	1	Programs the burst count.

Response
The 5251 will return the present burst count value.

TRIGger:DELay{OFF|ON|0|1}(?)

Description

This command will toggle the delayed trigger mode on and off. This command will affect the 5251 only after it will be set to INIT:CONT OFF.

Note: System delay must always be considered when using an external trigger. System delay is measured from a valid trigger input to the transition of the first waveform point. It has a fixed period that adds to the programmed trigger delay value. Consult Appendix A for the system delay specification.

Parameters

Name	Type	Default	Description
OFF	Discrete	OFF	Turns the delayed trigger mode off.
ON	Discrete		Enables the delayed trigger mode.

Response

The 5251 will return OFF, or ON depending on the selected option.

TRIGger:DELayTime<time>(?)

Description

The trigger delay time parameter defines the time that will elapse from a valid trigger signal to the initiation of the first output waveform. Trigger delay can be turned ON and OFF using the trig:del command. The trigger delay time command will affect the generator only after it has been programmed to operate in interrupted run mode. Modify the 5251 to interrupted run mode using the init:cont off command.

Parameters

Name	Range	Type	Default	Description
<time>	200e-9 to 20	Numeric	200e-9	Programs the trigger delay time.

Response

The 5251 will return the present trigger delay time value.

TRIGger:GATE{OFF|ON|0|1}(?)

Description

This command will toggle the gate run mode on and off. This command will affect the 5251 only after it will be set to INIT:CONT OFF.

Parameters

Name	Type	Default	Description
OFF	Discrete	OFF	Turns the gate run mode off.
ON	Discrete		Enables the gated run mode.

Response

The 5251 will return OFF, or ON depending on the selected option.

TRIGger:LEVel<level>(?)

Description
The trigger level command sets the threshold level at the trigger input connector. The trigger level command will affect the generator only after it has been programmed to operate in interrupted run mode. Modify the 5251 to interrupted run mode using the init:cont off command.

Parameters

Name	Range	Type	Default	Description
<level>	-5 to +5	Numeric	1.6	Programs the trigger level. The value affects the rear panel input only.

Response
The 5251 will return the present burst count value.

TRIGger:SOURce:ADVance{EXTernal|BUS|MIXed|TTLTrig 0-7 |STAR}(?)

Description
This selects the source from where the 5251 will be stimulated to generate waveforms. The source advance command will affect the generator only after it has been programmed to operate in interrupted run mode. Modify the 5251 to interrupted run mode using the init:cont off command.

Parameters

Name	Type	Default	Description
EXTernal	Discrete	EXT	Activates the rear panel TRIG IN input and the front panel MAN TRIG button. Either a front panel button push or a legal signal which will be applied to the rear panel input will stimulate the 5251 to generate waveforms. BUS commands are ignored.
BUS	Discrete		Selects the remote controller as the trigger source. Only software commands are accepted while rear and front panel signals are ignored
MIXed	Discrete		Hardware triggers are ignored until. First output cycle is initiated using a software command. Subsequent output cycles are initiated using one of the following: rear panel TRIG IN, or front panel MAN TRIG button.
TTL Trig 0-7	Discrete		The backplane on the PXI chassis has 8 trigger lines that can serve as source or target. Normally, these lines are designated as tri-state lines. The command converts one of these lines to input. <N> can range from 0 through 7.
STAR	Discrete		Will select the STAR trigger module, as trigger source. Select this option only if you have a STAR module in your system

Response
The 5251 will return EXT, BUS, MIX, TTLTrig 0-7 or STAR depending on the selected trigger source advance setting.

TRIGger:SLOPe{POSitive|NEGative}(?)

Description

The trigger slope command selects the sensitive edge of the trigger signal that is applied to the TRIG IN connector. The Model 5251 can be made sensitive to either the positive or negative transitions. Positive going transitions will trigger the generator when the POS option is selected. Negative transitions will trigger the generator when the NEG option is selected. In Gated mode, two transitions in the same direction are required to gate on and off the output. The trigger slope command will affect the generator only after it has been programmed to operate in interrupted run mode. Modify the 5251 to interrupted run mode using the init:cont off command.

Parameters

Name	Type	Default	Description
POSitive	Discrete	POS	Selects the positive going edge.
NEGative	Discrete		Selects the negative going edge.

Response

The 5251 will return POS, or NEG depending on the selected trigger slope setting.

RETRigger{OFF|ON|0|1}(?)

Description

This command will toggle the re-trigger mode on and off. This command will affect the 5251 only after it will be set to INIT:CONT OFF.

Parameters

Name	Type	Default	Description
OFF	Discrete	OFF	Turns the re-trigger mode off.
ON	Discrete		Enables the re-trigger mode.

Response

The 5251 will return OFF, or ON depending on the selected option.

RETRigger:Time<time>(?)

Description

This parameter specifies the amount of time that will elapse between the end of the delivery of the waveform cycle and the beginning of the next waveform cycle. Re-trigger can be initiated from any of the selected advance options. The re-trigger command will affect the generator only after it has been programmed to operate in interrupted run mode. Modify the 5251 to interrupted run mode using the init:cont off command.

Parameters

Name	Range	Type	Default	Description
<time>	200e-9 to 20	Numeric	200e-9	Programs the re-trigger period.

Response

The 5251 will return the present re-trigger period value.

TRIGger:STAR{OFF|ON|0|1}(?)

Description
In addition to bused PXI triggers, the PXI bus has included an independent trigger (PXI_STAR) for each slot that is oriented in a star configuration from the star trigger slot. The star trigger slot is adjacent to the system slot and uses the 13 left local bus signals as the star triggers. The PXI_STAR specifications are only partially implemented in the TE5251 where only 8 star lines are being addressed, all of them in parallel thus, if you plug the card in slot 2 and turn TRIG:STAR ON, the front-panel SYNC signal will be routed to 8 STAR lines simultaneously. The TE5251 controls star lines in slots 3 through 10.

Parameters

Name	Type	Default	Description
OFF (0)	Discrete	OFF	Turns the STAR mode off.
ON (1)	Discrete		Enables the STAR mode.

Response
The 5251 will return 1 if star lines are active, or 0 if star lines are disabled.

Auxiliary Commands

The auxiliary commands control auxiliary functions that are not directly related to the main function of the arbitrary waveform generator however, constitute an important part of operating the 5251. These commands can transform the 5251 into a stand-alone pulse generator, or counter/timer. Also use these commands to generate half cycle waveforms. The auxiliary commands are listed in Table 4-8. Factory defaults after *RST are shown in bold typeface. Parameter low and high limits are given where applicable.

Table 4-8, Auxiliary Commands

Keyword	Parameter Form	Default
Digital Pulse Commands		
:AUXiliary		
:PULSe		
:DELay	0 to 1e3	0
:DOUBle		
[:STATe]	OFF | ON | 0 | 1	0
:DELay	0 to 1e3	1e-3
:HIGH	0 to 1e3	1e-3
:LEVel		
:HIGH	-4.950 to 5	5
:LOW	-5 to 4.950	0
:PERiod	80e-9 to 2e6	10e-3
:POLARity	NORMal | COMPlemented | INVerted	NORM
[:STATe]	OFF | ON | 0 | 1	1
:TRANsition		
[:LEADing	0 to 1e3	1e-3
:TRAiling]	0 to 1e3	1e-3
	Counter/Timer Commands	
:COUNter		
:DISPlay		0
:MODe	NORMal | HOLD	NORM
:GATe		0
[:TIMe]	100e-6 to 1	1
:FUNCtion	FREQuency | PERiod | APERiod | PULSe | GTOTalize | ITOTalize	FREQ
:READ		
:RESet		
	Half Cycle Commands	
:HALFcycle		
:DELay	200e-9 to 20	1e-6
:DCYCle	0 to 99.99	50
:FREQuency	10e-3 to 1e6	1e6
:PHASe	0 to 360	0
:SHAPe	SINusoid | TRIangle | SQUare	SIN

Digital Pulse Programming

Use the following command for programming the pulse parameters. The pulse is created digitally however, it closely simulates an analog pulse generator so pulse parameters are programmed just as they would be programmed on a dedicated pulse generator instrument. Just bear in mind that since this is a digital instrument, there are some limitations to the pulse design that evolve from the fact that the best resolution is one sample clock interval and also, keep in mind that the pulse is created digitally in the arbitrary memory and therefore, its smallest incremental step has a maximum value limitation as specified in Appendix A.

AUXiliary:PULse:DELay<delay>(?)

Description

This command will program the delayed interval of which the output idles on the low level amplitude until the first transition to high level amplitude.

Parameters

Name	Range	Type	Default	Description
<delay>	0 to 1e3	Numeric	0	Will set the delay time interval in units of seconds. Note that the sum of all parameters, including the pulse delay time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed first and then all other pulse parameters.

Response

The 5251 will return the pulse delay value in units of seconds.

AUXiliary:PULse:DOUBle{OFF|ON|0|1}(?)

Description

This command will turn the double pulse mode on and off. The double pulse mode duplicates the first pulse parameters at a delayed interval set by the double pulse delay value.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Sets the double pulse mode on and off

Response

The 5251 will return 0, or 1 depending on the present double mode setting.

AUXiliary:PULse:DOUBle:DELay<d_delay>(?)

Description
This command will program the delay between two adjacent pulses when the double mode is selected. Otherwise, the double pulse delay has no effect on the pulse structure.

Parameters

Name	Range	Type	Default	Description
<d_delay>	0 to 1e3	Numeric	2e-3	Will set the delay between two adjacent pulses for the double pulse mode in units of seconds. Note that the sum of all parameters, including the pulse delay time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed before all other pulse parameters.

Response
The 5251 will return the present double pulse delay value in units of seconds.

AUXiliary:PULse:HIGH<high>(?)

Description
This command will program the interval the pulse will dwell on the high level value. Although they have similar interpretation, the high time and pulse width are significantly different. The standard terminology of pulse width defines the width of the pulse at the mid-point of its peak-to-peak amplitude level. Therefore, if you change the rise and fall time, the pulse width is changing accordingly. The digital pulse high time parameter defines how long the pulse will dwell on the high level so even if you change the rise and fall times, the high time remains constant. The pulse high time is programmed in units of seconds.

Parameters

Name	Range	Type	Default	Description
<high>	0 to 1e3	Numeric	1e-3	Will set the width of the high time for the pulse shape in units of seconds. Note that the sum of all parameters, including the high time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed before all other pulse parameters.

Response
The 5251 will return the present high time value in units of seconds

AUXiliary:PULse:LEVel:HIGH<high>(?)

Description
This command will program the high level for the pulse shape. Note that the same level is retained for the second pulse in the double pulse mode.

Parameters

Name	Range	Type	Default	Description
<high>	-4.950 to 5	Numeric	5	Will set the pulse high level in units of volts. Note that the high level setting must be higher than the low level setting. Also note that high to low level value must be equal or larger than 8 mV.

Response
The 5251 will return the present low level value in unit of volts.

AUXiliary:PULse:LEVel:LOW<low>(?)

Description
This command will program the phase offset between two adjacent instruments. Normally this command should be used on the slave unit. The phase offset control provides means of generating multiple signals with phase offset between them.

Parameters

Name	Range	Type	Default	Description
<low>	-5 to 4.950	Numeric	0	Will set the pulse low level in units of volts. Note that the low level setting must be smaller than the high level setting. Also note that low to high level value must be equal or larger than 8 mV.

Response
The 5251 will return the present high level value in unit of volts.

AUXiliary:PULse:PERiod<period>(?)

Description
This command will program the pulse repetition rate (period). Note that the sum of all parameters, including the pulse delay, rise, high and fall times must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed first before all other pulse parameters. Note that by selecting the double pulse mode, the pulse period remains unchanged.

Parameters

Name	Range	Type	Default	Description
<period>	80e-9 to 2e6	Numeric	10e-3	Will program the period of the pulse waveform in units of seconds.

Response
The 5251 will return the present pulse period value in units of seconds.

AUXiliary:PULse:POLarity{NORMal||COMPlemented|INVerted (?)

Description
This command will program the polarity of the pulse in reference to the base line level. The polarity options are: Normal, where the pulse is generated exactly as programmed; Inverted, where the pulse is inverted about the 0 level base line; and Complemented, where the pulse is inverted about its mid amplitude level.

Parameters

Name	Type	Default	Description
NORMal	Discrete	NORM	Programs normal pulse output
COMPlemeted	Discrete		Programs complemented pulse output
INVerted	Discrete		Programs an inverted pulse output

Response
The 5251 will return NORM, COMP or INV depending on the present polarity setting

AUXiliary:PULse{OFF|ON|0|1}(?)

Description
Use this command to disable a specific channel from calculating pulse parameters. This is specifically useful for accelerating pulse computation for channels that are needed for pulse generation.

Parameters

Range	Type	Default	Description
0-1	Discrete	0	Toggles pulse computation for a specific channel on and off

Response
The 5251 will return 0, or 1 depending on the present state setting.

AUXiliary:PULse:TRANsition<rise>(?)

Description
This command will program the interval it will take the pulse to transition from its low to high level settings. The parameter is programmed in units of seconds.

Parameters

Name	Range	Type	Default	Description
<rise>	0 to 1e3	Numeric	1e-3	Will set the rise time parameter. Note that the sum of all parameters, including the rise time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed before all other pulse parameters.

Response
The 5251 will return the present rise time value in units of seconds.

AUXiliary:PULse:TRANsition:TRAiling<fall>(?)

Description
This command will program the interval it will take the pulse to transition from its high to low level settings. The parameter is programmed in units of seconds.

Parameters

Name	Range	Type	Default	Description
<fall>	0 to 1e3	Numeric	1e-3	Will set the fall time parameter. Note that the sum of all parameters, including the fall time must not exceed the programmed pulse period and therefore, it is recommended that the pulse period be programmed before all other pulse parameters.

Response
The 5251 will return the present fall time value in units of seconds.

Counter/Timer Programming

Use the following command for programming the counter/timer measuring function and other parameters. The counter/timer function is created digitally however, it closely simulates a stand-alone counter/timer so its functions are programmed just as they would be programmed on a dedicated instrument. The specifications and limitations of the counter/timer are specified in Appendix A.

COUNter:FUNCtion{FREQuency|PERiod|APERiod|PULSe|ITOTalize|GTOTalize(?)

Description
This command will program the measurement function for the counter/timer. Each measurement can be set up with its gate time (where applicable) and display mode.

Parameters

Name	**Type**	**Default**	**Description**
FREQuency	Discrete	FREQ	Will select the frequency measurement function. Frequency is measured on continuous signal only. The result of the frequency measurement has gate-dependent resolution. The 5251 displays 7 digits of frequency reading in one second of gate time. If the gate time is decreased, the number of displayed digits decreases proportionally to the gate time interval. Reduce the gate time when you want to accelerate the reading process however, always make sure that the period of the signal is smaller than the gate time setting.
PERiod	Discrete		Will select the period measurement function. Period can be measured on either continuous or non-repetitive signals. Since the period of the signal is directly proportional to the gating time, the number of displayed digits decreases proportionally to the period of the signal. If you need to have more resolution and you signal is repetitive, use the period averaged measurement function. The best resolution in period measurements is 100 ns.
APERiod	Discrete		Will select the period averaged measurement function. Period averaged can be measured continuous signals only. In fact, this is the inverse function of frequency and therefore, gate time determines the resolution of the reading. Reduce the gate time when you want to accelerate the reading process however, always make sure that the period of the signal is smaller than the gate time setting.
PULSe	Discrete		Will select the pulse width measurement function. Pulse width can be measured on either continuous or non-repetitive signals. Since the width of the signal is directly

			proportional to the gating time, the number of displayed digits decreases proportionally to the pulse width of the signal. The best resolution in period measurements is 10 ns.
GTOTalize	Discrete		Will select the gated totalize measurement function. In this mode, the gate opens when the first valid signal is sensed at the counter input and closed at the end of the gate time interval. The number of pulses that enter during the gate time interval is displayed until cleared and the counter is armed for the next measurement cycle. The counter can accumulate 8 digits before it will overflow. An overflow indication is available.
ITOTalize	Discrete		Will select the totalize measurement function. In this mode, the gate opens when the first valid signal is sensed at the counter input and remains open until programmed otherwise. Pulse are counted and displayed continuously until intervened externally. The counter can accumulate 8 digits before it will overflow. An overflow indication is available.

Response

The 5251 will return FREQ, PER, APER, PULS, GTOT or ITOT depending on the present measurement function setting.

COUNter:DISPlay:MODe{NORMal|HOLD(?)

Description

This command will program the display time mode for the counter/timer. The two modes are normal for continuous display readings and hold for single reading after arming the counter input.

Parameters

Name	**Type**	**Default**	**Description**
NORMal	Discrete	NORM	Will select the continuous reading mode. In this case, the counter input is self-armed, which means that every valid signal that is sensed at the trigger input connector will be counted and measured processed and results placed on the interface port.
HOLD	Discrete		Will select the single reading mode. In this case, the counter input is armed first and the first valid signal that is sensed at the trigger input connector will be counted and measured and its result processed and placed on the interface port.

Response

The 5251 will return NORM, INV or COMP depending on the present polarity setting

COUNter:GATe<interval>(?)

Description
This command will program the gate time interval for frequency, period averaged and totalize in gated mode. Measurements will be taken only after the input has been armed and valid signal available at the input connector. Notice however, that the gate time internal must be larger than the period of the measure signal.

Parameters

Name	Range	Type	Default	Description
<interval>	100e-6 to 1	Numeric	1	Will program the gate time interval in units of seconds. In continuous mode, the counter is self-armed and therefore every valid signal at the counter input will open the gate and initiate a measurement cycle. In hold mode, the counter must be armed before the gate can open. Always make sure the programmed gate time interval is larger than the period of the measured signal.

Response
The 5251 will return the present gate time value in units of seconds.

COUNter:READ

Description
This command will interrogate the counter/timer for a reading. Note that the read command must follow a valid gate time interval otherwise reading will not be available and the interface bus will be held until the measurement cycle has been completed and result available to be read.

Response
The 5251 will return the result of the present measurement function reading. The returned value will be in standard scientific format (for example: 10 MHz would be returned as 10e6 – positive numbers are unsigned).

COUNter:RESet

Description
This command will reset the counter/timer and arm the instrument for its next reading.

Half Cycle Programming

Use the following command for programming the half cycle functions and their associated parameters. There are three half cycle functions: Sine, Triangle and Square. The specifications and limitations of the half cycle functions are specified in Appendix A.

AUXiliary:HALFcycle:DELay<delay>(?)

Description
This command will program the interval of which the output idles between half cycles. The idle level is normally 0 V except if programmed otherwise with the volt:offs command.

Parameters

Name	Range	Type	Default	Description
<delay>	200e-9 to 20	Numeric	1e-6	Will set the delay time interval between half cycles in units of seconds.

Response
The 5251 will return the half cycle delay value in units of seconds.

AUXiliary:HALFcycle:DCYCle<duty_cycle>(?)

Description
This command will program the duty cycle of the square waveform when the half cycle square shape is selected. Note that this command has no effect on the standard square wave duty cycle.

Parameters

Name	Range	Type	Default	Description
<duty_cycle>	0 to 99.99	Numeric	50	Will set the delay time interval between half cycles in units of seconds.

Response
The 5251 will return the square wave duty cycle value in units of percent.

AUXiliary:HALFcycle:FREQuency<freq>(?)

Description
This command programs the frequency of the half cycle waveforms in units of hertz (Hz). It has no affect on the frequency of other waveform functions.

Parameters

Name	Range	Type	Default	Description
<freq>	10e-3 to 1e6	Numeric	1e6	Will set the frequency of the half cycle waveform in units of Hz. This parameter does not affect the frequency of other waveform functions.

Response
The 5251 will return the present half cycle frequency value. The returned value will be in standard scientific format (for example: 100mHz would be returned as 100e-3 – positive numbers are unsigned).

AUXiliary:HALFcycle:PHASe<phase>(?)

Description
This command programs the start phase of the half cycle sine and triangle waveform. This command has no affect on other waveform functions.

Parameters

Name	Range	Type	Default	Description
<phase>	0 to 360	Numeric	0	Programs the start phase parameter for the half cycle sine and triangle waveforms in units of degrees. The phase can be programmable with resolution of 0.05° throughout the entire frequency range of the half cycle function.

Response
The 5251 will return the present start phase value.

AUXiliary:HALFcycle:SHAPe{SINusoid|TRIangle|SQUare}(?)

Description
This command defines the type of half cycle waveform that will be available at the output connector.

Parameters

Name	Type	Default	Description
SINusoid	Discrete	SIN	Selects the half cycle sine waveform.
TRIangle	Discrete		Selects the half cycle triangular waveform.
SQUare	Discrete		Selects the half cycle square waveform.

Response
The 5251 will return SIN, TRI, or SQU depending on the present 5251 setting

System Commands

The system-related commands are not related directly to waveform generation but are an important part of operating the 5251. These commands can reset or test the instrument, or query the instrument for system information.

Table 4-9, System Commands Summary

Keyword	Parameter Form	Default
:RESet (*RST)		
:SYSTem		
:ERRor?		
:INFOrmation		
:CALibration?		
:MODel?		
:SERial?		

RESet, or *RST

Description
This command will reset the 5251 to its factory defaults.

SYSTem:ERRor?

Description
Query only. This query will interrogate the 5251 for programming errors.

Response
The 5251 will return error code. Error messages are listed later in this manual.

SYSTem:INFormation:CALibration?

Description
Query only. This query will interrogate the instrument for its last calibration date.

Response
The generator will return the last calibration date in a format similar to the following: 24 Oct 2006 (10 characters maximum).

SYSTem:INFormation:MODel?

Description

Query only. This query will interrogate the instrument for its model number in a format similar to the following: 5251. The model number is programmed to a secure location in the flash memory and cannot be modified by the user.

Response

The generator will return its model number either 2571A or 5251.

SYSTem:INFormation:SERial?

Description

Query only. This query will interrogate the instrument for its serial number. The serial number is programmed to a secure location in the flash memory and cannot be modified by the user.

Response

The generator will return its serial number in a format similar to the following: 000000451 (10 characters maximum).

IEEE-STD-488.2 Common Commands and Queries

Since most instruments and devices in an ATE system use similar commands that perform similar functions, the IEEE-STD-488.2 document has specified a common set of commands and queries that all compatible devices must use. This avoids situations where devices from various manufacturers use different sets of commands to enable functions and report status. The IEEE-STD-488.2 treats common commands and queries as device dependent commands. For example, *TRG is sent over the bus to trigger the instrument. Some common commands and queries are optional, but most of them are mandatory.

The following is a complete listing of all common-commands and queries, which are used by the 5251

***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.

***IDN?** - Query the generator’s identity. The returned data is organized into four fields, separated by commas. The generator responds with its manufacturer and model number in the first two fields, and may also report its serial number and options in fields three and four. If the latter information is not available, the device must return an ASCII 0 for each. For example, Model 5251 response to *IDN? is:

Tabor,5251,0,1.0

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

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

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

Error Messages

In general, whenever the 5251 receives an invalid SCPI command, it automatically generates an error. Errors are stored in a special error queue and may be retrieved from this buffer one at a time. Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. When you have read all errors from the queue, the generator responds with a 0,"No error" message.

If more than 30 errors have occurred, the last error stored in the queue is replaced with -350, “Queue Overflow”. No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the generator responds with 0,"No error".

The error queue is cleared when power has been shut off or after a *CLS command has been executed. The *RST command does not clear the error queue. Use the following command to read the error queue:

`SYSTem:ERRor?`

Errors have the following format (the error string may contain up to 80 characters):

-102,"Syntax error"

A complete listing of the errors that can be detected by the generator is given below.

-100,"Command error". When the generator cannot detect more specific errors, this is the generic syntax error used.

-101,"Invalid Character". A syntactic element contains a character, which is invalid for that type.

-102,"Syntax error". Invalid syntax found in the command string.

-103,"Invalid separator". An invalid separator was found in the command string. A comma may have been used instead of a colon or a semicolon. In some cases where the generator cannot detect a specific separator, it may return error -100 instead of this error.

-104,"Data type error". The parser recognized a data element different than allowed.

-108,"Parameter not allowed". More parameters were received than expected for the header.

-109,"Missing parameter". Too few parameters were received for the command. One or more parameters that were required for the command were omitted.

-128."Numeric data not allowed". A legal numeric data element was received, but the instrument does not accept one in this position.

-131,"Invalid suffix". A suffix was incorrectly specified for a numeric parameter. The suffix may have been misspelled.

-148,"Character data not allowed". A character data element was encountered where prohibited by the instrument.

-200,"Execution error". This is the generic syntax error for the instrument when it cannot detect more specific errors. Execution error as defined in IEEE-488.2 has occurred.

-221,"Setting conflict". Two conflicting parameters were received which cannot be executed without generating an error. Listed below are events causing setting conflicts.

1. Sum of pulse or ramp parameters is more than 100. Corrective action: Change parameters to correct the problem.
2. ampl/2 + |offset| is more than 16. Corrective action: Reduce offset to 0, then change amplitude-offset values to correct the problem.
3. Activating filters when the 5251 is set to output the built-in sine

waveform, or activating the built-in sine waveform when one of the 5251 filters is turned on. Corrective action: If in sine, select another function and activate the filter(s).

4. Activating burst mode when the 5251 is set to sequence mode, or activating sequence mode when the 5251 is set to burst mode. Corrective action: Remove the 5251 from burst or sequence and then selected the desired mode.

5. Changing operating mode from triggered to continuous when the 5251 is set to single sequence advance, or changing the operating mode from continuous to triggered when the 5251 is set to automatic sequence advance mode. Corrective action: Observe the 5251 advance mode while setting sequence advance.

-222,"Data out of range". Parameter data, which followed a specific header, could not be used because its value is outside the valid range defined by the generator.

-224,"Illegal parameter value". A discrete parameter was received which was not a valid choice for the command. An invalid parameter choice may have been used.

-300,"Device-specific-error". This is the generic device-dependent error for the instrument when it cannot detect more specific errors. A device- specific error as defined in IEEE-488.2 has occurred.

-311,"Memory error". Indicates that an error was detected in the instrument's memory.

-350,"Queue Overflow". The error queue is full because more than 30 errors have occurred. No additional errors are stored until the errors from the queue are removed. The error queue is cleared when power has been shut off, or after a *CLS command has been executed.

-410,"Query INTERRUPTED". A command was received which sends data to the output buffer, but the output buffer contained data from a previous command (the previous data is not overwritten). The output buffer is cleared when power is shut off or after a device clear has been executed.

This page was left intentionally blank

Chapter 5
Performance Checks

Title	Page

What's in This Chapter

This chapter provides performance tests necessary to troubleshoot the Model 5251 PXIbus Universal Waveform Generator.

WARNING

The procedures described in this section are for use only by qualified service personnel. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.

CAUTION

ALWAYS PERFORM PERFORMANCE TESTS IN A STATIC SAFE WORKSTATION.

Performance Checks

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

1. As a part of the incoming inspection of the instrument specifications;
2. As part of the troubleshooting procedure;
3. After any repair or adjustment before returning the instrument to regular service.

Environmental Conditions

Tests should be performed under laboratory conditions having an ambient temperature of 25°C, ±5°C and at relative humidity of less than 80%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure. Specifications are valid within an ambient temperature of 25°C, ±5°C and at relative humidity of less than 80%. Below 20°C and above 30°C, the specifications are degraded by 0.1% for every ±1°C change

Warm-up Period

Most equipment is subject to a small amount of drift when it is first turned on. To ensure accuracy, turn on the power to the Model 5251 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 Model 5251 to factory defaults, use the Factory Rest option in the Utility Panel.

Recommended Test Equipment

Recommended test equipment for troubleshooting, calibration and performance checking is listed in Table 1 below. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

Table Chapter 5-1, Recommended Test Equipment

Equipment	Model No.	Manufacturer
Oscilloscope (with jitter package)	LT342	LeCroy
Distortion Analyzer	6900B	Krohn Hite
Digital Multimeter	2000	Keithley
Freq. Counter	6020R	Tabor Electronics
Spectrum Analyzer	E4411	HP
Pulse Generator (with manual trigger)	8571	Tabor Electronics

Test Procedures

Use the following procedures to check the Model 5251 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 must be calibrated or tested to find the source of the problem.

Frequency Accuracy

Frequency accuracy checks tests the accuracy of the internal oscillator. The internal oscillator determines the accuracy and stability of the entire generator.

Frequency Accuracy, Internal Reference

Equipment: Counter

Preparation:
1. Configure the counter as follows:
   Termination: 50 Ω, DC coupled
2. Connect the 5251 output to the counter input – channel A
3. Configure the 5251 as follows:
   Waveform: Squarewave
   Amplitude: 2 V
   Output: On
   Frequency: As specified in Table 2

Test Procedure:
1. Perform frequency Accuracy tests using Table 2

Table Chapter 5-2, Frequency Accuracy

5251 Setting	Error Limits	Counter Reading	Pass	Fail
10.0000000 Hz	±10µHz			
1.00000000 kHz	±1mHz			
100.000000 kHz	±100mHz			
1.00000000 MHz	±1Hz			
100.0000000 MHz	±100Hz			

Frequency Accuracy, External 10MHz Reference

Equipment: 10MHz reference (at least 0.1ppm), Counter

Preparation:
2. Leave counter setting and 5251 connections as in last test
3. Connect the 10MHz reference oscillator to the 5251 10 MHz reference input
4. Configure the 5251 as follows:
   10 MHz: External
   Waveform: Squarewave
   Amplitude: 2 V
   Output: On
   Frequency: As specified in Table 3

Test Procedure:
1. Perform frequency Accuracy tests using Table 3

Table Chapter 5-3, Frequency Accuracy Using External 10 MHz Reference

5251 Setting	Error Limits	Counter Reading	Pass	Fail
10.000000000 MHz	±1 Hz			
50.000000000 MHz	±5 Hz			

Amplitude Accuracy

Amplitude accuracy checks tests the accuracy of the output amplifier and attenuators. Each channel has its own set of amplifiers and attenuators and therefore, the accuracy is tested on each channel separately. Amplitude path is checked for both the DAC route (arbitrary and standard waveforms) and the DDS route (CW and modulated waveforms).

Amplitude Accuracy, DAC Output

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Termination: 50 Ω feedthrough at the DMM input
   Function: ACV
2. Connect 5251 Channel to the DMM input
3. Configure the 5251 as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: As specified in Table 4

Test Procedure:

1. Perform amplitude Accuracy tests using Table 4

Table Chapter 5-4, Amplitude Accuracy, DAC output

5251 Amplitude Setting	Error Limits	DMM Reading	Pass	Fail
10.00V	3.534V, ±60mV			
5.000V	1.767V, ±42mV			
500mV	176.7mV, ± 6.7mV			
50.00mV	17.67mV, ± 2.1mV			

Amplitude Accuracy, DDS Output

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Termination: 50 Ω feedthrough at the DMM input
   Function: ACV
2. Connect 5251 output to the DMM input
3. Configure the 5251 as follows:

Waveform: Modulated
Modulation: OFF
CW Frequency: 1 kHz
Output: On
Amplitude: As specified in Table 5

Test Procedure:

1. Perform amplitude Accuracy tests using Table 5

Table Chapter 5-5, Amplitude Accuracy, DDS output

5251 Amplitude Setting	Error Limits	DMM Reading	Pass	Fail
10.00V	3.534V, ±60mV			
5.000V	1.767V, ±42mV			
500mV	176.7mV, ± 6.7mV			
50.00mV	17.67mV, ± 2.1mV			

Offset Accuracy

Offset accuracy checks tests the accuracy of the offset generators. Each channel has its own set of offset generators and therefore, the accuracy is tested on each channel separately. Offset path is checked for both the DAC route (arbitrary and standard waveforms) and the DDS route (CW and modulated waveforms).

Offset Accuracy, DAC Output

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Termination: 50 Ω feedthrough at the DMM input
   Function: DCV
2. Connect 5251 output to the DMM input
3. Configure the 5251 as follows:
   Frequency: 1 MHz
   Amplitude: 20 mV
   Output: On
   Offset: As specified in Table 6

Test Procedure:

1. Perform Offset Accuracy tests using Table 6

Table Chapter 5-6, Offset Accuracy, DAC Output

5251 Offset Setting	Error Limits	DMM Reading	Pass	Fail
+4.000 V	4.000 V ±45 mV			
+1.500 V	1.500 V ±20 mV			
0.000 V	0 V ±20 mV			
-1.500 V	-1.500 V ±20 mV			
-4.000 V	-4.000 V ±45 mV			

1. Modify 5251 Amplitude setting to 6 V and offset setting to 0 V
2. Continue the Offset tests using Table 7

Table Chapter 5-7, Offset Accuracy, DAC Output - Continued

5251 Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±65 mV			

Offset Accuracy, DDS Output

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   - Termination: 50 Ω feedthrough at the DMM input
   - Function: DCV
2. Connect 5251 output to the DMM input
3. Configure the 5251 as follows:
   - Waveform: Modulated
   - Modulation: OFF
   - CW Frequency: 1 MHz
   - Amplitude: 1 V
   - Output: On

Test Procedure:

1. Perform Offset Accuracy tests using Table 8

Table Chapter 5-8, Offset Accuracy, DDS Output

5251 Offset Setting	Error Limits	DMM Reading	Pass	Fail
0.000 V	0 ±10 mV			

Squarewave Characteristics

This tests the characteristics of the square waveform. It includes transition times, ringing and overshoot.

Squarewave Checks

Equipment: Oscilloscope, 50 Ω, 20 dB attenuator feed through

Preparation:

1. Configure the Oscilloscope follows:
   Termination: 50 Ω, 20 dB attenuator feed through at the oscilloscope input
   Setup: As required for the test
2. Connect 5251 output to the oscilloscope input

   Configure the 5251 as follows:

   Frequency: 1 MHz
   Waveform: Squarewave
   Amplitude: 10 V
   Output: On

Test Procedure:

1. Perform Squarewave Characteristics tests using Table 9

Table Chapter 5-9, Square wave Characteristics - Continued

Parameter Tested	Error Limits	Oscilloscope Reading	Pass	Fail
Rise/Fall Time	<4.5 ns			
Ringing	<6 % + 10 mV			
Over/undershoot	<6 % + 10 mV			

Sinewave Characteristics

This tests the characteristics of the sine waveform. It includes distortion, spectral purity and flatness. Tests are done for both the DAC route (arbitrary and standard waveforms) and the DDS route (CW and modulated waveforms).

Sinewave Distortion, DAC Output

Equipment: Distortion Analyzer, Spectrum Analyzer, and ArbConnection

Preparation:

1. Connect 5251 output to the distortion analyzer input. Configure the 5251 as follows:
   SCLK: As required by the test
   Waveform: Arbitrary
   Amplitude: 5 V
   Output: On

2. Using ArbConnection prepare and download the following waveform:
   Wavelength: As required by the test
   Waveform: Sinewave

Test Procedure:
1. Perform Sinewave distortion tests using Table 10

Table Chapter 5-10, Sinewave Distortion, DAC Output Tests

5251 SCLK Settings	Sinewave Points	5251 Frequency	Reading Limits	Distortion Reading	Pass	Fail
4 MS/s	4000	1.000 kHz	< 0.1%			
40 Ms/s	4000	10.00 kHz	< 0.1%			
200 Ms/s	2000	100.00 kHz	< 0.1%			

Sinewave Spectral Purity, DAC Output

Equipment: Spectrum Analyzer

Preparation:
1. Connect 5251 output to the spectrum analyzer input. Use 50Ω and 20dB feedthrough termination at the spectrum analyzer input
2. Configure the 5251 as follows:
   Amplitude: 5 V
   Output: On
   Frequency: As required by the test

Test Procedure:
1. Perform sinewave spectral purity, DAC waveforms tests using Table 11

Table Chapter 5-11, Sinewave Spectral Purity, DAC Output Test

5251 Freq Settings	Reading Limits	Spectrum Analyzer Settings			Pass	Fail
		Start	Stop	Reading		
10 MHz	>45 dBc	1 MHz	100 MHz			
50 MHz	>30 dBc	10 MHz	200 MHz			
100 MHz	>30 dBc	10 MHz	250 MHz			

Sinewave Spectral Purity, DDS Output

Equipment: Spectrum Analyzer

Preparation:

1. Connect 5251 output to the spectrum analyzer input. Use 50 Ω and 20 dB feedthrough termination at the spectrum analyzer input
2. Configure the 5251 as follows:
   Waveform: Modulated
   Modulation: OFF
   Amplitude: 5 V
   Output: On
   CW Frequency: As required by the test

Test Procedure:

1. Perform sinewave spectral purity, DDS Waveforms tests using Table 12

Table Chapter 5-12, Sine Wave Spectral Purity, DDS Output Tests

5251 Freq Settings	Reading Limits	Spectrum Analyzer Settings			Pass	Fail
		Start	Stop	Reading		
10 MHz	>45 dBc	1 MHz	100 MHz			
50 MHz	>30 dBc	10 MHz	200 MHz			
100 MHz	>30 dBc	10 MHz	250 MHz			

Sinewave Flatness, DAC Output

Equipment: Oscilloscope

Preparation:

1. Configure the Oscilloscope follows:
   Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
2. Connect 5251 output to the oscilloscope input
3. Configure the 5251 as follows:
   Amplitude: 5 V
   Output: On
   Frequency: Initially, 1 kHz then, as required by the test

Test Procedure:

1. Adjust the vertical controls of the Oscilloscope to get 6 division of display
2. Perform Sine flatness, DAC waveforms tests using Table 13

Table Chapter 5-13, Sinewave Flatness, DAC Output Test

5251 Sine Frequency	Error Limits	Oscilloscope Reading	Pass	Fail
1 MHz	6 Divisions	Reference	X	X
10 MHz	6 ±0.2 Divisions			
50 MHz	6 ±0.3 Divisions			
100 MHz	6 ±0.5 Divisions			

Sinewave Flatness, DDS Output

Equipment: Oscilloscope

Preparation:

1. Configure the Oscilloscope follows:
   Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
2. Connect 5251 output to the oscilloscope input
3. Configure the 5251 as follows:
   Waveform: Modulated
   Modulation: OFF
   Amplitude: 5 V
   Output: On
   CW Frequency: Initially, 1 kHz then, as required by the test

Test Procedure:

1. Adjust the vertical controls of the Oscilloscope to get 6 division of display
2. Perform Sine flatness, DDS waveforms tests using Table 14

Table Chapter 5-14, Sinewave Flatness Test, DDS Output

5251 Sine Frequency	Error Limits	Oscilloscope Reading	Pass	Fail
1 MHz	6 Divisions	**Reference**	**X**	**X**
10 MHz	6 ±0.2 Divisions			
50 MHz	6 ±0.3 Divisions			
100 MHz	6 ±0.5 Divisions			

Trigger operation Characteristics

This tests the operation of the trigger circuit. It includes tests for the triggered, gated and counted bursts run modes. It also tests the operation of the trigger advance options, the delayed trigger and re-trigger functions, as well as the trigger input level and slope sensitivity.

Trigger, Gate, and Burst Characteristics

Equipment: Oscilloscope, function generator, counter

Preparation:

1. Configure the Oscilloscope as follows:
   Termination: 50 Ω, 20d B feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
2. Configure the counter as follows:
   Function: TOT B
   Trigger Level: 100 mV
3. Connect 5251 output to the oscilloscope input
4. Configure the function generator as follows:
   Frequency 1 MHz
   Run Mode: As required by the test
   Wave: TTL Square
5. Connect the function generator output to the 5251 TRIG IN connector
6. Configure the 5251 as follows:
   Frequency: 25 MHz
   Waveform: Sinewave
   Burst Count: 1e6 counts
   Amplitude: 1 V
   Trigger Source: External
   Output: On

Test Procedure:

1. Perform trigger and gate tests using Tables 15

Table Chapter 5-15, Trigger, gate, and burst Characteristics

5251 Run Mode	External Trigger Pulse	Oscilloscope/Counter Reading	Pass	Fail
Triggered	1 MHz, Continuous	Triggered waveform		
Gated	1 MHz, Continuous	Gated Waveform		
Burst	Single shot	Burst, 106 waveforms		

Mixed Trigger Advance Test

Equipment: Oscilloscope, function generator, ArbConnection

Preparation:

1. Configure the Oscilloscope follows:
   Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
   Run Mode: Single
2. Connect 5251 output to the oscilloscope input
3. Configure the function generator as follows:
   Frequency 100 kHz
   Run Mode: Continuous

Wave: TTL Square from the main output.

4. Connect the function generator output to the 5251 TRIG IN connector
5. Configure the 5251 as follows:
   Frequency: 25 MHz
   Waveform: Sinewave
   Run Mode: Burst
   Burst Count: 5 counts
   Trigger Delay: On
   Delay: 5 s
   Amplitude: 5 V
   Trigger Source: Mixed
   Output: On

Test Procedure:

1. Note that no signal is shown on the oscilloscope
2. From ArbConnection, press the MAN TRIG button.
3. Note and record the time that lapsed from when you pressed MANUAL Trigger button until you first see the burst of 5 sine waveforms. Lapsed time should be 5 seconds

Test Results	Pass		Fail	

4. Modify oscilloscope setting to Auto, or Normal and observe that bursts of 5 sine cycles appear at 10μs intervals

Test Results	Pass		Fail	

Delayed Trigger Characteristics

Equipment: Function generator, 50 Ω “T” connector, Counter, ArbConnection CAD

Preparation:

1. Configure the Function generator as follows:
   Amplitude: 1 V
   Frequency: 1 MHz
   Trigger Mode: Triggered.
   Wave: Squarewave
2. Place the “T” connector on the output terminal of the function generator. Connect one side of the “T” to the 5251 TRIG IN connector and the other side of the “T” to the channel A input of the counter
3. Connect the 5251 output to channel B input of the counter
4. Configure the counter to TI A to B measurements
5. Using ArbConnection prepare and download the following waveform:
   Wavelength: 100 points
   Waveform: Pulse, Delay = 0.1, Rise/Fall = 0, High Time = 99.99

6. Configure the 5251, channel 1 only, as follows:
   SCLK: 200 MS/s
   Waveform: Arbitrary
   Run Mode: Triggered
   Trigger Level 0 V
   Trigger Delay: On
   Delay: As required for the test
   Amplitude: 5 V
   Trigger Source: External
   Output: On

Test Procedure:
1. Perform trigger delay tests using Tables 16

Table Chapter 5-16, Trigger Delay Tests

5251 Delay Setting	Error Limits	Counter Reading	Pass	Fail
1 µs	1 µs ±150 ns			
1 ms	1 ms ±50 ns			
1 s	1 s ±50 ms			

Re-trigger Characteristics

Equipment: Counter, ArbConnection

Preparation:
1. Configure the counter as follows:
   Function: Pulse Width Measurement
   Ch A Slope: Negative
2. Connect the counter channel A to the 5251 output
3. Using ArbConnection prepare and download the following waveform:
   Wavelength: 100 points
   Waveform: Pulse, Delay = 0.1, Rise/Fall = 0, High Time = 99.99
4. Configure the 5251 as follows:
   SCLK 200 MS/s
   Waveform: Arbitrary
   Amplitude: 5 V
   Run Mode: Triggered
   Trigger Level 0 V
   Re-trigger: On
   Re-trigger Delay: As required by the test
   Trigger Source: Bus
   Output: On

Test Procedure:
1. Manually trigger the instrument
2. Perform trigger delay tests using Tables 17

Table Chapter 5-17, Re-Trigger Delay Tests

5251 Re-trigger Setting	Error Limits	Counter Reading	Pass	Fail
1 µs	1 µs ±150 ns			
1 ms	1 ms ±50 ns			
1 s	1 s ±50 ms			

Trigger Slope

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope follows:
   Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
   Trigger Source: External
2. Connect 5251 output to the oscilloscope input
3. Configure the function generator as follows:
   Frequency 10 kHz
   Run Mode: Continue
   Waveform: TTL Output
4. Connect the function generator TTL output to the 5251 TRIG IN connector
5. Connect the function generator main output to the 2nd channel of the oscilloscope
6. Configure the 5251 as follows:
   Frequency: 1 MHz
   Waveform: Sine wave
   Run Mode: Triggered
   Output: On

Test Procedure:

1. Toggle 5251 trigger slope from positive to negative visa versa
2. Verify on the oscilloscope that the 5251 transitions are synchronized with the slope of the trigger

Test Results	Pass		Fail	

Trigger Level

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope as follows:
   Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
2. Connect 5251 output to the oscilloscope input
3. Configure the function generator as follows:

Frequency 10 kHz
Run Mode: Continuous
Waveform: Squarewave.
Amplitude: 1 V

4. Connect the function generator output to the 5251 TRIG IN connector
5. Configure the 5251 as follows:
   Frequency: 1 MHz
   Waveform: Sine wave
   Run Mode: Triggered
   Trigger level: 0 V
   Ch1 Output: On

Test Procedure:

1. Verify that the 5251 outputs triggered waveforms spaced at 0.1 ms
2. Modify the function generator offset to +2 V and change the 5251 trigger level to +4 V. Verify that the 5251 triggered waveforms are spaced 0.1 ms apart
3. Modify the function generator offset to -2 V and change the 5251 trigger level to -4 V. Verify that the 5251 triggered waveforms are spaced 0.1 ms apart

Test Results	Pass		Fail	

Sequence operation

This tests the operation of the sequence generators. This also checks the various sequence advance options.

Automatic Advance

Equipment: Counter

Preparation:

1. Configure the Counter as follows:
   Function: TOTB Measurement
2. Connect the counter channel B to the 5251 output
3. Configure the 5251 as follows:
   SCLK 200 MS/s
   Waveform: Sequence
   Run Mode: Trigger
   Amplitude: 2 V
   Output: On
4. Using ArbConnection prepare and download the following waveform:
   Segments: 1 to 5

Wavelength: 128 points
Waveform: 1 cycle square

5. Using ArbConnection, build and download the following sequence table:
   Step 1: Segment 1, loop 100,000
   Step 2: Segment 2, loop 100,000
   Step 3: Segment 3, loop 100,000
   Step 4: Segment 4, loop 100,000
   Step 5: Segment 5, loop 100,000

Test Procedure:

1. From ArbConnection, click on the Manual Trigger button and observe that counter reading is 500,000 counts. Reset counter and repeat the test a few times. Every time the counter reading should be 500,000 counts exactly

Test Results	Pass		Fail	

Step Advance

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope as follows:
   Termination: 50 Ω, 20 dB feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
2. Connect the 5251 output to the oscilloscope input
3. Configure the function generator as follows:
   Frequency 10 kHz
   Run Mode: Triggered
   Waveform: Squarewave.
   Amplitude: Adjust for TTL level on 50 Ω
4. Connect the function generator output to the 5251 TRIG IN connector
5. Connect the 5251 to the Oscilloscope input
6. Configure the 5251 as follows:
   SCLK 200 MS/s
   Waveform: Sequence
   Seq. Advance: Step
   Amplitude: 2 V
   Trigger Source: External
   Output: On
7. Using ArbConnection prepare and download the following waveform:
   Segment 1: Sine, 1000 points
   Segment 2: Triangle, 1000 points
   Segment 3: Square, 1000 points
   Segment 4: Sinc, 1000 points
   Segment 5: Gaussian Pulse, 1000 points

8. Using ArbConnection, build and download the following sequence table:
   Step 1: Segment 1, loop 1
   Step 2: Segment 2, loop 1
   Step 3: Segment 3, loop 1
   Step 4: Segment 4, loop 1
   Step 5: Segment 5, loop 1

Test Procedure:

1. From ArbConnection, click on the Manual Trigger and observe that the waveforms advance through the sequence table repeatedly

Test Results	Pass		Fail	

Note

Leave the same setup for the next test

Single Advance

Equipment: Oscilloscope, function generator

Preparation: (Same preparation as for previous step, except change mode to single sequence advance)

1. Change Oscilloscope configuration to single

Test Procedure:

1. From ArbConnection, click on the Manual Trigger observe that one cycle waveform advances through the sequence table repeatedly with each external trigger signal. Note that you need to press the Single mode on the oscilloscope for each trigger advance

Test Results	Pass		Fail	

SYNC Output Operation

This tests the operation of the SYNC output. There are two synchronous output are being tested – Bit and LCOM. Bit normally operates with standard and arbitrary waveforms and LCOM is always associated with sequenced and burst outputs. The sync output has fixed TTL level amplitude into an open circuit.

SYNC Qualifier - Bit

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: As required by the test
   Amplitude: 2 V/div
2. Connect 5251 SYNC output to the oscilloscope input
3. Configure model 5251 as follows:
   Waveform: Sine
   Output: On
   SYNC: On

Test Procedure:

1. Verify trace on the oscilloscope shows synchronization pulses at 1 μs intervals

Test Results	Pass		Fail	

SYNC Qualifier - LCOM

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: As required by the test
   Amplitude: 2 V/div
2. Connect the 5251 output to the oscilloscope input (1)
3. Connect the 5251 SYNC output to the oscilloscope input (2)
4. Configure model 5251 channel as follows:
   Waveform: Sine
   Run Mode: Burst
   Burst Count: 10
   Re-trigger On
   Re-trig period: 10 μs
   Output: On

Test Procedure:

1. From ArbConnection, click on the Manual Trigger and verify that trace on the oscilloscope shows synchronization pulse having 10 μs pulse width. Verify that the SYNC is high for the duration of the burst.

Test Results	Pass		Fail	

Arbitrary Waveform Memory Operation

This tests the integrity of the waveform memory. The waveform memory stores the waveforms that are being generated at the output connector and therefore, flaws in the memory can cause distortions and impurity of the output waveforms.

Waveform memory

Equipment: Distortion Analyzer, ArbConnection

Preparation:

1. Connect 5251 output to the distortion analyzer input. Configure the 5251 as follows:
   SCLK: As required by the test
   Waveform: Arbitrary
   Amplitude: 5 V
   Output: On
2. Using ArbConnection prepare and download the following waveform:
   Wavelength: 2 M points
   Waveform: Sine wave
   SCLK 200 MS/s

Test Procedure:

1. Perform Sine wave distortion. It should be less than 0.1 %

Test Results	Pass		Fail	

Modulated Waveforms Operation

This tests the operation of the modulation circuits. It includes tests for the various modulation functions: FM, AM, FSK, PSK, Frequency hops and Sweep. Since the run modes are common to all modulation functions, they are being tested on the FM function only.

FM - Standard Waveforms

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 50 μs
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC output to the oscilloscope input, channel 2

4. Configure model 5251 controls as follows:
   Waveform: Modulated
   Modulation: FM
   Carrier Freq: 1 MHz
   Mod Frequency: 10 kHz
   Deviation: 500 kHz
   Sync: On
   Output: On

Test Procedure:
1. Verify FM operation on the oscilloscope as follows:
   Waveform: Sine
   Frequency: 10 kHz
   Max A: 1.25 MHz
   Min A: 750 kHz

Test Results	Pass		Fail	

2. Modify 5251 modulating waveform to triangle, then square and ramp and verify FM waveforms as selected

Test Results	Pass		Fail	

3. Move 5251 marker position to 1.25MHz and verify marker position

Test Results	Pass		Fail	

Triggered FM - Standard Waveforms

Equipment: Oscilloscope, function generator

Preparation:
1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC output to the oscilloscope input, channel 2
4. Configure the function generator as follows:
   Frequency 1 kHz

Run Mode:	Continuous
Waveform:	Squarewave.
Amplitude:	2 V
Offset:	1 V

5. Connect the function generator output connector to the 5251 TRIG IN connector
6. Configure model 5251 controls as follows:

Waveform:	Modulated
Modulation:	FM
Mod Run Mode:	Triggered
Carrier Freq:	1 MHz
Mod Frequency:	10 kHz
Deviation:	500 kHz
Sync:	On
Output:	On

Test Procedure:

1. Verify triggered FM – standard waveforms operation on the oscilloscope as follows:

Waveform:	Triggered sine waves
Sine Frequency:	10 kHz
Trigger Period:	1 ms
Max A:	1.25 MHz
Min A:	750 kHz

Test Results	Pass		Fail	

FM Burst - Standard Waveforms

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the oscilloscope as follows:

Time Base:	0.2 ms
Sampling Rate:	50 MS/s at least.
Trace A View:	Jitter, Type: FREQ, CLK.
Trigger source:	Channel 2, positive slope
Amplitude:	1 V/div

2. Connect 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC output to the oscilloscope input, channel 2
4. Configure the function generator as follows:

Frequency	1 kHz
Run Mode:	Continuous
Waveform:	Squarewave.
Amplitude:	Adjust to TTL level on 50 Ω

5. Connect the function generator output connector to the 5251 TRIG IN connector
6. Configure model 5251 controls as follows:

Waveform: Modulated
Modulation: FM
Modulation Run Mode: Burst
Burst: 5
Carrier Freq: 1 MHz
Mod Frequency: 10 kHz
Deviation: 500 kHz
Sync: On
Output: On

Test Procedure:

1. Verify Burst FM – standard waveforms operation on the oscilloscope as follows:
   Waveform: Burst of 5 Sine waveforms
   Sine Frequency: 10 kHz
   Burst Period: 1 ms
   Max A: 1.25 MHz
   Min A: 750 kHz

Test Results	Pass		Fail	

Gated FM - Standard Waveforms

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC output to the oscilloscope input, channel 2
4. Configure the function generator as follows:
   Frequency 1 kHz
   Run Mode: Continuous
   Waveform: Squarewave.
   Amplitude: 2 V
   Offset: 1 V
5. Connect the function generator output connector to the 5251 TRIG IN connector
6. Configure model 5251 controls as follows:
   Waveform: Modulated
   Modulation: FM
   Mod Run Mode: Gated
   Carrier Freq: 1 MHz
   Mod Frequency: 10 kHz
   Deviation: 500 kHz

Sync: On
Output: On

Test Procedure:

1. Verify Gated FM – standard waveforms operation on the oscilloscope as follows:
   Waveform: Gated sine waveforms
   Sine Frequency: 10 kHz
   Gated Period: 1 ms
   Max A: 1.25 MHz
   Min A: 750 kHz

Test Results	Pass		Fail	

Re-triggered FM Bursts - Standard Waveforms

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC to the oscilloscope input, channel 2
4. Configure model 5251 controls as follows:
   Waveform: Modulated
   Modulation: FM
   Modulation Run Mode: Burst
   Burst Count: 5
   Carrier Freq: 1 MHz
   Mod Frequency: 10 kHz
   Deviation: 500 kHz
   Sync: On
   Re-trigger: On
   Re-trigger Delay: 200 μs
   Output: On

Test Procedure:

1. Verify re-triggered FM burst – standard waveforms operation on the oscilloscope as follows:
   Waveform: Repetitive burst of 5-cycle sine waveforms
   Sine Frequency: 10 kHz
   Re-trigger delay: 200 μs
   Max A: 1.25 MHz
   Min A: 750 kHz

Test Results	Pass		Fail	

FM - Arbitrary Waveforms

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: 0.2 ms
   - Sampling Rate: 50 MS/s at least.
   - Trace A View: Jitter, Type: FREQ, CLK.
   - Trigger source: Channel 2, positive slope
   - Amplitude: 1 V/div
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC to the oscilloscope input, channel 2
4. Configure model 5251 controls as follows:
   - Waveform: Modulated
   - Modulation: FM
   - Mod Waveform: Arbitrary
   - Carrier Freq: 1 MHz
   - FM SCLK: 2.5 MS/s
   - Sync: On
   - Output: On
5. Using ArbConnection prepare, open the FM Composer and download the following waveform:
   - Wavelength: 4000 points
   - Waveform: 4 cycles sinewave
   - Deviation: 0.5 MHz

Test Procedure:

1. Verify FM operation on the oscilloscope as follows:
   - Waveform: Sine
   - Frequency: 2.5 kHz
   - Max A: 1.25 MHz
   - Min A: 750 kHz

Test Results	Pass		Fail	

AM

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   - Time Base: 0.5 ms
   - Trigger source: Channel 2, positive slope
   - Amplitude: 1 V/div
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC to the oscilloscope input, channel 2

4. Configure model 5251 controls as follows:
   Waveform: Modulated
   Modulation: AM
   Carrier Freq: 1 MHz
   Mod Frequency: 1 kHz
   Mod Depth: 50 %
   Mod Wave Ch1 Sine
   Mod Wave Ch2 Triangle
   Sync: On
   Output: On

Test Procedure:

1. Verify AM operation on the oscilloscope as follows:
   Waveform: Amplitude modulated sine
   Mod depth: 50 % ±5 %

Test Results	Pass		Fail	

FSK

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.1 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div.
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC to the oscilloscope input, channel 2
4. Configure model 5251 controls as follows:
   Waveform: Modulated
   Modulation: FSK
   Carrier Freq: 2 MHz
   Shift Frequency: 4 MHz
   Baud Rate: 10 kHz
   Marker Index: 1
   Sync: On
   Output: On
5. Using ArbConnection, prepare and download 10-step FSK list with alternating “0” and “1”

Test Procedure:

1. Verify FSK operation on the oscilloscope as follows:
   Waveform: Squarewave
   Period: 0.2 ms
   Max Freq.: 4 MHz
   Min Freq.: 2 MHz

Test Results	Pass		Fail	

PSK

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 50 µs
   Amplitude: 1 V/div.
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC to the oscilloscope input, channel 2
4. Configure model 5251 controls as follows:
   Reset
   Waveform: Modulated
   Modulation: PSK
   Carrier Freq: 10 kHz
   Shift Phase: 180 degrees
   Baud Rate: 10 kHz
   Sync: On
   Output: On
5. Using ArbConnection, prepare and download 10-step PSK list with alternating “0” and “1”

Test Procedure:

1. Verify PSK operation on the oscilloscope as follows:
   Waveform: Sinewave
   Period: 0.1 ms
   Phase: Every 0.1 ms change 180 degrees

Test Results	Pass		Fail	

ASK

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 50 µs
   Amplitude: 1 V/div.
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC to the oscilloscope input, channel 2
4. Configure model 5251 controls as follows:
   Reset
   Waveform: Modulated
   Modulation: ASK
   Carrier Freq: 10 kHz
   Base Amplitude: 4 V

Shift Amplitude: 2 V
Baud Rate: 10 kHz
Sync: On
Output: On

5. Using ArbConnection, prepare and download 10-step ASK list with alternating “0” and “1”

Test Procedure:

1. Verify ASK operation on the oscilloscope as follows:
   Waveform: Sinewave
   Period: 0.1 ms
   Amplitude: Every 0.1 ms alternates between 2 and 4 V

Test Results	Pass		Fail	

Variable Dwell Time Frequency Hops

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.5 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC to the oscilloscope input, channel 2
4. Configure model 5251 controls as follows:
   Waveform: Modulated
   Modulation: Hop
   Hop Mode: Variable
   Sync: On
   Output: On
5. Using ArbConnection prepare, open the Hop Table composer and download the following table (both channels):

Frequency	Dwell Time
1.0e6	50e-6
1.2e6	100e-6
1.4e6	150e-6
1.6e6	200e-6
1.8e6	250e-6
2.0e6	300e-6
2.2e6	350e-6
2.4e6	400e-6
2.6e6	450e-6
2.8e6	500e-6

Test Procedure:

1. Verify Hop operation on the oscilloscope as follows:

   Waveform: Frequency steps, increasing dwell time from 50 μs to 500 μs
   Max A: 2.8 MHz
   Min A: 1.0 MHz
   Period: 2750 μs

Test Results	Pass		Fail	

Fix Dwell Time Frequency Hops

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:

   Time Base: 1.0 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div

2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC to the oscilloscope input, channel 2
4. Configure model 5251 controls as follows:

   Waveform: Modulated
   Modulation: Hop
   Hop Mode: Fix
   Dwell Time: 50μs
   Sync: On
   Output: On

5. Using ArbConnection prepare, open the Hop Table composer and download the following table:

   Frequency

   1.0e6
   1.2e6
   1.4e6
   1.6e6
   1.8e6
   2.0e6
   2.2e6
   2.4e6
   2.6e6
   2.8e6

Test Procedure:

1. Verify Hop operation on the oscilloscope as follows:

   Waveform: Frequency steps, fixed dwell time of 50 μs
   Max A: 2.8 MHz
   Min A: 1.0 MHz
   Period: 500 μs

Test Results	Pass		Fail	

Sweep

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 0.2 ms
   Sampling Rate: 50 MS/s at least.
   Trace A View: Jitter, Type: FREQ, CLK.
   Trigger source: Channel 2, positive slope
   Amplitude: 1 V/div
2. Connect the 5251 output to the oscilloscope input, channel 1
3. Connect the 5251 SYNC output to the oscilloscope input, channel 2
4. Configure model 5251 controls as follows:
   Waveform: Modulated
   Modulation: Sweep
   Start Frequency: 1 MHz
   Stop Frequency: 2 MHz
   Sweep Time: 1 ms
   Sweep Type: Linear
   Sync: On
   Output: On

Test Procedure:

1. Verify Sweep operation on the oscilloscope as follows:
   Waveform: Ramp up
   Frequency: 1 kHz
   Max A: 2 MHz
   Min A: 1 MHz

Test Results	Pass		Fail	

2. Move 5251 sweep marker position to 1.5 MHz and verify marker position at the middle of the ramp

Test Results	Pass		Fail	

3. Reverse between Start and Stop frequencies and verify oscilloscope reading as before except the ramp is down

Test Results	Pass		Fail	

4. Change sweep step to logarithmic and verify oscilloscope exponential down waveform with properties as in 3 above

Test Results	Pass		Fail	

Auxiliary Counter/Timer Operation

This tests the operation of the auxiliary counter/timer function. Note that when you select the counter/timer function all other 5251 waveform generation are automatically purged and the instrument operational mode is transformed to a stand-alone counter/timer. Waveform generation is resumed as soon as the counter/timer function is turned off.

Frequency

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   Frequency: As required by the test
   Wave: Square
   Amplitude 500 mV
2. Connect the function generator to the 5251 TRIG IN connector
3. Configure the 5251, as follows:
   Auxiliary Function: Counter/Timer
   Function: Frequency
   Trigger Level: 0 V

Test Procedure:

1. Perform Frequency Measurement Accuracy tests using Table 18

Table Chapter 5-18, Frequency Measurement Accuracy

Function Generator Setting	Error Limits	5251 Counter Reading	Pass	Fail
1.000000 MHz	±2 Hz			
100.0000 MHz	±100 Hz			
120.0000 MHz	±200 Hz			

2. Change the display time to Hold
3. Press the Reset/Arm button and verify that the frequency reading is 120.000000 MHz, ±200 Hz

Test Results	Pass		Fail	

Period, Period Averaged

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   Frequency: As required by the test
   Wave: Square
   Amplitude 500 mV
2. Connect the function generator to the 5251 TRIG IN connector
3. Configure the 5251, as follows:
   Auxiliary Function: Counter/Timer
   Function: Period
   Trigger Level: 0 V

Test Procedure:

1. Perform Period Accuracy tests using Table 19

Table Chapter 5-19, Period Measurement Accuracy

Function Generator Setting	Error Limits	5251 Counter Reading	Pass	Fail
10 kHz	100.0 μs ±100 ns			
100 kHz	10.00 μs ±100 ns			
1 MHz	1.000 μs ±100 ns			

2. Change the counter/timer function to Period Averaged
3. With the last function generator setting in Table 27, verify that the period reading is 1.000000 μs ±50 ps

Test Results	Pass		Fail	

Pulse Width

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   Frequency: As required by the test
   Wave: Square
   Duty Cycle: As required by the test
   Amplitude 500 mV
2. Connect the function generator to the 5251 TRIG IN connector
3. Configure the 5251, as follows:
   Auxiliary Function: Counter/Timer
   Function: Pulse Width
   Trigger Level: 0 V

Test Procedure:

1. Perform Pulse Width Accuracy tests using Table 20

Table Chapter 5-20, Pulse Width Measurement Accuracy

Function Generator Setting			5251		
Frequency	**Duty Cycle**	**Error Limits**	**Counter Reading**	**Pass**	**Fail**
10 kHz	50 %	50.00 µs ±100 ns			
100 kHz	50 %	5.000 µs ±100 ns			
1 MHz	70 %	700 ns ±100 ns			

2. Change the counter/timer slope to Negative
3. With the last function generator setting in Table 28, change the function generator duty cycle to 70 %
4. Verify that the pulse width reading is 300 ns ±100 ns

Test Results	Pass		Fail	

Totalize, Gated

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   Frequency: 1 MHz
   Wave: Square
   Amplitude 500 mV
   Run Mode: Burst
   Burst Count: 100
2. Connect the function generator to the 5251 TRIG IN connector
3. Configure the 5251, as follows:
   Auxiliary Function: Counter/Timer
   Function: Totalize, Gated
   Trigger Level: 0 V

Test Procedure:

1. Manually reset the 5251 to reset and arm the totalize function
2. Manually trigger the function generator and verify that the 5251 counter reading is 100 ±1

Test Results	Pass		Fail	

Totalize, Infinite

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   Frequency: 100 MHz
   Wave: Square
   Amplitude 500 mV
2. Connect the function generator to the 5251 TRIG IN connector
3. Configure the 5251, as follows:
   Auxiliary Function: Counter/Timer
   Function: Totalize, Infinite
   Trigger Level: 0 V

Test Procedure:

1. Verify that the display is updated continuously with the totalized counts
2. Verify that the reading is held at 4000000000 counts and that the overflow indication turns on

Test Results	Pass		Fail	

3. Change the function generator run mode to Burst and set Burst Count to 1000000
4. Press the Reset/Arm button on the 5251 to reset and arm the totalize function
5. Manually trigger the function generator and verify that the 5251 counter reading is 1000000 ±2

Test Results	Pass		Fail	

This page was intentionally left blank

Chapter 6

Adjustments and Firmware Update

Title	Page

What's in This Chapter

This chapter provides adjustment information for the 5251 single channel PXIbus waveform generator.

WARNING

The procedures described in this section are for use only by qualified service personnel. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.

CAUTION

ALWAYS PERFORM DISASSEMBLY, REPAIR AND CLEANING AT A STATIC SAFE WORKSTATION.

Performance Checks

Do not attempt to calibrate the instrument before you verify that there is no problem with the functionality of the product. A complete set of specification is listed in Appendix A. If the instrument fails to perform within the specified limits, the instrument must be tested to find the source of the problem.

In case there is a reasonable suspicion that an electrical problem exist within the 5251, perform a complete performance checks as given in Chapter 6 to verify proper operation of the instrument.

Environmental Conditions

The 5251 can operate from 0°C to 50°C. Adjustments should be performed under laboratory conditions having an ambient temperature of 25°C, ±5°C and at relative humidity of less than 80%. Turn on the power to the 5251 and allow it to warm up for at least 30 minutes before beginning the adjustment procedure. 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.

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 Model 5251 and allow it to warm-up for at least 30 minutes before beginning the performance test procedure.

Recommended Test Equipment

Recommended equipment for adjustments is listed in Table 6-1. Instruments other than those listed may be used only if their specifications equal or exceed the required minimal characteristics. Also listed below are accessories required for calibration.

Table 6-1, Recommended calibration for Adjustments

Equipment	Model No.	Manufacturer
Oscilloscope (with jitter package)	LC684	LeCroy
Digital Multimeter	2000	Keithley
Frequency Counter (Rubidium reference)	6020R	Tabor Electronics
Function Generator (with manual trigger)	8571	Tabor Electronics
Accessories	BNC to BNC cables	
	50Ω Feedthrough termination	
	Dual banana to BNC adapter	

Adjustment Procedures

Use the following procedures to calibrate the Model 5251. The following paragraphs show how to set up the instrument for calibration and what the acceptable calibration limits are.

Calibration requires that ArbConnection utility be installed and interfaced to the instrument.

Calibration is performed from the Calibration Panel in ArbConnection. To invoke this panel, one requires a password that is available to service centers only. Contact your nearest Tabor service center for information and permit to obtain your calibration password. Use the following procedure to calibrate the generator:

1. Invoke ArbConnection
2. Click on the Calibration tab on the Panels bar
3. Expect to be prompted with the following dialog box

Figure 6-1, Calibration Password

4. Type your User Name Password and click on OK. The Calibration Panel as shown in Figure 6-2 will appear.

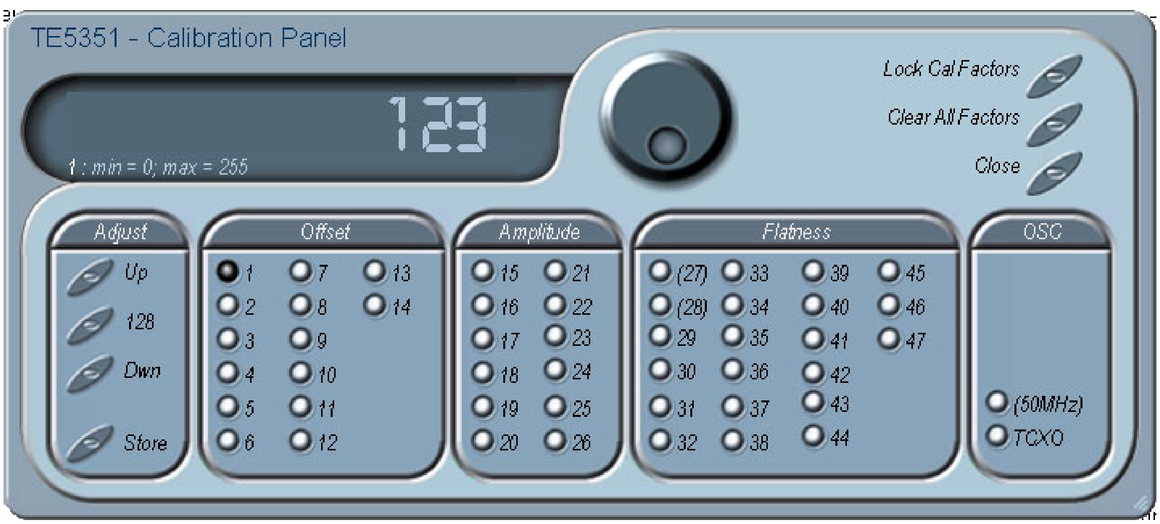

Figure 6-2, Calibration Panel

NOTE

Initial factory adjustments require that the covers be removed from the instrument. Field calibration does not require re-adjustments of these factory settings unless the unit was repaired in an authorized service center. Factory adjustments are enclosed in parentheses to differentiate from normal field calibration setups; bypass these adjustments when performing field calibration.

Calibrations are marked with numbers from 1 to 47 and, except the (50M) and TCXO adjustments in the OSC (oscillators) group, should be carried out exactly in the order as numbered on the panel. The numbers that are associated with each adjustment are identified as Setup Number at the title of each of the adjustments in the following procedure.

Remote adjustments have the range of 1 through 256 with the center alignment set to 128. Therefore, if you are not sure of the direction, set the adjustment to 128 and add or subtract from this value. If you have reached 1 or 256 and were not able to calibrate the range, there is either a problem with the way you measure the parameter or possibly there is a problem with the instrument. In either case, do not leave any adjustment in its extreme setting but center the adjustment and contact your nearest service center for clarifications and support.

Note in the following procedures that although configuration of the 5251 is done automatically, some of the configurations are shown for reference only. There is no requirement to change configuration of the 5251 during the remote adjustment procedure except in places where specifically noted.

Reference Oscillators Adjustments

Use this procedure to adjust the reference oscillators. The reference oscillators determine the accuracy of the output frequency so if you suspect that there is an accuracy issue, proceed with the calibration of the reference oscillators. Note that the 50MHz is marked as a factory adjustment and therefore, it is not normally required to be performed during normal calibration cycles except if the gated oscillator accuracy does not meet the published specification limits, or after a repair has been executed on this same circuit.

(Setup 50MHz)

50 MHz Gated Oscillator Adjustment

Equipment: Counter, Function Generator, BNC to BNC cables
Preparation:

1. Configure the counter as follows:
   Termination: 50 Ω DC
   Function: TI A -> B
   Slope B: Negative
2. Connect the 5251 output to the oscilloscope input
3. Connect an external function generator to the rear panel TRIG IN connector
4. Using ArbConnection prepare and download the following waveform:
   Wavelength: 100 points
   Waveform: Pulse: Delay = 0.01 %,
   Rise/Fall Time = 0 %, High Time = 99.99 %
5. Configure the 5251as follows:
   Function Mode: Arbitrary
   Run Mode: Triggered
   Retrigger Mode: On
   Retrigger Delay: 20 μs
6. Using an external function generator, manually trigger the 2572A

Adjustment:

1. Adjust C132 for a period of 20 μs, ±5 %

Setup TCXO

10 MHz TCXO Frequency

Equipment: Counter, BNC to BNC cables
Preparation:

1. Configure the counter as follows:
   Function: Freq A
   Termination: 50 Ω
2. Connect the 5251 output to the counter input.
3. Configure the 5251as follows:
   Frequency: 10 MHz
   Output: On

Amplitude	2 V
Wave:	Square

Adjustment:
1. Adjust CAL:SETUP57 for counter reading of 10 MHz, ±2 Hz

Base Line Offset Adjustments

The base line offset adjustments assure that the AC signal is symmetrical around the 0V line. Use this procedure if you suspect that there is a base line accuracy issue.

Setup 1

Amplifier Offset

Equipment: DMM, BNC to BNC cable, 50 Ω Feedthrough termination, Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feedthrough termination
3. Configure the 5251as follows:
   CAL:SERV 1

Adjustment:
1. Adjust CAL:SETUP1 for DMM reading of 0 V, ±20 mV

Setup 2

Pre-Amplifier Offset

Equipment: DMM, BNC to BNC cable, 50 Ω Feedthrough termination, Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   CAL:SERV 2

Adjustment:
1. Adjust CAL:SETUP2 for DMM reading of 0 V, ±5 mV

Setup 3

Base Line Offset, Amplifier In – Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω Feedthrough termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50Ω Feed through termination
3. Configure the 5251as follows:
   Mode: Modulation
   Output: On
   Amplitude: 6 V

Adjustment:

1. Adjust CAL:SETUP 3 for DMM reading of 0 V, ±20 mV

Setup 4

Base Line Offset, Amplifier Out – Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Mode: Modulation
   Output: On
   Amplitude: 1 V

Adjustment::

1. Adjust CAL:SETUP 4 for DMM reading of 0 V, ±5 mV

Setup 5

Base Line Offset, Amplifier In – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:

Output: On
Amplitude: 6 V

Adjustment:
1. Adjust CAL:SETUP 5 for DMM reading of 0 V, ±20 mV

Setup 6

Base Line Offset, Amplifier Out - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: DCV
   Range: 100 mV
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Output: On
   Amplitude: 1 V

Adjustment:
1. Adjust CAL: SETUP 6 for DMM reading of 0 V, ±5 mV

Offset Adjustments

The offset adjustments assure that the DC offsets are within the specified range. Use this procedure if you suspect that the offset accuracy is an issue.

Setup 7

Offset (+1 V) Output Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω Feedthrough termination, Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the 50 Ω Feed through termination
3. Configure the 5251as follows:
   Amplitude: 20 mV
   Offset +1 V
   Output: On

Adjustment:
1. CAL: SETUP 7 for DMM reading of +1 V, ± 5 mV

Setup 8

Offset (+3 V) Output Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the 50 Ω Feed through termination
3. Configure the 5251as follows:
   Amplitude: 20 mV
   Offset +3 V
   Output: On

Adjustment:

1. CAL: SETUP 8 for DMM reading of +3 V, ± 15 mV

Setup 9

+4 V Offset Output Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the 50 Ω Feed through termination
3. Configure the 5251as follows:
   Amplitude: 20 mV
   Offset +4 V
   Output: On

Adjustment:

1. CAL: SETUP 9 for DMM reading of +5 V, ± 25 mV

Setup 10

-1 V Offset Output Amplifier In

Equipment: DMM, BNC to BNC cable, 50Ω Feedthrough termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the 50 Ω Feed through

termination

3. Configure the 5251as follows:
   Amplitude: 20 mV
   Offset -1 V
   Output: On

Adjustment:

1. CAL: SETUP 10 for DMM reading of -1 V, ± 5 mV

Setup 11

-3 V Offset Output Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the 50 Ω Feed through termination
3. Configure the 5251as follows:
   Amplitude: 20 mV
   Offset -3 V
   Output: On

Adjustment:

1. CAL: SETUP 11 for DMM reading of -3 V, ± 15 mV

Setup 12

-4 V Offset Output Amplifier In

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the 50 Ω Feed through termination
3. Configure the 5251as follows:
   Amplitude: 20 mV
   Offset -4 V
   Output: On

Adjustment:

1. CAL: SETUP 12 for DMM reading of -5 V, ± 25 mV

Setup 13

(+) Offset, Output Amplifier Out

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the 50 Ω Feed through termination
3. Configure the 5251as follows:
   Amplitude: 20 mV
   Offset +400 mV
   Output: On

Adjustment:

1. CAL:SETUP13 for DMM reading of +400 mV, ±5 mV; Note reading

Setup 14

(-) Offset, Output Amplifier Out

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the 50 Ω Feed through termination
3. Configure the 5251as follows:
   Amplitude: 20 mV
   Offset -1 V
   Output: On

Adjustment:

1. CAL:SETUP14 for DMM reading of -400 mV, ±5 mV; note reading
2. Repeat steps Setup 17 and Setup 18 until errors are balanced between the steps

Amplitude Adjustments

The amplitude adjustments assure that the AC levels are within the specified range. Use this procedure if you suspect that the amplitude accuracy is an issue.

Setup 15

9 V Amplitude - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 10 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 9 V

Adjustment:

1. Adjust CAL:SETUP15 for DMM reading of 3.182 V ±30 mV

Setup 16

7 V Amplitude - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 7 V

Adjustment:

1. Adjust CAL:SETUP16 for DMM reading of 2.475 V ±25 mV

Setup 17

5 V Amplitude - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 5 V

Adjustment:

1. Adjust CAL:SETUP17 for DMM reading of 1.767 V ±20 mV

Setup 18

3 V Amplitude – Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 3 V

Adjustment:

1. Adjust CAL:SETUP18 for DMM reading of 1.060 V ±10 mV

Setup 19

1.1 V Amplitude - Arbitrary

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination

3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 1.1 V

Adjustment:
1. Adjust CAL:SETUP19 for DMM reading of 389 mV ±3 mV

Setup 20

1 V Amplitude – Arbitrary, Amp-Out

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 1 V

Adjustment:
1. Adjust CAL:SETUP20 for DMM reading of 353.5 mV ±3 mV

Amplitude Adjustments-Modulation

The amplitude adjustments assure that the AC levels are within the specified range. Use this procedure if you suspect that the amplitude accuracy is an issue.

Setup 21

9 V Amplitude - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:
1. Configure the DMM as follows:
   Function: ACV
   Range: 10 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On

Amplitude:	9 V
Mode:	Modulation

Adjustment:

1. Adjust CAL:SETUP21 for DMM reading of 3.182 V ±30 mV

Setup 22

7 V Amplitude - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:

Function:	ACV
Range:	1 V

2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:

Frequency:	1 kHz
Output:	On
Amplitude:	7 V
Mode:	Modulation

Adjustment:

1. Adjust CAL:SETUP22 for DMM reading of 2.475 V ±25 mV

Setup 23

5 V Amplitude - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:

Function:	ACV
Range:	1 V

2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:

Frequency:	1 kHz
Output:	On
Amplitude:	5 V
Mode:	Modulation

Adjustment:

1. Adjust CAL:SETUP23 for DMM reading of 1.767 V ±20 mV

Setup 24

3 V Amplitude - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 3 V
   Mode: Modulation

Adjustment:

1. Adjust CAL:SETUP24 for DMM reading of 1.060 V ±10 mV

Setup 25

1.1 V Amplitude - Modulation

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V
2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: 1.1V
   Mode: Modulation

Adjustment:

1. Adjust CAL:SETUP25 for DMM reading of 389 mV ±3 mV

Setup 26

1 V Amplitude – Modulation ,Amp-Out

Equipment: DMM, BNC to BNC cable, 50 Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: ACV
   Range: 1 V

2. Connect the 5251 output to the DMM input. Terminate the 5251output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 5251as follows:

Frequency:	1 kHz
Output:	On
Amplitude:	1 V
Mode:	Modulation

Adjustment:

1. Adjust CAL:SETUP26 for DMM reading of 353.5 mV ±3 mV

Pulse Response Adjustments

The pulse response adjustments assure that the rise and fall times, as well as, the aberrations are within the specified range. Use this procedure if you suspect that the pulse response is an issue. Note that setups 27 and 28 are marked as a factory adjustment and therefore, it is not normally required to be performed during normal calibration cycles except if the pulse response of the output stage has been degraded and does not meet the published specification limits, or after a repair has been executed on these very circuit.

(Setup 27)

Pulse Response, Amplifier Out

Equipment: Oscilloscope, BNC to BNC cable, 20 dB Feedthrough attenuator

Preparation:

1. Configure the 5251as follows:

Function:	Square
Amplitude:	1 V

2. Connect the 5251 output to the oscilloscope input. Set oscilloscope input impedance to 50 Ω
3. Set oscilloscope vertical sensitivity to 20 mV

Adjustment:

1. Adjust vertical trace to 6 divisions
2. Adjust RV1 for best pulse response (4 ns type, 5 % aberrations)

(Setup 28)

Pulse Response, Amplifier In

Equipment: Oscilloscope, BNC to BNC cable, 20 dB Feedthrough attenuator

Preparation:

1. Configure the 5251as follows:

Function:	Square
Amplitude:	6 V

2. Connect the 5251 output to the oscilloscope input. Use 20 dB Feedthrough attenuator at the oscilloscope input

3. Set oscilloscope input impedance to 50 Ω
4. Set oscilloscope vertical sensitivity to 0.1 V

Adjustment:
1. Adjust vertical trace to 6 divisions
2. Adjust C25 for best pulse response (4 ns type, 5 % aberrations)

Flatness Adjustments

The flatness adjustments assure that the flatness of the amplifier is within the specified range. Use this procedure if you suspect that the flatness is an issue.

Setup 29

1 MHz Amplitude

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:
1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 1 MHz
   Output: On

Adjustment:
1. Adjust the Fine Amplitude of the Oscilloscope to get the signal of 6 divisions on the screen.

Setup 30

10 MHz Amplitude

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:
1. Configure the Oscilloscope as follows:
   Input Impedance: 50 ohms
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 10 MHz
   Output: On

Adjustment:
1. Adjust CAL:SETUP30 to get the signal of 6 divisions on the screen.

Setup 31

20 MHz Amplitude

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:

Input Impedance:	50 Ω
Range:	100 mV

2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:

Frequency:	20 MHz
Output:	On

Adjustment:

1. Adjust CAL:SETUP31 to get the signal of 6 divisions on the screen.

Setup 32

30 MHz Amplitude

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:

Input Impedance:	50 Ω
Range:	100 mV

2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:

Frequency:	30 MHz
Output:	On

Adjustment:

1. Adjust CAL:SETUP32 to get the signal of 6 divisions on the screen.

Setup 33

37.3333333 MHz Amplitude

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:

Input Impedance:	50 Ω
Range:	100 mV

2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:

Frequency: 37.3333333 MHz
Output: On

Adjustment:

1. Adjust CAL:SETUP33 to get the signal of 6 divisions on the screen.

Setup 34

56 MHz Amplitude

Equipment: 50Ω, 20dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 56 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP34 to get the signal of 6 divisions on the screen.

Setup 35

56.0000001 MHz Amplitude

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 56.0000001 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP35 to get the signal of 6 divisions on the screen.

Setup 36

80 MHz Amplitude

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω

Range: 100 mV

2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:

   Frequency: 80 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP36 to get the signal of 6 divisions on the screen.

Setup 37

100 MHz Amplitude

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:

   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:

   Frequency: 100 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP37 to get the signal of 6 divisions on the screen.

Setup 38

1 MHz Amplitude, Amplifier Out (Amp-1V)

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:

   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:

   Frequency: 1 MHz
   Output: On
   Amplitude 1 V

Adjustment:

1. Adjust the Fine Amplitude of the Oscilloscope to get the signal of 6 divisions on the screen.

Setup 39

10 MHz Amplitude, Amplifier Out

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 10 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP39 to get the signal of 6 divisions on the screen.

Setup 40

20 MHz Amplitude, Amplifier Out

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 20 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP40 to get the signal of 6 divisions on the screen.

Setup 41

30 MHz Amplitude, Amplifier Out

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:

Frequency: 30 MHz
Output: On

Adjustment:

1. Adjust CAL:SETUP41 to get the signal of 6 divisions on the screen.

Setup 42

37.3333333 MHz Amplitude, Amplifier Out

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 37.3333333 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP42 to get the signal of 6 divisions on the screen.

Setup 43

56 MHz Amplitude, Amplifier Out

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 56 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP43 to get the signal of 6 divisions on the screen.

Setup 44

56.0000001 MHz Amplitude, Amplifier Out

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:

Input Impedance: 50 Ω
Range: 100 mV

2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 56.0000001 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP44 to get the signal of 6 divisions on the screen.

Setup 45

80 MHz Amplitude, Amplifier Out

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 80 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP45 to get the signal of 6 divisions on the screen.

Setup 46

100 MHz Amplitude, Amplifier Out

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100 mV
2. Connect the 5251 output to the Oscilloscope input. Terminate the 5251output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 5251as follows:
   Frequency: 100 MHz
   Output: On

Adjustment:

1. Adjust CAL:SETUP46 to get the signal of 6 divisions on the screen.

Setup 47

Frequency Flatness – Modulation

Equipment: Oscilloscope, BNC to BNC cable, 20 dB Feedthrough attenuator

Preparation:

1. Configure the 5251as follows:

Function:	Modulation ON
Modulation:	Sweep
Start Freq:	1 MHz
Stop Freq:	100 MHz
Sweep Time:	1 ms
Marker:	1 MHz
Amplitude:	6 V

2. Connect the 5251 output to the oscilloscope input. Use 20 dB Feedthrough attenuator at the oscilloscope input
3. Set oscilloscope input impedance to 50 Ω
4. Set oscilloscope vertical sensitivity to 0.1 V

Adjustment:

1. Adjust C10 for the best flatness.

Updating the 5251 Firmware

WARNING

Only qualified persons may perform Firmware updates. DO NOT even attempt to perform this operation unless you were trained and certified by Tabor as you may inflict damage to the operation of the instrument. Always verify with the factory that you have the latest firmware file before you start with your update.

Before you update the firmware of your 5251 card, check the revision level which is installed on your computer. Each firmware update was done for a reason and therefore, if you want to update the firmware for a problem in your system, check the readme file that is associated with the update to see if an update will solve your problem. There are a number of ways to check he revision level of your firmware:

1) Using Explorer, open the SYSTEM32 folder in the Windows directory and locate the file TE5251.dll. Right click with your mouse on the file name and select properties. Click on the Version tab and note the File version information as listed in this tab. The TE5251.dll Properties dialog box is shown in Figure 6-3.

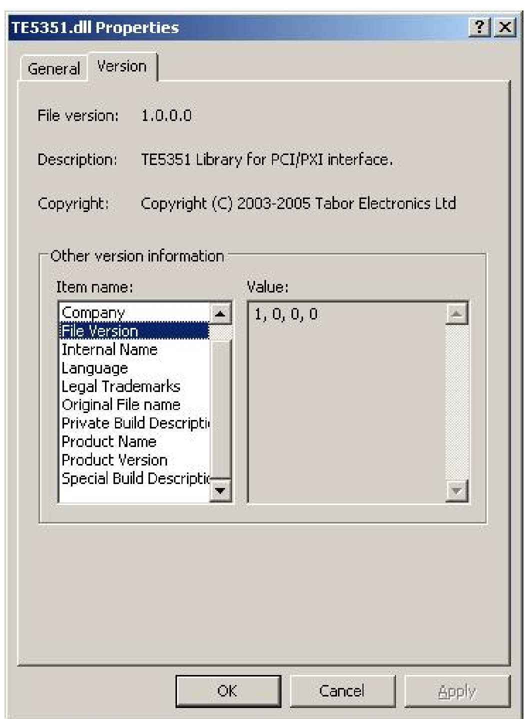

Figure 6-3, TE5251.dll Properties

2) Using a SCPI command from an external utility, you can read the firmware version by sending the following query:

SYST:INFO:FIRM:VERS?

The response is a string showing the firmware version, similar to 1.0.

3) Using ArbConnection, select the General/Filters panel from the System tab and click on the Firmware Version button. The General/Filters panel with the firmware revision indication is shown in Figure 6-4.

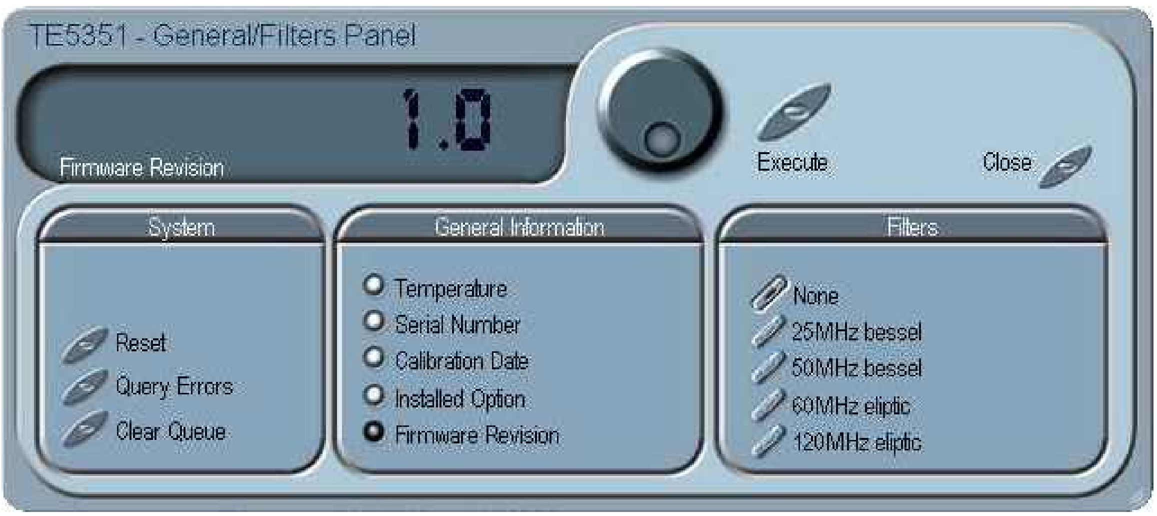

Figure 6-4, Firmware Revision Screen

To update the 5251 firmware, you will simply have to install the latest version of the driver or the latest version of ArbConnection or, you may also just replace the TE5251.dll in the WINDOWS32 folder with a newer version but before you do that, make sure the firmware revision of your new dll agrees with the hardware revision you currently have.

This page was intentionally left blank

Appendices

Appendix A
Specifications

Operating Modes

Description	The 5251 can source multiple waveform shapes and functions. It can be programmed to operate as one of the following modes: Function Generator, Arbitrary Waveform Generator, Sequence Generator, Pulse Generator, Modulation Generator, and Half Cycle Generator. It can also be used as a stand-alone Counter/Timer

Outputs

Main Output

Channels	1
Connector	Front panel BNC Impedance: 50 Ω ±1%
Protection	Short Circuit to Case Ground, 10 s max
Standby	Output On or Off (Output Disconnected)
Amplitude	200 mV to 20 Vp-p, output open circuit 100 mV to 10 Vp-p, into 50 Ω
Resolution	4 digits
Accuracy (measured at 1 kHz into 50Ω)	1 V to 10 Vp-p: ±(1% + 70 mV) 100 mV to 999 mVp-p: ±(1% + 10 mV)
DC Offset Range	0 to ±4.950 V
Resolution	1 mV
Accuracy	±(1% ± 1% from Amplitude ±5 mV)

Square Wave, Pulse Performance

Rise/Fall Time (10%-90%)	<5 ns
Aberration	<6%

Sync Output

Connector	Front panel BNC
Level	0.5V on 50Ω
Sync Type	Pulse with Arbitrary and Standard Waves; LCOM in Sequence and Burst Modes (including Burst Modulation); Marker with Modulation Mode only, programmable position
Position	Point 0 to maximum segment size, programmable with 4-point resolution

Filters

Description	Filters can be switch in and out freely except in standard waveform shape where the filters are automatically used by the instrument to reconstruct the sine shape.
Type	25 MHz, Bessel; 50 MHz Bessel; 60 MHz Elliptic; 120 MHz Elliptic

General Run Modes

Description	Define how waveforms start and stop. Run modes description applies to all waveform types and functions, except where noted otherwise.
Continuous	Continuously free-run output of a waveform. Waveform generation can be enabled and disabled from a remote interface only.
Triggered	Upon trigger, outputs one waveform cycle. Last cycle always completed
Burst	Upon trigger, outputs a single or multiple pre-programmed number of waveform cycles. (Does not apply to Sequence Mode). Burst is programmable from 1 through 1M cycles
Gated	Transition enables or disables generator output. Last cycle always completed
Mixed	Same as triggered except first output cycle is initiated by a software trigger. Consequent output requires external triggers through the rear panel TRIG IN connector

Trigger Characteristics

Trigger Sources	
External	Front panel BNC
BUS	Trigger commands from a remote controller only
Mixed	Operates in conjunction with the Mixed Run Mode.

External Trigger Input

Impedance 10 kΩ	
Trigger Level Range	±5 V
Resolution	1 mV
Sensitivity	200 mV
Damage Level	±12 V
Frequency Range	DC to 2 MHz
Slope	Positive/Negative transitions, selectable
Minimum Pulse Width	≥10 ns
System Delay (Trigger input to waveform output)	6 sample clock cycles+150 ns
Trigger Delay (Trigger input to waveform output)	[(0; 200 ns to 20 s) + system delay]
Resolution	20 ns
Error	6 sample clock cycles + 150 ns + 5% of setting
Re-trigger Delay (Waveform end to waveform restart)	200 ns to 20 s
Resolution	20 ns
Error	3 sample clock cycles + 20 ns + 5% of setting
Trigger Jitter	±1 sample clock period

Frequency/Time Accuracy

Internal 10 MHz Reference	≥0.0001% (1 ppm TCXO) initial tolerance from 19°C to 29°C; 1ppm/°C below 19°C and above 29°C; 1 ppm/year aging rate
External	10 MHz Reference
Connector	Front panel SMB
Frequency	10 MHz
Impedance and Level	10 kΩ ±5%, TTL, 50% ±2% duty cycle, or 50 Ω ±5%, 0 dBm, manually selectable using internal jumpers
External Sample Clock	
Connector	Front panel SMB
Frequency	From dc to 250 MHz
Impedance and Level	50 Ω ±5%, PECL

Function Generator Characteristics

Description	One may select from a list of a built-in library of standard waveforms. The waveforms are computed every time a waveform is selected. The integrity of the waveform and its upper frequency limit depend on the programmed frequency value and the number of waveform points that are used for computing one cycle interval
Frequency Range	
Sine, Square	1 mHz to 100 MHz
All other waveforms	1 mHz to 16 MHz
Frequency Resolution	11 digits
Accuracy & Stability	Same as frequency reference

Sine

Start Phase Range	0-360.0°
Start Phase Resolution	0.01°

Sine Wave Performance

THD	0.15% to 100 kHz, STD and CW
Harmonics and Spurious at less than 3 Vp-p	28dBc, <100 MHz 35dBc, <50 MHz 48dBc, <10 MHz 55dBc, <1 MHz
Harmonics and Spurious at less than 5 Vp-p	25dBc, <100 MHz 30dBc, <50 MHz 43dBc, <10 MHz 45dBc, <1 MHz
Harmonics & Spurious at less than 10 Vp-p	22dBc, <100 MHz 25dBc, <50 MHz 35dBc, <10 MHz 37dBc, <1 MHz
Flatness at less than 5 Vp-p	5% to 10 MHz 10% to 100 MHz

Triangle

Start Phase Range	0-360.0°

Start Phase Resolution	0.01°
Square	
Duty Cycle Range	0% to 99.9%
Pulse	
Delay, Rise/Fall Time, High Time Ranges	0%-99.99% of period (each independently)
Ramp	
Delay, Rise/Fall Time, High Time Ranges	0%-99.9% of period (each independently)
Gaussian Pulse	
Time Constant Range	10-200
Sinc Pulse	
"Zero Crossings" Range	4-100
Exponential Pulse	
Time Constant Range	-100 to 100
DC Output Function	
Range	-5 V to +5 V

Arbitrary Waveforms Generator Characteristics

Description	Arbitrary Waveforms are created on a remote computer and downloaded to the instrument through one of the available remote interfaces. The frequency of the waveform is calculated from its programmed sample clock value and the number of waveform points that were used for creating the waveform
Sample Clock Range	
Continuous Run Mode	1 S/s to 250 MS/s (300 MS/s, typically at 25°C)
All Other Run Modes	1 S/s to 225 MS/s (240 MS/s, typically at 25°C)
Resolution	14 digits
Accuracy and Stability	Same as reference
Vertical Resolution	20 bits (65,536 amplitude increments)
Waveform Segmentation	Permits division of the waveform memory into smaller segments.
Number of Memory Segments	1 to 10 k
Waveform Segments, size and resolution	4 points size increments from 16 to 2 M points
Custom Waveform Creation Software	ArbConnection software allows instrument control and creation of custom waveforms

Sequenced Waveforms Generator Characteristics

Description	Segments may be linked and repeated in a user-selectable order. Segments are advanced using either a command or a trigger
Sample Clock Range	
Continuous Run Mode	1 S/s to 250 MS/s (300 MS/s, typically at 25°C)
All Other Run Modes	1 S/s to 225 MS/s (240 MS/s, typically at 25°C)
Resolution	14 digits
Accuracy and Stability	Same as reference
Advance Modes	
Automatic Sequence Advance	No trigger required to step from one segment to the next. Sequence is repeated continuously per a pre-programmed sequence table.
Stepped Sequence Advance	Current segment is sampled continuously until a trigger advances the sequence to the next programmed segment and sample clock rate.

Single Sequence Advance	Current segment is sampled the specified number of repetitions and then idles at the end of the segment. Next trigger samples the next segment the specified repeat count, and so on.
Mixed Sequence Advance	Each step of a sequence can be programmed to advance either a) automatically (Automatic Sequence Advance), or b) with a trigger (Stepped Sequence Advance)
Sequencer Steps	1 to 4096
Segment Loops	1 to 1Meg
Minimum Segment Duration	600 ns
Minimum Segment Size in a Sequence	16 points
Multi Sequence	1 to 10, selectable
Custom Sequence Creation Software	ArbConnection software allows instrument control and creation of custom sequences. Sequences are built as tables and downloaded to the instrument

Modulated Waveforms Generator Characteristics

General

Description	Using this mode of operation, one may select from a list of built-in modulation schemes.
Carrier Waveform (CW)	Sinewave
Modulation Source	Internal
Run Modes	Off (outputs CW), Continuous, Triggered, Delayed Trigger, Re-trigger, Burst and Gated
Interrupted Modulation Carrier Idle Mode	On or Off, programmable
Run Mode Advance Source	Front panel TRIG IN, Software commands
Trigger Delay (Trigger input to modulation output)	[(0; 200 ns to 20 s) + system delay]
Resolution	20 ns
Error	6 sample clock cycles + 150 ns + 5% of setting
Re-trigger Delay (Modulation end to modulation restart)	200 ns to 20 s
Resolution	20 ns
Error	3 sample clock cycles + 20 ns + 5% of setting
Trigger Parameters	All trigger parameters such as level, slope, jitter, etc. apply

Marker Output

Description	Marks the crossing of a specific frequency and step setting. The marker pulse is generated through the SYNC connector. Marker placement is available for all modulation modes except AM
Level	TTL into open circuit
Marker Type	Single pulse at the specified frequency
Position	Programmable for a specific frequency setting

Sweep

Swept Waveform	Sine wave
Sweep Step	Linear or log
Sweep Direction	Up or Down
Sweep Range	10 Hz to 100 MHz
Sweep Time	1.4 μs to 40 s

FM

Modulated Waveform	Sine wave
Modulating Waveforms	Sine, square, triangle, Ramp
Carrier Frequency Range	10 Hz to 100 MHz

Modulating Frequency Range	10 mHz to 100 kHz
Peak Deviation	Up to 50 MHz

ARBITRARY FM

Description	Operated from an external utility only such as ArbConnection. The modulating waveform can be designed as an arbitrary waveform
Modulated Waveform	Sine wave
Carrier Frequency Range	10 Hz to 100 MHz
Modulating Waveform	Arbitrary waveform
Modulating Waveform Sampling Clock	1 S/s to 2.5 MS/s
Number of frequencies	2 to 10,000

AM

Modulated Waveform	Sine wave
Carrier Frequency Range	10 Hz to 100 MHz
Envelop Waveform	Sine, square, triangle, Ramp
Envelop Frequency	10 mHz to 100 kHz
Modulation Depth	0% to 100%

FREQUENCY HOPS

Hopped Waveform	Sine wave
Hop Frequency Range	10 Hz to 100 MHz
Resolution	11 digits
Hop Table Size	2 to 1000
Dwell Time Mode	Fixed or Programmable for each step
Dwell Time	200 ns to 20 s
Dwell Time Resolution	20 ns

FSK

Shifted Waveform	Sine wave
Carrier/Shifted Frequency Range	10 Hz to 100 MHz
Baud Range	1 bit/sec to 10 Mbits/sec
FSK Data Bits Length	2 to 4000

PSK

Shifted Waveform	Sine wave
Carrier Frequency Range	10 Hz to 100 MHz
Phase Shift Range	0° to 360°
Baud Range	1 bits/sec to 10 Mbits/sec
PSK Data Bits Length	2 to 4000

ASK

Shifted Waveform	Sine wave
Carrier Frequency Range	10 Hz to 100 MHz
Amplitude Shift Range	0 V to 10 Vp-p
Resolution Maximum amplitude/4096	
Baud Range	1bits/sec to 10 Mbits/sec
ASK Data Bits Length	2 to 4000

3D

Operation	Operated from an external utility only such as ArbConnection, the carrier waveform can be programmed to freely sweep in three dimensions: amplitude, frequency and phase.
Modulated Waveform	Sine

Carrier Frequency Range	10 Hz to 100 MHz
Modulating Sampling Clock	1 S/s to 2.5 MS/s
Number of profile indexes	2 to 30000

Pulse Generator Waveforms Characteristics

Operation	The 5251 has a special mode where the instrument type is transformed to operate as a digital pulse generator. When this mode is selected, the operation of the arbitrary waveform and its outputs are disabled and possibly, arbitrary waveforms are overwritten
Programmability	1. All pulse parameters, except rise and fall times, may be freely programmed within the selected pulse period provided that the ratio between the period and the smallest incremental unit does not exceed the ratio of 1,000,000 to 1. With the 2M option, the ratio is extended to 2,000,000 to 1, hence the specifications below do not show maximum limit as each must be computed from the above relationship. 2. Rise and fall times, may be freely programmed provided that the ratio between the rise/fall time and the smallest incremental unit does not exceed the ratio of 100,000 to 1. 3. The sum of all pulse parameters must not exceed the pulse period setting
Pulse State	On or Off. On generates pulse output; Off generates 0 Vdc
Pulse Mode	Single or double, programmable
Polarity	Normal, inverted or complemented
Period	80 ns minimum, programmed with 4 ns increments
Delay	0 ns min; 1e6 s max (2e6 s max with option 1)
Pulse Width	4 ns minimum; 1e3 s max
Double Pulse Delay	0 ns minimum; 1e3 s max
Rise/Fall Times	0 ns minimum; 1e3 s max (actual min = <5 ns)
High Time	0 ns minimum
Amplitude Window	10 mVp-p to 10 Vp-p
Low Level	-5 V to +4.950 V
High Level	-4.950 V to +5 V

Half-Cycle Waveforms Generator Characteristics

Description	Half Cycle waveforms are the same as the standard functions except waveforms are generated as a sequence of half cycles. The delay between the half cycles is programmable
Function Shape	Sine, Triangle, Square
Frequency Range	0.01 Hz to 1 MHz
Phase Start Range	0° to 360.0° (Sine and triangle only)
Start Phase Resolution	0.1°
Duty Cycle Range	0% to 99.99% (Square only)
Duty Cycle Resolution	0.1%
Run Modes	Continuous, Triggered
Delay Between Half Cycles	200 ns to 20 s (Applies to continuous run mode only)
Resolution	20 ns

Counter/Timer Characteristics

Operation	The 5251 has a special mode where the instrument type is transformed to operate as a counter/timer. When this mode is selected, the operation of the arbitrary waveform and its outputs are disabled
Measurement Functions	Frequency, Period, Period Averaged, Pulse Width and Totalize

Frequency, Period Averaged

Frequency Range	20 Hz to 100 MHz (typically >120 MHz)
Period Averaged Range	10 ns to 50 ms
Resolution	7 digits in one second of gate time, reduced proportionally with lower gate times

Period, Pulse Width

Range	500 ns to 50 ms
Resolution	100 ns

Totalize

Frequency Range	20 Hz to 100 MHz
Accumulation Range	10^{12}-1

General

Input	Front panel TRIG IN, BNC connector
Trigger Level Range	±5 V
Sensitivity	500 mVp-p
Damage Level	±12 V
Minimum Pulse Width	≥10 ns
Slope	Positive/Negative transitions, selectable
Gate Time 100 µs to 1 s	
Reading Modes	
Repetitive	Continuous measurements are executed when signal is present at the input
Hold	Single measurement is executed upon command
Gated	Active in Gated Totalize mode only
Time Base	
Type	TCXO
Temperature Stability	1 ppm, 0°C - 40°C
Long Term Stability	1 ppm, 1 year

General

Power Requirements	22 W maximum
Current Consumption	+5 V - 185 mA +12 V - 900 mA +3.3 V - 2.6 A
EMC Certification	CE marked
Operating temperature	0 °C - 40 °C
Safety	Designed to meet IEC 61010-1, UL 3111-1, CSA 22.2 #1010
Workmanship Standards	Conform to IPC-A-610D