396/397
Waveform Generators

Getting Started

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Introduction

This Getting Started Manual provides an overall description of the Model 396 Arbitrary Waveform Generator, the Model 397 Waveform Generator, and the applicable Safety Information. It also contains descriptions of the various options available for each Model.

The descriptions throughout this manual apply to both Models 396 and 397 unless specifically noted in the description as 396 or 397. Otherwise the descriptions refer to both products collectively as the Instrument.

Description

The 396 is a single-channel Arbitrary Waveform Generator, and the 397 is a dual-channel Waveform Generator. Both are high performance waveform generators that combine many functions and features in one small but powerful package. The ArbExplorer software supplied with the Generator is used for controlling the Instrument and generating, editing and downloading waveforms from a remote computer. The following highlights the Instrument and the ArbExplorer features.

Feature Highlights

- **397** - Dual output configuration with independent waveform control
- **397** - Tight phase offset control between channels (1 point resolution)
- 14-bit vertical resolution
- Nearly 19-bit offset resolution
- **396** - 1 Meg memory depth
- **397** - 4 Meg memory depth for each channel
- Ultra fast waveform downloads using DMA
- 125 MS/s sample clock frequency
- **396** -100 MHz REAR-PANEL sinewave output
- **397** - 125 MHz REAR-PANEL sinewave output
- 1 ppm clock stability
- Extremely low phase noise carrier
- External amplitude modulation
- Frequency agility: FSK, ramped FSK, sweep, FM
- Trigger start phase control and breakpoints
- Built-in standard waveforms
- **396** - Sequence generator
- **397** – Separate sequence generators for each channel
- Multiple instrument synchronization with tight phase control
- **396** - GPIB and RS232 Interfaces
- **397** - GPIB, USB, and Ethernet Interfaces

ArbExplorer Feature Highlights

- **396** - Three powerful tools in one software package: complete Instrument control panel, Waveform composer and FM signal composer
- **397** - Four powerful tools in one software package: complete Instrument control panel, Waveform, pulse, and FM signal composer
- **397** - Detailed virtual front panels control all of the Instrument's functions and modes
- Wave composer generates, edits and downloads complex waveforms
- FM wave composer generates and downloads complex modulating signals
- **397** - Easy, onscreen generation of complex pulses using the pulse composer.
- **396** - 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

Features, Functions, and Options

The following is a general description of the features, functions, and options available with the Instrument.

Output Channels

The 396 is a single channel arbitrary waveform generator.

The 397 is a dual-channel waveform generator. Although the two channels share a single sample clock source, each channel can be controlled separately to generate different waveform, amplitude and waveforms sequence. Having a single sample clock source is an advantage in a dual-channel configuration because it allows tight control over inter-channel synchronization and leading edge start phase where the initial skew between the two channels is just a few nanoseconds.

Output Functions

The Instrument 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 is programmed with 7 digits on the 396 and 9 digits on the 397. Frequency accuracy of the output waveform is determined by the clock reference. The internal reference oscillator provides 1 ppm accuracy and stability over time and temperature. If higher accuracy and/or stability are required, you may connect an external frequency reference to the rear-panel reference input connector.

Amplitude

The output level of the Instrument may be programmed from 20mV to 20Vp-p into high impedance, or 10mV to 10V into 50 Ω. 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. A special fine offset generator is built into each channel, which allows programming of extremely small offset increments. This feature extends the offset resolution to 6 digits and is very useful in applications such as mixer balancing where few micro-volts could sway the balance either way.

Trigger Modes

Besides its normal continuous mode, the Instrument responds to a variety of trigger sources. The output waveform may be gated, triggered, or generate a counted burst of waveforms. A built-in trigger generator, having a programmable period can be used as a replacement of an external trigger source. The internal trigger generator can be programmed with resolution of 7 digits.

Arbitrary Waveforms

The Instrument generates arbitrary waveforms with 14 bits of vertical resolution. Any waveform it generates must first be downloaded to waveform memory. The arbitrary waveform memory is a bank of 14-bit words. Each word represents a point on the horizontal waveform scale. Each word has a horizontal address that can range from 0 to 1,048,576 for the 396 (0 to 4,191,280 for the 397) and a vertical address that can range from -8192 to +8191 (14 bits). Using a high speed clocking circuit, the digital contents of the arbitrary waveform memory are 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 complete memory every time an arbitrary waveform is generated. Waveform memory can be divided into up to 4096 smaller segments and different waveforms can be loaded into each 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 4096 segments for the 396 (2048 for the 397), while each segment can loop up to 1 million 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 Instrument, the first being low-level programming of each individual parameter using SCPI commands. The second alternative is to use ArbExplorer for high-level programming. ArbExplorer is a software package supplied with the Instrument that simulates a set of mechanical front panels. 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 LabVIEW or IVI.

The Instrument 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 fully in the Users Manual.

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 instrument. Having such an enormous range opens the door for a wide range of applications such as wide band sweep, FSK and frequency modulation. The Instrument can generate FSK, Ramped FSK and Linear or Logarithmic sweep. The Instrument can also frequency modulate its carrier using one of its built-in waveforms, or with any user-defined modulating signal, which can be downloaded using the FM wave composer.

Multi-Instrument Synchronization

There are applications requiring multiple of synchronized channels. Synchronization between completely independent, free-running units is complex. Besides distribution of the sample clock to all units, each unit has to be told when to start generating waveforms so that all start at the same point and with the same phase. Triggering multiple units to achieve synchronization is not enough because it will generate a jitter of ±1 count. Multi-unit synchronization is built into the Instrument, where special connectors and cables were designed to eliminate jitter and to provide start phase control. There is no limit to the number of units that can be daisy-chained, multiple unit synchronization is built into each Instrument.

Safety Considerations

The Instrument has been manufactured according to international safety standards. The Instrument meets EN61010, VDE 0411/03.81 and UL 1244 standards for safety of commercial electronic measuring and test equipment for instruments with an exposed metal chassis that is directly connected to earth via the chassis power supply cable.

⚠Warning

To avoid personal injury from electrical shock and fire hazards, carefully read and follow the WARNINGS given in the following paragraphs.

- **Do not remove covers form the Instrument when operating it or when the power cord is connected to line power.**
- **Do not operate the unit with power applied and protective covers removed unless you are qualified to service the product.**
- **If you are qualified to service the product, read all of the calibration and maintenance procedures and heed all warnings to avoid “live” circuits points.**

If the Instrument exhibits any of the following conditions do not operate the Instrument:

- **Fails to operate satisfactorily**
- **Shows visible damage**
- **Has been stored under unfavorable conditions**
- **Has sustained stress**

Before operating the Instrument check the following:

- **Instrument performance has been verified by qualified personnel.**
- **The common connector on the power cord is connected to the neutral connection (ground) of the power outlet.**

- **The proper power cord is connected to the unit. Do not use a two-conductor extension cord or a three-prong to two-prong adapter. This will defeat the protective feature of the third conductor in the power cord.**
- **The instrument is configured to operate on the voltage at the power source. See Installation Section.**
- **The proper fuse is in place for the power source to operate. The correct fuse to use is: Littelfuse, Cat.No. 218500; T, 250VAC, 0.5A.**
- **All other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.**

Supplied Accessories

The Instrument is supplied with this Getting Started Manual, a disk containing the Getting Started Manual and the Users Manual, and a disk containing a Windows® version of the ArbExplorer software.

Specifications

The Instrument specifications are listed in Appendix A of the Users Manual. These specifications are the performance standards or limits against which the instrument is tested.